MOTOROLA

LM117L
LM217L
LM317L

T-58-11-23

Specifications and Applications Information

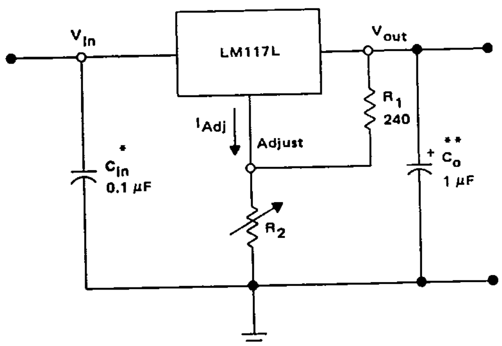
THREE-TERMINAL ADJUSTABLE OUTPUT POSITIVE VOLTAGE REGULATORS

The LM117L/217L/317L are adjustable 3-terminal positive voltage regulators capable of supplying in excess of 100 mA over an output voltage range of 1.2 V to 37 V. These voltage regulators are exceptionally easy to use and require only two external resistors to set the output voltage. Further, they employ internal current limiting, thermal shutdown and safe area compensation, making them essentially blow-out proof.

The LM117L series 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 LM117L series can be used as a precision current regulator.

- Output Current in Excess of 100 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
- Standard 3-Lead Transistor Packages
- Eliminates Stocking Many Fixed Voltages

STANDARD APPLICATION



* = 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.

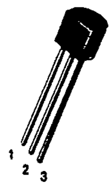
$$V_{out} = 1.25\ V\ (1 + \frac{R_2}{R_1}) + I_{Adj}\ R_2$$

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

LOW-CURRENT THREE-TERMINAL ADJUSTABLE POSITIVE VOLTAGE REGULATORS

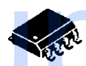
SILICON MONOLITHIC INTEGRATED CIRCUIT

Z SUFFIX
PLASTIC PACKAGE
CASE 29-04
(LM317 only)

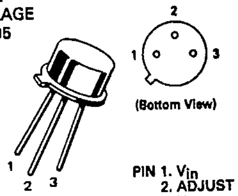


PIN 1. ADJUST
2. V_{out}
3. V_{in}

D SUFFIX
PLASTIC PACKAGE
CASE 751-03
(SOP-8)



H SUFFIX
METAL PACKAGE
CASE 79-05



PIN 1. V_{in}
2. ADJUST
3. V_{out}

CASE IS OUTPUT

ORDERING INFORMATION

Device	Tested Operating Temperature Range	Package
LM117LH	T_J = −55°C to +150°C	Metal Can
LM217LH	T_J = −25°C to +150°C	Metal Can
LM317LH	T_J = 0°C to +125°C	Metal Can
LM317LZ		Plastic

LM117L, LM217L, LM317L

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MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Input-Output Voltage Differential	V_I-V_O	40	Vdc
Power Dissipation	P_D	Internally Limited	
Operating Junction Temperature Range LM117L LM217L LM317L	T_J	−55 to +150 −25 to +150 0 to +150	°C
Storage Temperature Range	T_{stg}	-65 to +150	°C

ELECTRICAL CHARACTERISTICS

($V_I - V_O$ = 5.0 V; I_O = 40 mA; T_J = T_{low} to T_{high} [see Note 1]; I_{max} and P_{max} per Note 2; unless otherwise specified.)

Characteristic	Figure	Symbol	LM117L/217L Min	LM117L/217L Typ	LM117L/217L Max	LM317L Min	LM317L Typ	LM317L Max	Unit
Line Regulation (Note 3) T_A = 25°C, 3.0 V ≤ V_I-V_O ≤ 40 V	1	Reg_{line}	—	0.01	0.02	—	0.01	0.04	%/V
Load Regulation (Note 3), T_A = 25°C 5.0 mA ≤ I_O ≤ I_{max} — LM117L/217L 10 mA ≤ I_O ≤ I_{max} — LM317L V_O ≤ 5.0 V V_O ≥ 5.0 V	2	Reg_{load}	— —	5.0 0.1	15 0.3	— —	5.0 0.1	25 0.5	mV % V_O
Adjustment Pin Current	3	I_{Adj}	—	50	100	—	50	100	µA
Adjustment Pin Current Change 2.5 V ≤ V_I-V_O ≤ 40 V, P_D ≤ P_{max} 5.0 mA ≤ I_O ≤ I_{max} — LM117L/217L 10 mA ≤ I_O ≤ I_{max} — LM317L	1,2	ΔI_{Adj}	—	0.2	5.0	—	0.2	5.0	µA
Reference Voltage (Note 4) 3.0 V ≤ V_I-V_O ≤ 40 V, P_D ≤ P_{max} 5.0 mA ≤ I_O ≤ I_{max} — LM117L/217L 10 mA ≤ I_O ≤ I_{max} — LM317L	3	V_{ref}	1.20	1.25	1.30	1.20	1.25	1.30	V
Line Regulation (Note 3) 3.0 V ≤ V_I-V_O ≤ 40 V	1	Reg_{line}	—	0.02	0.05	—	0.02	0.07	%/V
Load Regulation (Note 3) 5.0 mA ≤ I_O ≤ I_{max} — LM117L/217L 10 mA ≤ I_O ≤ I_{max} — LM317L V_O ≤ 5.0 V V_O ≥ 5.0 V	2	Reg_{load}	— —	20 0.3	50 1.0	— —	20 0.3	70 1.5	mV % V_O
Temperature Stability (T_{low} ≤ T_J ≤ T_{high})	3	T_S	—	0.7	—	—	0.7	—	% V_O
Minimum Load Current to Maintain Regulation (V_I-V_O = 40 V)	3	I_{Lmin}	—	3.5	5.0	—	3.5	10	mA
Maximum Output Current V_I-V_O ≤ 20 V, P_D ≤ P_{max}, H Package V_I-V_O ≤ 6.25 V, P_D ≤ P_{max}, Z Package V_I-V_O = 40 V, P_D ≤ P_{max}, T_A = 25°C H Package Z Package	3	I_{max}	100 100 — —	200 200 50 20	— — — —	100 100 — —	200 200 50 20	— — — —	mA
RMS Noise, % of V_O T_A = 25°C, 10 Hz ≤ f ≤ 10 kHz	—	N	—	0.003	—	—	0.003	—	% V_O
Ripple Rejection (Note 5) V_O = 1.25 V, f = 120 Hz C_{ADJ} = 10 µF V_O = 10.0 V	4	RR	66 —	80 80	— —	60 —	80 80	— —	dB
Long Term Stability, T_J = T_{high} (Note 6) T_A = 25°C for Endpoint Measurements	3	S	—	0.3	1.0	—	0.3	1.0	%/1.0 k Hrs.
Thermal Resistance Junction to Case H Package Z Package	—	$R_{\theta JC}$	— —	40 —	— —	— —	40 83	— —	°C/W
Thermal Resistance Junction to Air H Package Z Package	—	$R_{\theta JA}$	— —	185 —	— —	— —	185 160	— —	°C/W

NOTES:

(1) T_{low} = -55°C for LM117L; -25°C for LM217L; 0°C for LM317L. T_{high} = +150°C for LM117L; = +150°C for LM217L; = +125°C for LM317L

(2) I_{max} = 100 mA; P_{max} = 2 W for H Package; = 625 mW for Z Package

(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) Selected devices with tightened tolerance reference voltage available.

(5) C_{ADJ}, when used, is connected between the adjustment pin and ground.

(6) 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.

LM117L, LM217L, LM317L

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SCHEMATIC DIAGRAM

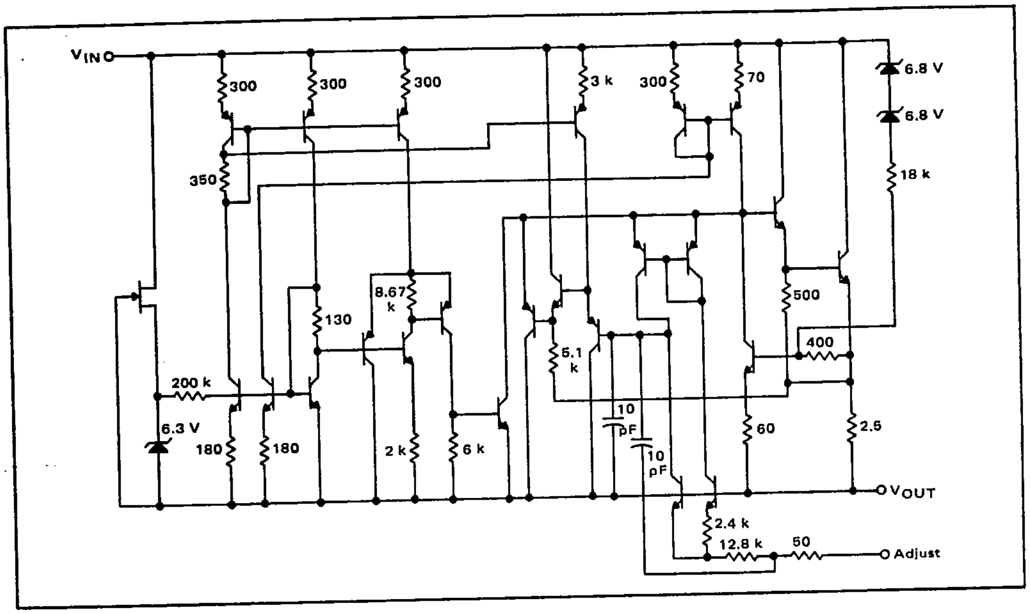

FIGURE 1 – LINE REGULATION AND ΔI_{Adj}/LINE TEST CIRCUIT

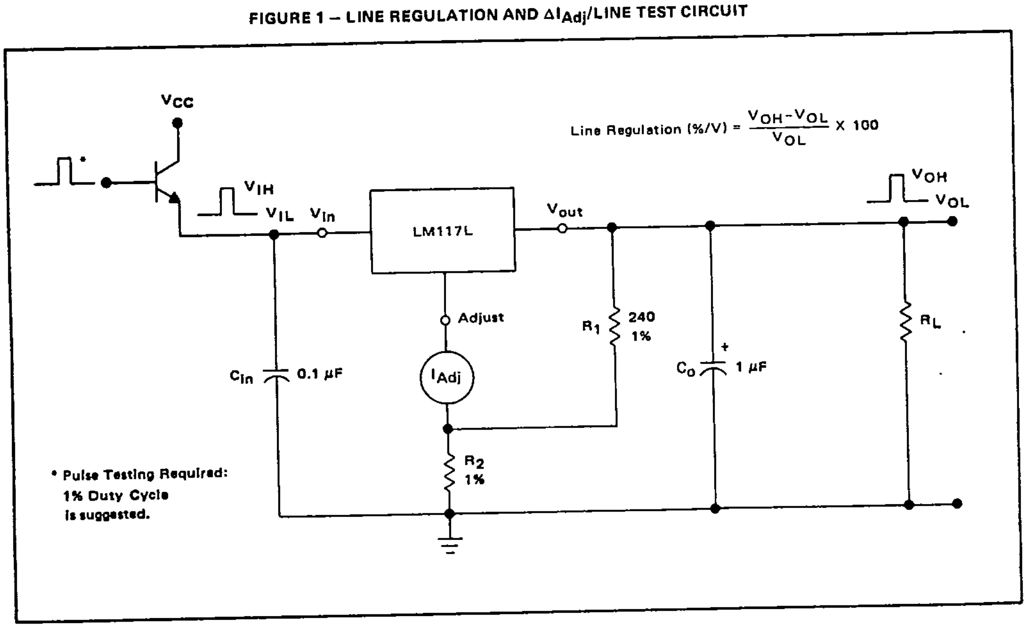

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FIGURE 2 — LOAD REGULATION AND ΔI_{Adj}/LOAD TEST CIRCUIT

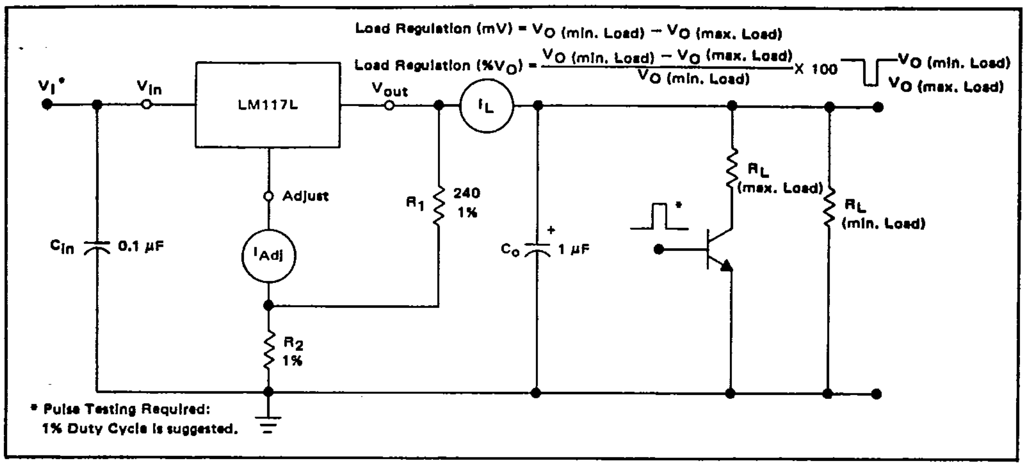

FIGURE 3 — STANDARD TEST CIRCUIT

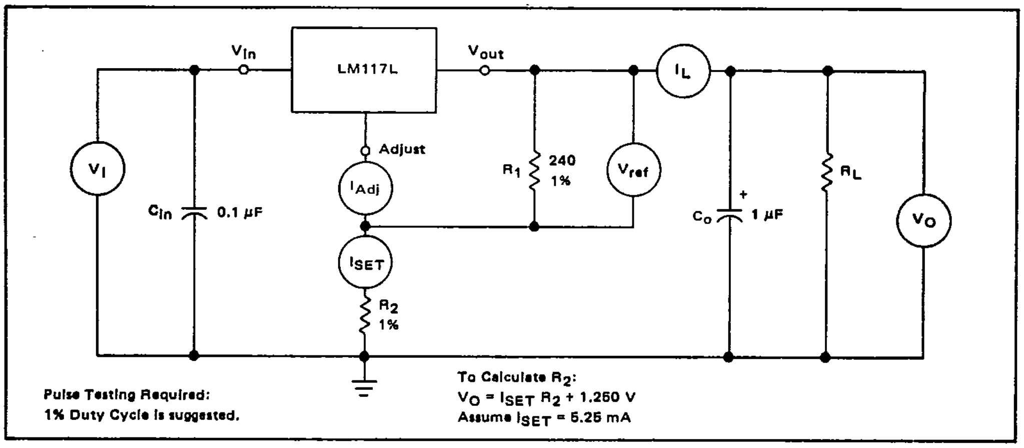

FIGURE 4 — RIPPLE REJECTION TEST CIRCUIT

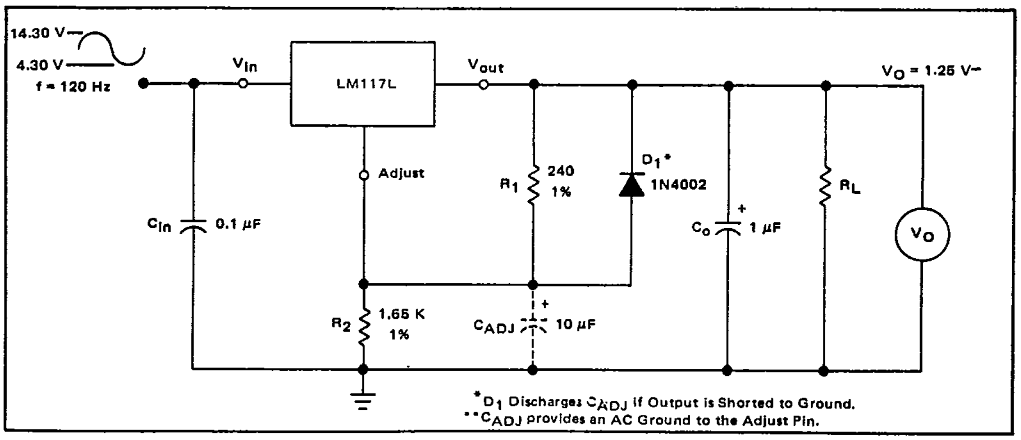

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FIGURE 5 — LOAD REGULATION

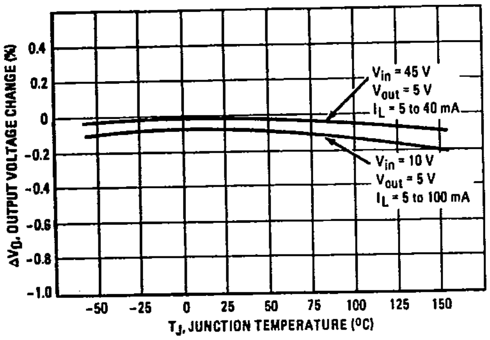


FIGURE 6 — RIPPLE REJECTION

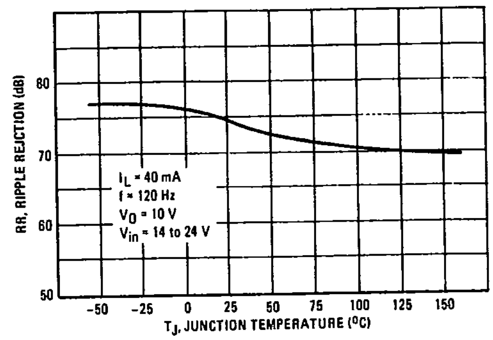


FIGURE 7 — CURRENT LIMIT

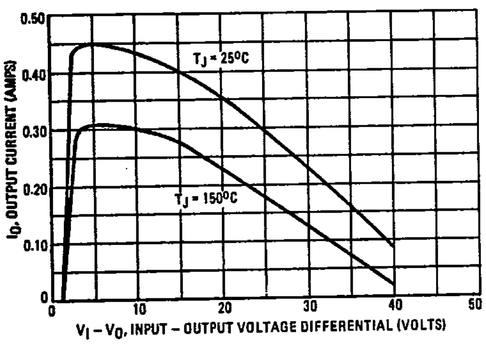


FIGURE 8 — DROPOUT VOLTAGE

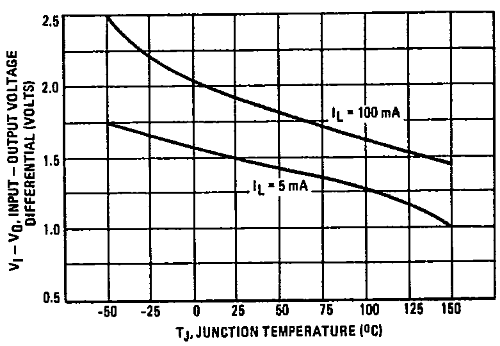


FIGURE 9 — MINIMUM OPERATING CURRENT

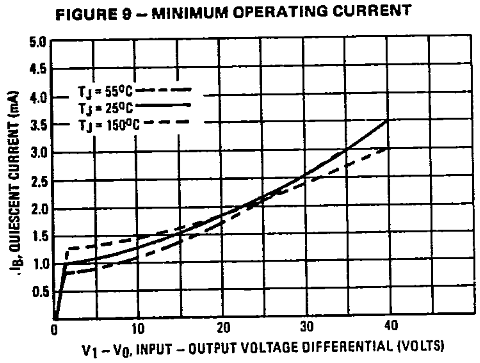


FIGURE 10 — RIPPLE REJECTION versus FREQUENCY

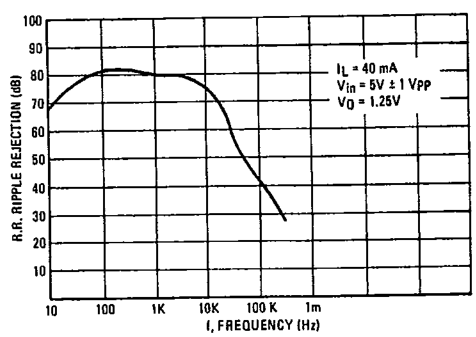


FIGURE 11 — TEMPERATURE STABILITY

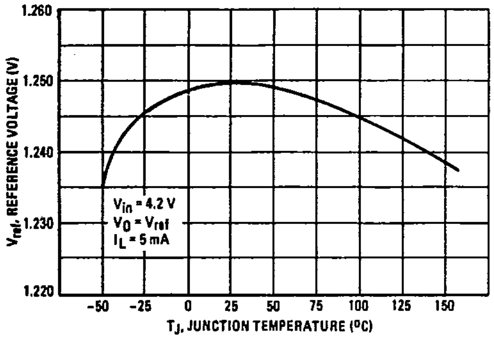


FIGURE 12 — ADJUSTMENT PIN CURRENT

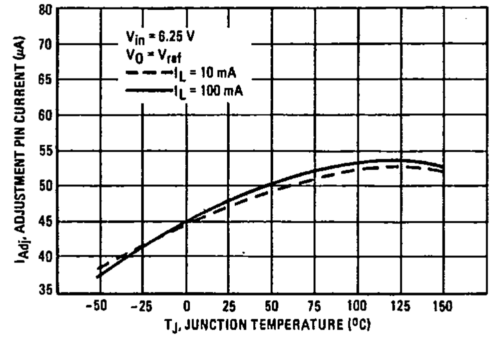


FIGURE 13 — LINE REGULATION

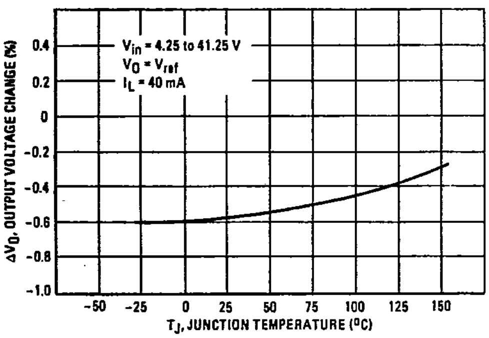


FIGURE 14 — OUTPUT NOISE

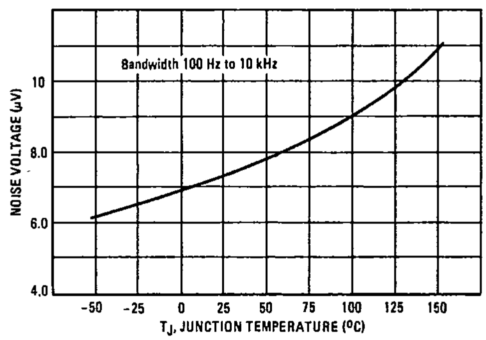


FIGURE 15 — LINE TRANSIENT RESPONSE

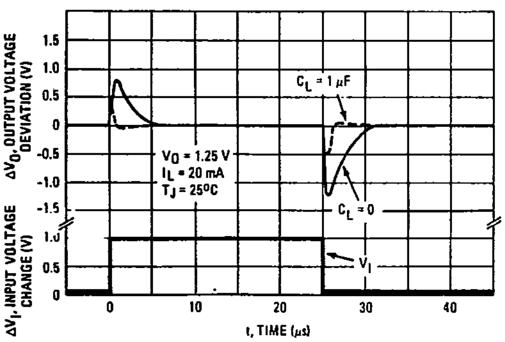
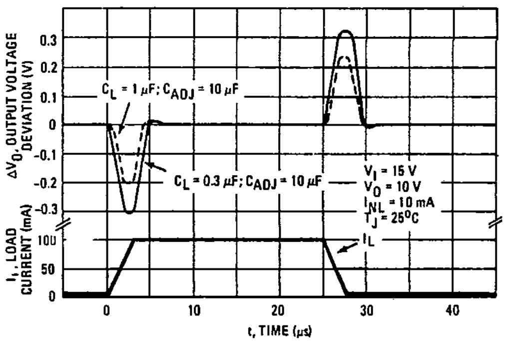


FIGURE 16 — LOAD TRANSIENT RESPONSE



APPLICATIONS INFORMATION

BASIC CIRCUIT OPERATION

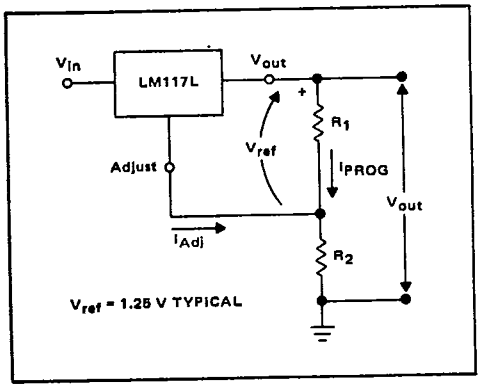
The LM117L is a 3-terminal floating regulator. In operation, the LM117L develops and maintains a nominal 1.25 volt reference (V_{ref}) between its output and adjustment terminals. This reference voltage is converted to a programming current (I_{PROG}) by R1 (see Figure 13), and this constant current flows through R2 to ground. The regulated output voltage is given by:

$$V_{out} = V_{ref}\left(1 + \frac{R2}{R1}\right) + I_{Adj}\,R2$$

Since the current from the adjustment terminal (I_{Adj}) represents an error term in the equation, the LM117L 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 LM117L 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



LOAD REGULATION

The LM117L 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 CAPACITORS

A 0.1 µF disc or 1 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 15dB at 120 Hz in a 10 volt application.

Although the LM117L 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 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 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 14 shows the LM117L with the recommended protection diodes for output voltages in excess of 25 V or high capacitance values ($C_o > 10$ µF, $C_{ADJ} > 5$ µF). Diode D_1 prevents C_o from discharging thru the I.C. during an input short circuit. Diode D_2 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.

FIGURE 18 – VOLTAGE REGULATOR WITH PROTECTION DIODES

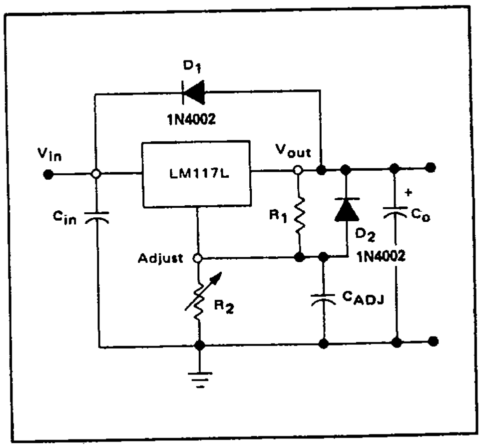


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FIGURE 19 — ADJUSTABLE CURRENT LIMITER

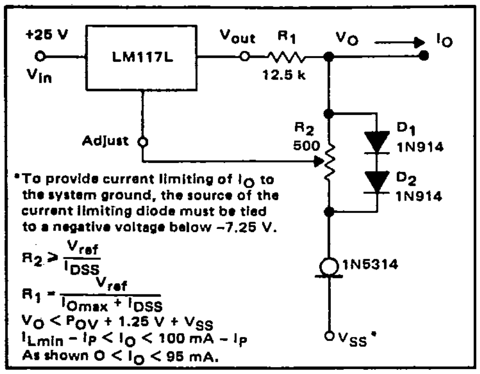


FIGURE 20 — 5 V ELECTRONIC SHUTDOWN REGULATOR

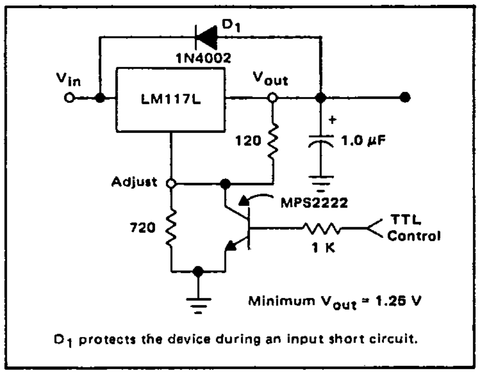


FIGURE 21 — SLOW TURN-ON REGULATOR

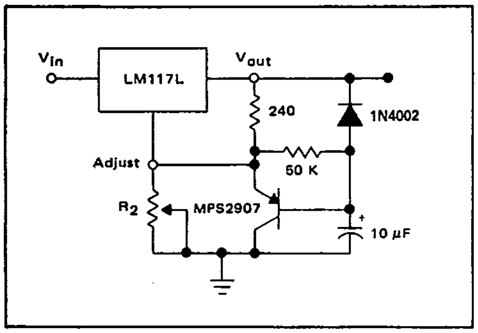
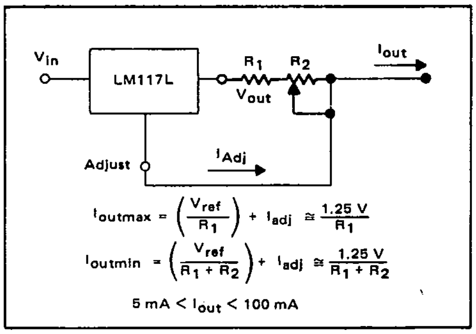


FIGURE 22 — CURRENT REGULATOR



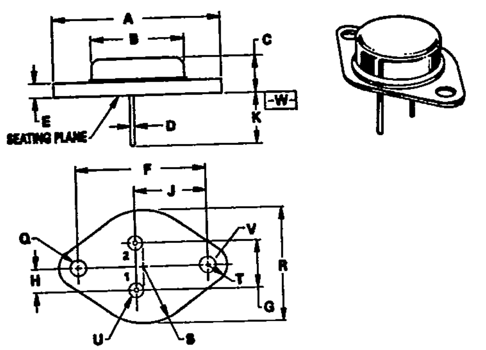
SECTION 19

PACKAGE OUTLINE DIMENSIONS

K SUFFIX
METAL PACKAGE
CASE 1-03
$R_{\theta JA}$ = 45°C/W (TYP)
(TO-3)

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
B	—	22.23	—	0.875
C	6.35	11.43	0.250	0.450
D	0.97	1.09	0.038	0.043
E	—	3.43	—	0.135
F	30.15 BSC		1.187 BSC	
G	10.92 BSC		0.430 BSC	
H	5.46 BSC		0.215 BSC	
J	16.89 BSC		0.665 BSC	
K	7.92	—	0.312	—
Q	3.84	4.09	0.151	0.161
S	—	13.34	—	0.525
T	—	4.78	—	0.188
V	3.84	4.09	0.151	0.161

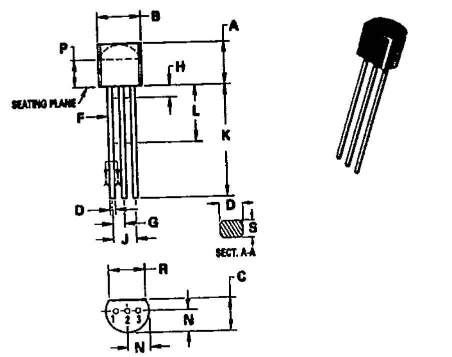
NOTES:
1. DIAMETER V AND SURFACE W ARE DATUMS.
2. POSITIONAL TOLERANCE FOR HOLE Q:
   ⌖ | φ 0.25 (0.010) Ⓜ | W | V Ⓜ
3. POSITIONAL TOLERANCE FOR LEADS:
   ⌖ | φ 0.30 (0.012) Ⓜ | W | V Ⓜ | Q Ⓜ



LP, P, Z SUFFIX
PLASTIC PACKAGE
CASE 29-04
$R_{\theta JA}$ = 200°C/W (TYP)
(TO-226AA/TO-92)

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	4.32	5.33	0.170	0.210
B	4.45	5.20	0.175	0.205
C	3.18	4.19	0.125	0.165
D	0.41	0.55	0.016	0.022
F	0.41	0.48	0.016	0.019
G	1.15	1.39	0.045	0.055
H	—	2.54	—	0.100
J	2.42	2.66	0.095	0.105
K	12.70	—	0.500	—
L	6.35	—	0.250	—
N	2.04	2.66	0.080	0.105
P	2.93	—	0.115	—
R	3.43	—	0.135	—
S	0.39	0.50	0.015	0.020

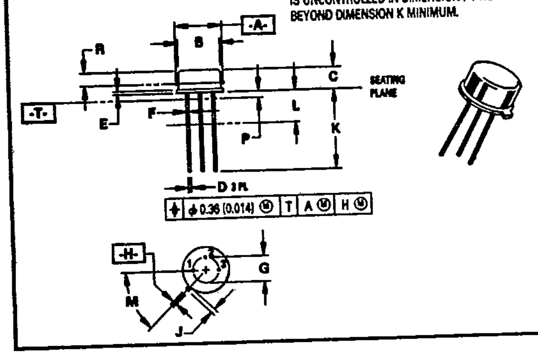
NOTES:
1. CONTOUR OF PACKAGE BEYOND ZONE "P" IS UNCONTROLLED.
2. DIM "F" APPLIES BETWEEN "H" AND "L". DIM "D" & "S" APPLIES BETWEEN "L" & 12.70mm (0.5") FROM SEATING PLANE. LEAD DIM IS UNCONTROLLED IN "H" & BEYOND 12.70mm (0.5") FROM SEATING PLANE.
3. CONTROLLING DIM: INCH.



G, H SUFFIX
METAL PACKAGE
CASE 79-05
$R_{\theta JA}$ = 185°C/W (TYP)
(TO-39)

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.02	9.29	0.355	0.366
B	8.01	8.50	0.315	0.335
C	4.20	4.57	0.165	0.180
D	0.44	0.53	0.017	0.021
E	0.44	0.88	0.017	0.035
F	0.41	0.48	0.016	0.019
G	5.08 BSC		0.200 BSC	
H	0.72	0.86	0.028	0.034
J	0.74	1.01	0.029	0.040
K	12.70	19.05	0.500	0.750
L	6.35	—	0.250	—
M	45° BSC		45° BSC	
P	—	1.27	—	0.050
R	2.54	—	0.100	—

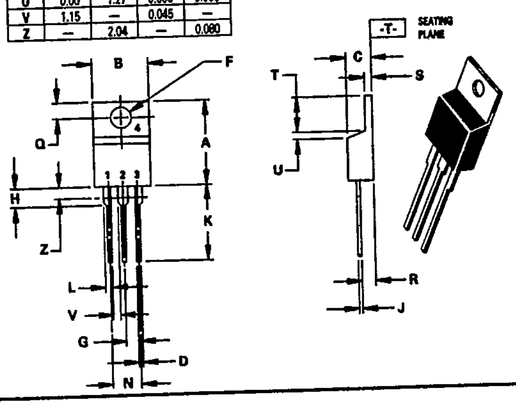
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION J MEASURED FROM DIMENSION A MAXIMUM.
4. DIMENSION B SHALL NOT VARY MORE THAN 0.25 (0.010) IN ZONE R. THIS ZONE CONTROLLED FOR AUTOMATIC HANDLING.
5. DIMENSION F APPLIES BETWEEN DIMENSION P AND L. DIMENSION D APPLIES BETWEEN DIMENSION L AND K MINIMUM. LEAD DIAMETER IS UNCONTROLLED IN DIMENSION P AND BEYOND DIMENSION K MINIMUM.



KC, T SUFFIX
PLASTIC PACKAGE
CASE 221A-04
$R_{\theta JA}$ = 65°C/W (TYP)
(TO-220AB)

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	14.48	15.75	0.570	0.620
B	9.68	10.28	0.380	0.405
C	4.07	4.82	0.160	0.190
D	0.64	0.88	0.025	0.035
F	3.61	3.73	0.142	0.147
G	2.42	2.66	0.095	0.105
H	2.80	3.93	0.110	0.155
J	0.36	0.55	0.014	0.022
K	12.70	14.27	0.500	0.562
L	1.15	1.39	0.045	0.055
N	4.83	5.33	0.190	0.210
Q	2.54	3.04	0.100	0.120
R	2.04	2.79	0.080	0.110
S	1.15	1.39	0.045	0.055
T	5.97	6.47	0.235	0.255
U	0.00	1.27	0.000	0.050
V	1.15	—	0.045	—
Z	—	2.04	—	0.080

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

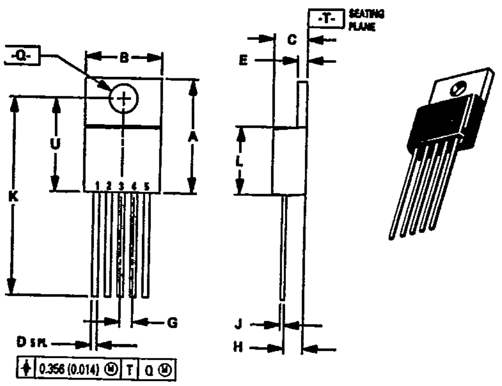


PACKAGE OUTLINE DIMENSIONS (continued)

T SUFFIX
PLASTIC PACKAGE
CASE 314D-02

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	14.529	15.570	0.572	0.613
B	9.908	10.541	0.390	0.415
C	4.318	4.572	0.170	0.180
D	0.635	0.965	0.025	0.038
E	1.169	1.397	0.046	0.055
G	1.702 BSC		0.067 BSC	
H	2.109	2.717	0.083	0.107
J	0.381	0.635	0.015	0.025
K	25.807	26.670	1.016	1.050
L	8.052	9.398	0.317	0.370
Q	3.556	3.937	0.140	0.155
U	11.889	12.827	0.468	0.505

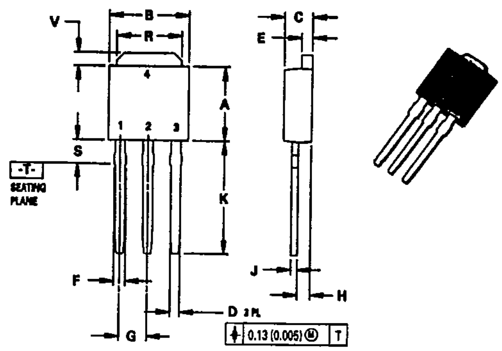
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.



DT-1 SUFFIX
PLASTIC PACKAGE
CASE 369-03

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.97	6.22	0.235	0.245
B	6.35	6.73	0.250	0.265
C	2.19	2.38	0.086	0.094
D	0.69	0.88	0.027	0.035
E	0.84	0.94	0.033	0.037
F	0.77	1.14	0.030	0.045
G	2.29 BSC		0.090 BSC	
H	0.97	1.06	0.038	0.042
J	0.46	0.58	0.018	0.023
K	8.89	9.65	0.350	0.380
R	5.21	5.46	0.205	0.215
S	1.91	2.28	0.075	0.090
V	0.89	1.27	0.035	0.050

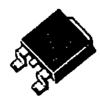
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.

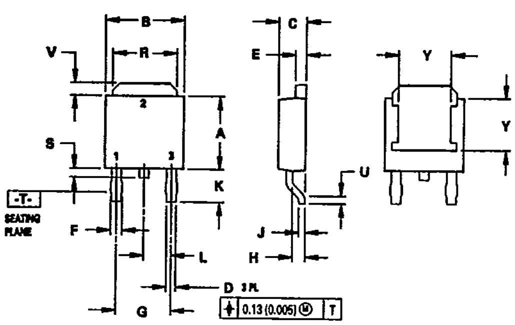


DT SUFFIX
PLASTIC PACKAGE
CASE 369A-03
DPAK

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	5.97	6.22	0.235	0.245
B	6.35	6.73	0.250	0.265
C	2.19	2.38	0.086	0.094
D	0.69	0.88	0.027	0.035
E	0.84	0.94	0.033	0.037
F	0.77	1.14	0.030	0.045
G	4.58 BSC		0.180 BSC	
H	0.97	1.06	0.038	0.042
J	0.46	0.58	0.018	0.023
K	2.60	2.89	0.102	0.114
L	2.29 BSC		0.090 BSC	
R	5.21	5.46	0.205	0.215
S	0.64	0.88	0.025	0.035
U	0.51	—	0.020	—
V	0.89	1.27	0.035	0.050
Y	4.32	—	0.170	—

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



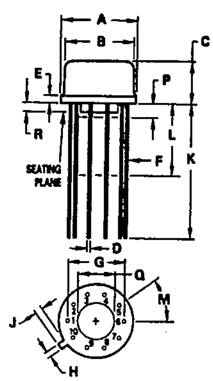


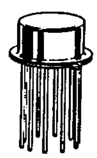
H, G SUFFIX
METAL PACKAGE
CASE 603-04
$R_{\theta JA}$ = 160°C/W
(TO-100)

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.51	0.305	0.335
C	4.19	4.70	0.165	0.185
D	0.407	0.533	0.016	0.021
E	—	1.02	—	0.040
F	0.406	0.483	0.016	0.019
G	5.84 BSC		0.230 BSC	
H	0.712	0.864	0.028	0.034
J	0.737	1.14	0.029	0.045
K	12.70	—	0.500	—
L	6.35	12.70	0.250	0.500
M	36° BSC		36° BSC	
P	—	1.27	—	0.050
Q	3.56	4.06	0.140	0.160
R	0.254	1.02	0.010	0.040

NOTE:
LEADS WITHIN 0.18 mm (0.007) RADIUS OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION.

All JEDEC Dimensions and Notes Apply.



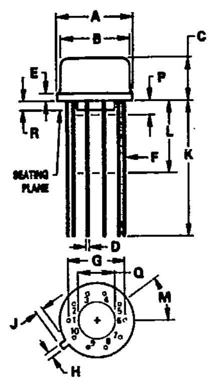


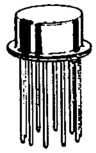
PACKAGE OUTLINE DIMENSIONS (continued)

G SUFFIX
METAL PACKAGE
CASE 603C-01
$R_{\theta JA}$ = 150°C/W (TYP)
(TO-100)

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.51	9.39	0.335	0.370
B	7.75	8.51	0.305	0.335
C	4.19	6.73	0.165	0.265
D	0.407	0.533	0.016	0.021
E	—	1.02	—	0.040
F	0.406	0.483	0.016	0.019
G	5.84 BSC		0.230 BSC	
H	0.712	0.864	0.028	0.034
J	0.737	1.14	0.029	0.045
K	12.70	—	0.500	—
L	6.35	12.70	0.250	0.500
M	36° BSC		36° BSC	
P	—	1.27	—	0.050
Q	3.56	4.06	0.140	0.160
R	0.254	1.02	0.010	0.040

NOTES:
1. LEADS WITHIN 0.18 mm (0.007) RADIUS OF TRUE POSITION TO DIM. "A" & "H" AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION.
2. LEAD DIA UNCONTROLLED BEYOND DIM "K" MIN.

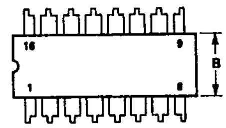


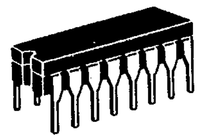


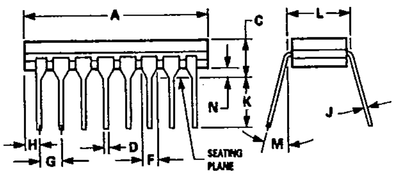
DP2, D, J, L, N SUFFIX
CERAMIC PACKAGE
CASE 620-10
$R_{\theta JA}$ = 100°C/W (TYP)

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	19.05	19.94	0.750	0.785
B	6.10	7.49	0.240	0.295
C	—	5.08	—	0.200
D	0.38	0.53	0.015	0.021
F	1.40	1.78	0.055	0.070
G	2.54 BSC		0.100 BSC	
H	0.51	1.14	0.020	0.045
J	0.20	0.30	0.008	0.012
K	3.18	4.32	0.125	0.170
L	7.62 BSC		0.300 BSC	
M	—	15°	—	15°
N	0.51	1.02	0.020	0.040

NOTES:
1. LEADS WITHIN 0.13 mm (0.005) RADIUS OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION.
2. PACKAGE INDEX: NOTCH IN LEAD NOTCH IN CERAMIC OR INK DOT.
3. DIM "L" TO CENTER OF LEADS WHEN FORMED PARALLEL.
4. DIM "A" AND "B" DO NOT INCLUDE GLASS RUN-OUT.
5. DIM "F" MAY NARROW TO 0.76 mm (0.030) WHERE THE LEAD ENTERS THE CERAMIC BODY.



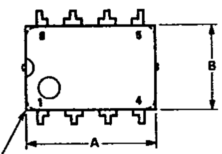


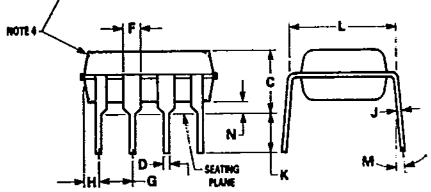


N, P1 SUFFIX
PLASTIC PACKAGE
CASE 626-05
$R_{\theta JA}$ = 100°C/W (TYP)

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.40	10.16	0.370	0.400
B	6.10	6.60	0.240	0.260
C	3.94	4.45	0.155	0.175
D	0.38	0.51	0.015	0.020
F	1.02	1.52	0.040	0.060
G	2.54 BSC		0.100 BSC	
H	0.76	1.27	0.030	0.050
J	0.20	0.30	0.008	0.012
K	2.92	3.43	0.115	0.135
L	7.62 BSC		0.300 BSC	
M	—	10°	—	10°
N	0.76	1.01	0.030	0.040

NOTES:
1. LEAD POSITIONAL TOLERANCE:
   | ⌖ | ⌀ 0.13 (0.005) Ⓜ | T | A Ⓜ | B Ⓜ |
2. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
3. PACKAGE CONTOUR OPTIONAL (ROUND OR SQUARE CORNERS).
4. DIMENSIONS A AND B ARE DATUMS.
5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.

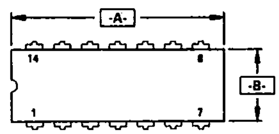


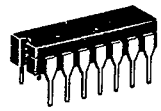


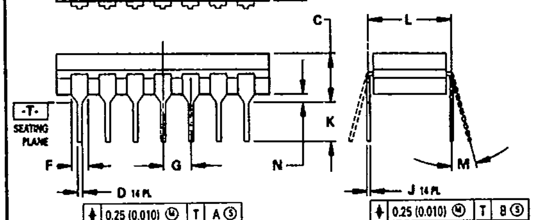
L SUFFIX
CERAMIC PACKAGE
CASE 632-08
$R_{\theta JA}$ = 100°C/W (TYP)
(TO-116)

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	19.05	19.94	0.750	0.785
B	6.23	7.11	0.245	0.280
C	3.94	5.08	0.155	0.200
D	0.39	0.50	0.015	0.020
F	1.40	1.65	0.055	0.065
G	2.54 BSC		0.100 BSC	
J	0.21	0.38	0.008	0.015
K	3.18	4.31	0.125	0.170
L	7.62 BSC		0.300 BSC	
M	0°	15°	0°	15°
N	0.51	1.01	0.020	0.040

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEAD WHEN FORMED PARALLEL.
4. DIM F MAY NARROW TO 0.76 (0.030) WHERE THE LEAD ENTERS THE CERAMIC BODY.





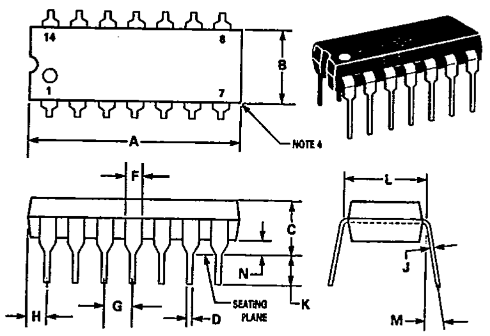


PACKAGE OUTLINE DIMENSIONS (continued)

N, P, N-14, P2 SUFFIX
PLASTIC PACKAGE
CASE 646-06
$R_{\theta JA}$ = 100°C/W (TYP)

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	18.16	19.56	0.715	0.770
B	6.10	6.60	0.240	0.260
C	3.69	4.69	0.145	0.185
D	0.38	0.53	0.015	0.021
F	1.02	1.78	0.040	0.070
G	2.54 BSC		0.100 BSC	
H	1.32	2.41	0.052	0.095
J	0.20	0.38	0.008	0.015
K	2.92	3.43	0.115	0.135
L	7.62 BSC		0.300 BSC	
M	0°	10°	0°	10°
N	0.39	1.01	0.015	0.039

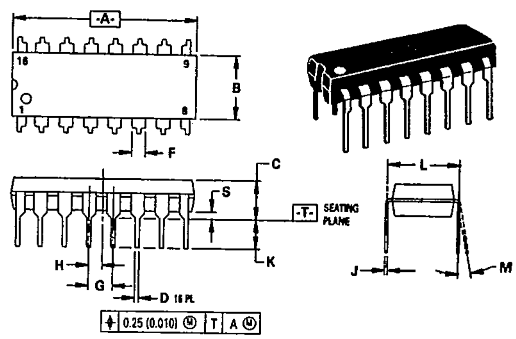
NOTES:
1. LEADS WITHIN 0.13 mm (0.005) RADIUS OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION.
2. DIMENSION "L" TO CENTER OF LEADS WHEN FORMED PARALLEL.
3. DIMENSION "B" DOES NOT INCLUDE MOLD FLASH.
4. ROUNDED CORNERS OPTIONAL.



N, P SUFFIX
PLASTIC PACKAGE
CASE 648-08
$R_{\theta JA}$ = 100°C/W (TYP)

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	18.80	19.55	0.740	0.770
B	6.35	6.85	0.250	0.270
C	3.69	4.44	0.145	0.175
D	0.39	0.53	0.015	0.021
F	1.02	1.77	0.040	0.070
G	2.54 BSC		0.100 BSC	
H	1.27 BSC		0.050 BSC	
J	0.21	0.38	0.008	0.015
K	2.80	3.30	0.110	0.130
L	7.50	7.74	0.295	0.305
M	0°	10°	0°	10°
S	0.51	1.01	0.020	0.040

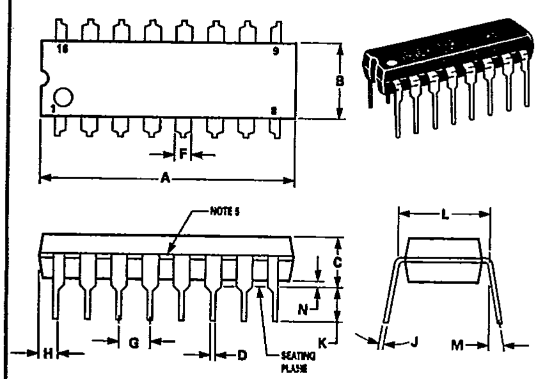
NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION "L" TO CENTER OF LEADS WHEN FORMED PARALLEL.
4. DIMENSION "B" DOES NOT INCLUDE MOLD FLASH.
5. ROUNDED CORNERS OPTIONAL.



P SUFFIX
PLASTIC PACKAGE
CASE 648C-02

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	18.80	21.34	0.740	0.840
B	6.10	6.60	0.240	0.260
C	3.69	4.69	0.145	0.185
D	0.38	0.53	0.015	0.021
F	1.02	1.78	0.040	0.070
G	2.54 BSC		0.100 BSC	
H	0.38	2.41	0.015	0.095
J	0.20	0.38	0.008	0.015
K	2.92	3.43	0.115	0.135
L	7.62 BSC		0.300 BSC	
M	0°	10°	0°	10°
N	0.39	1.01	0.015	0.040

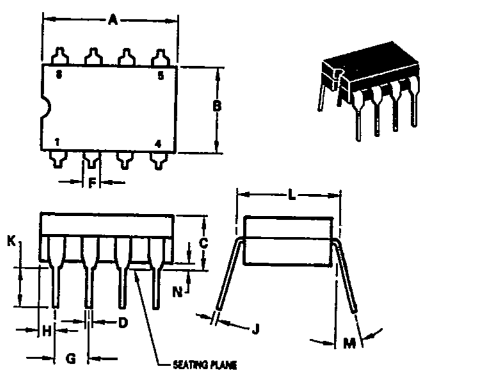
NOTES:
1. LEADS WITHIN 0.13 mm (0.005) RADIUS OF TRUE POSITON AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION.
2. DIMENSION "L" TO CENTER OF LEADS WHEN FORMED PARALLEL.
3. DIMENSION "B" DOES NOT INCLUDE MOLD FLASH.
4. ROUNDED CORNERS OPTIONAL.
5. EXTERNAL LEAD CONNECTION, BETWEEN 4 AND 5, 12 AND 13 AS SHOWN.



J-8, J, JG, U, Z SUFFIX
CERAMIC PACKAGE
CASE 693-02
$R_{\theta JA}$ = 100°C/W (TYP)

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	9.91	10.92	0.390	0.430
B	6.22	6.99	0.245	0.275
C	4.32	5.08	0.170	0.200
D	0.41	0.51	0.016	0.020
F	1.40	1.65	0.055	0.065
G	2.54 BSC		0.100 BSC	
H	1.14	1.65	0.045	0.065
J	0.20	0.30	0.008	0.012
K	3.18	4.06	0.125	0.160
L	7.37	7.87	0.290	0.310
M	—	15°	—	15°
N	0.51	1.02	0.020	0.040

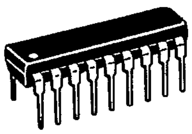
NOTES:
1. LEADS WITHIN 0.13 mm (0.005) RAD OF TRUE POSITION AT SEATING PLANE AT MAXIMUM MATERIAL CONDITION.
2. DIMENSION "L" TO CENTER OF LEADS WHEN FORMED PARALLEL.



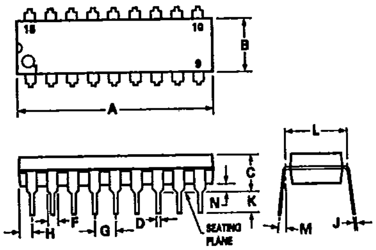
PACKAGE OUTLINE DIMENSIONS (continued)

A, B, N, P SUFFIX
PLASTIC PACKAGE
CASE 707-02
$R_{\theta JA}$ = 100°C/W (TYP)

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	22.22	23.24	0.875	0.915
B	6.10	6.60	0.240	0.260
C	3.56	4.57	0.140	0.180
D	0.36	0.56	0.014	0.022
F	1.27	1.78	0.050	0.070
G	2.54 BSC		0.100 BSC	
H	1.02	1.52	0.040	0.060
J	0.20	0.30	0.008	0.012
K	2.92	3.43	0.115	0.135
L	7.62 BSC		0.300 BSC	
M	0°	15°	0°	15°
N	0.51	1.02	0.020	0.040



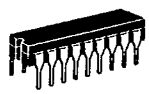
NOTES:
1. POSITIONAL TOLERANCE OF LEADS (D), SHALL BE WITHIN 0.25mm(0.010) AT MAXIMUM MATERIAL CONDITION, IN RELATION TO SEATING PLANE AND EACH OTHER.
2. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
3. DIMENSION B DOES NOT INCLUDE MOLD FLASH.

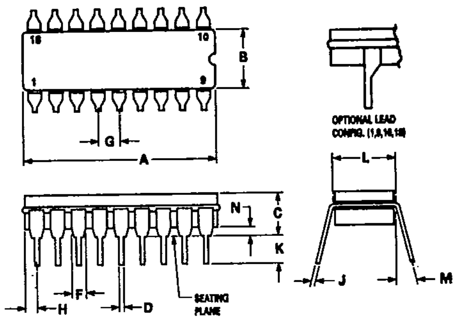


J, L SUFFIX
CERAMIC PACKAGE
CASE 726-04
$R_{\theta JA}$ = 100°C/W (TYP)

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	22.35	23.11	0.880	0.910
B	6.10	7.49	0.240	0.295
C	—	5.08	—	0.200
D	0.38	0.53	0.015	0.021
F	1.40	1.78	0.055	0.070
G	2.54 BSC		0.100 BSC	
H	0.51	1.14	0.020	0.045
J	0.20	0.30	0.008	0.012
K	3.18	4.32	0.125	0.170
L	7.62 BSC		0.300 BSC	
M	0°	15°	0°	15°
N	0.51	1.02	0.020	0.040

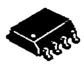
NOTES:
1. LEADS, TRUE POSITIONED WITHIN 0.25 mm (0.010) DIA. AT SEATING PLANE, AT MAXIMUM MATERIAL CONDITION.
2. DIM "L" TO CENTER OF LEADS WHEN FORMED PARALLEL.
3. DIM "A" & "B" INCLUDES MENISCUS.
4. "F" DIMENSION IS FOR FULL LEADS. "HALF" LEADS ARE OPTIONAL AT LEAD POSITIONS 1, 9, 10, AND 18.



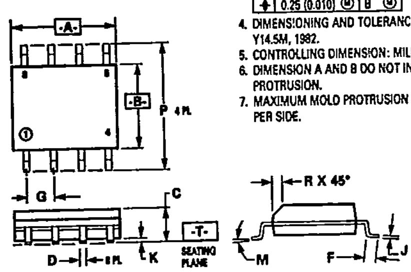


D SUFFIX
CASE 751-03
PLASTIC PACKAGE
SO-8, SOP-8
$R_{\theta JA}$ = 190°C/W (SO-8)
$R_{\theta JA}$ = 160°C/W (SOP-8)

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	4.80	5.00	0.189	0.196
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.008	0.009
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019



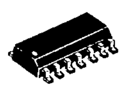
NOTES:
1. DIMENSIONS A AND B ARE DATUMS AND T IS A DATUM SURFACE.
2. POSITIONAL TOLERANCE FOR D DIMENSION (8 PLACES):
   | ⌖ | 0.25 (0.010) Ⓜ | T | B Ⓢ | A Ⓢ |
3. POSITIONAL TOLERANCE FOR P DIMENSION (4 PLACES):
   | ⌖ | 0.25 (0.010) Ⓜ | B Ⓜ |
4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
5. CONTROLLING DIMENSION: MILLIMETER.
6. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
7. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.

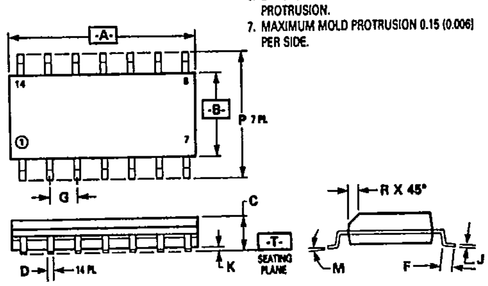


D SUFFIX
PLASTIC PACKAGE
CASE 751A-02
SO-14
$R_{\theta JA}$ = 145°C/W (TYP)

DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	8.55	8.75	0.337	0.344
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.008	0.009
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

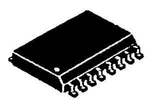
NOTES:
1. DIMENSIONS A AND B ARE DATUMS AND T IS A DATUM SURFACE.
2. POSITIONAL TOLERANCE FOR D DIMENSION (14 PLACES):
   | ⌖ | 0.25 (0.010) Ⓜ | T | B Ⓢ | A Ⓢ |
3. POSITIONAL TOLERANCE FOR P DIMENSION (7 PLACES):
   | ⌖ | 0.25 (0.010) Ⓜ | B Ⓜ |
4. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
5. CONTROLLING DIMENSION: MILLIMETER.
6. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
7. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.



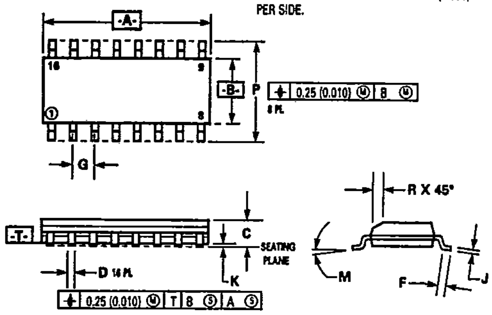


DW SUFFIX
PLASTIC PACKAGE
CASE 751G-01
SO-16L

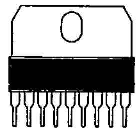
DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	10.15	10.45	0.400	0.411
B	7.40	7.60	0.292	0.299
C	2.35	2.65	0.093	0.104
D	0.35	0.49	0.014	0.019
F	0.50	0.90	0.020	0.035
G	1.27 BSC		0.050 BSC	
J	0.25	0.32	0.010	0.012
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	10.05	10.55	0.395	0.415
	0.25	0.75	0.010	0.029



NOTES:
1. DIMENSIONS A AND B ARE DATUMS AND T IS A DATUM SURFACE.
2. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
3. CONTROLLING DIMENSION: MILLIMETER.
4. DIMENSION A AND B DO NOT INCLUDE MOLD PROTRUSION.
5. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.



CASE 762-01
PLASTIC MEDIUM
POWER PACKAGE
SIP-9



DIM	MILLIMETERS MIN	MILLIMETERS MAX	INCHES MIN	INCHES MAX
A	22.40	23.00	0.873	0.897
B	6.40	6.60	0.252	0.260
C	3.45	3.65	0.136	1.143
D	0.40	0.55	0.015	0.021
E	9.35	9.60	0.368	0.377
F	1.40	1.60	0.055	0.062
G	2.54 BSC		0.100BSC	
H	1.51	1.71	0.059	0.067
J	0.380	0.400	0.014	0.015
K	3.95	4.20	0.155	0.165
M	30° BSC		30° BSC	
N	2.50	2.70	0.099	0.106
Q	3.15	3.45	0.124	0.136
R	13.60	13.90	0.535	0.547
S	1.65	1.95	0.064	0.076
U	22.00	22.20	0.866	0.874
V	0.55	0.75	0.021	0.029
W	2.89 BSC		0.113 BSC	
X	0.65	0.75	0.025	0.029
Y	2.70	2.80	0.106	0.110

NOTES:
1. DIMENSIONS A, AND C ARE DATUMS. AND -T- IS A DATUM PLANE.
2. POSITIONAL TOLERANCE FOR LEAD DIMENSION D:
   ⌖ | φ 0.25 (0.010) M | -T- | A M
3. POSITIONAL TOLERANCE FOR LEAD DIMENSION J:
   ⌖ | φ 0.25 (0.010) M | -T- | C M
4. POSITIONAL TOLERANCE FOR LEAD DIMENSION Q:
   ⌖ | φ 0.25 (0.010) M | -T- | A M
5. DIMENSIONING AND TOLERANCING PER ANSI Y14.5, 1982.
6. CONTROLLING DIMENSION: MILLIMETER.