MOTOROLA

MC78L00, A Series

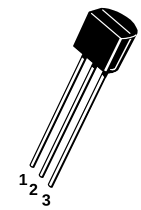
Three-Terminal Low Current Positive Voltage Regulators

The MC78L00, A Series of positive voltage regulators are inexpensive, easy–to–use devices suitable for a multitude of applications that require a regulated supply of up to 100 mA. Like their higher powered MC7800 and MC78M00 Series cousins, these regulators feature internal current limiting and thermal shutdown making them remarkably rugged. No external components are required with the MC78L00 devices in many applications.

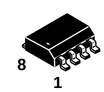
These devices offer a substantial performance advantage over the traditional zener diode–resistor combination, as output impedance and quiescent current are substantially reduced.

- Wide Range of Available, Fixed Output Voltages
- Low Cost
- Internal Short Circuit Current Limiting
- Internal Thermal Overload Protection
- No External Components Required
- Complementary Negative Regulators Offered (MC79L00 Series)
- Available in either ±5% (AC) or ±10% (C) Selections

P SUFFIX
CASE 29



Pin 1. Output
2. GND
3. Input

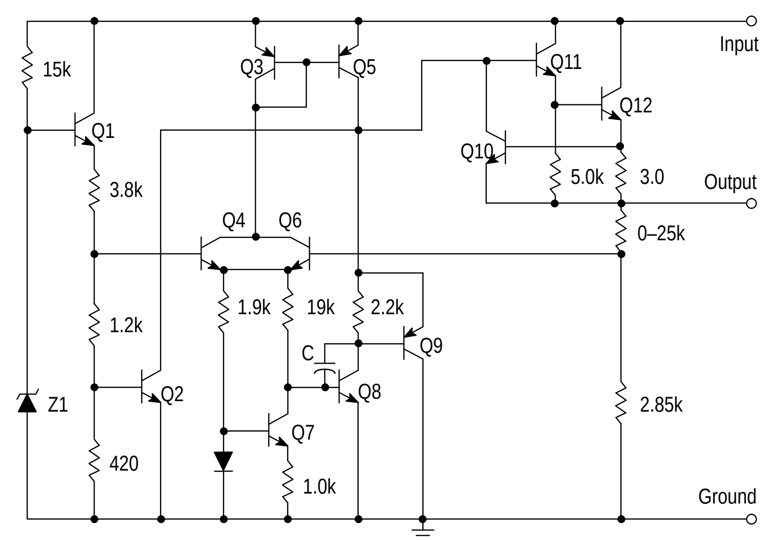


D SUFFIX
PLASTIC PACKAGE
CASE 751
(SOP–8)*

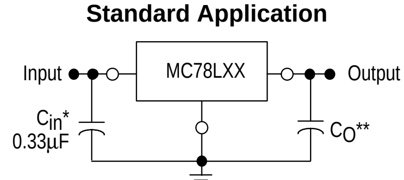
Pin			
1.	V_{out}	5.	NC
2.	GND	6.	GND
3.	GND	7.	GND
4.	NC	8.	V_{in}

* SOP–8 is an internally modified SO–8 package. Pins 2, 3, 6, and 7 are electrically common to the die attach flag. This internal lead frame modification decreases package thermal resistance and increases power dissipation capability when appropriately mounted on a printed circuit board. SOP–8 conforms to all external dimensions of the standard SO–8 package.

Representative Schematic Diagram



Standard Application



A common ground is required between the input and the output voltages. The input voltage must remain typically 2.0 V above the output voltage even during the low point on the input ripple voltage.

*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.

ORDERING INFORMATION

Device	Operating Temperature Range	Package
MC78LXXACD*	T_J = 0° to +125°C	SOP–8
MC78LXXACP		Plastic Power
MC78LXXCP		Plastic Power
MC78LXXABD*	T_J = –40° to +125°C	SOP–8
MC78LXXABP*		Plastic Power

XX indicates nominal voltage
*Available in 5, 8, 9, 12 and 15 V devices.

DEVICE TYPE/NOMINAL VOLTAGE

10%	5%	Voltage
MC78L05C	MC78L05AC	5.0
MC78L08C	MC78L08AC	8.0
MC78L09C	MC78L09AC	9.0
MC78L12C	MC78L12AC	12
MC78L15C	MC78L15AC	15
MC78L18C	MC78L18AC	18
MC78L24C	MC78L24AC	24

MAXIMUM RATINGS (T_A = +125°C, unless otherwise noted.)

Rating	Symbol	Value	Unit
Input Voltage (2.6 V–8.0 V) (12 V–18 V) (24 V)	V_I	30 35 40	Vdc
Storage Temperature Range	T_{stg}	–65 to +150	°C
Operating Junction Temperature Range	T_J	0 to +150	°C

ELECTRICAL CHARACTERISTICS (V_I = 10 V, I_O = 40 mA, C_I = 0.33 μF, C_O = 0.1 μF, –40°C < T_J < +125°C (for MC78LXXAB), 0°C < T_J < +125°C (for MC78LXXAC), unless otherwise noted.)

Characteristics	Symbol	MC78L05AC, AB			MC78L05C			Unit
		Min	Typ	Max	Min	Typ	Max	
Output Voltage (T_J = +25°C)	V_O	4.8	5.0	5.2	4.6	5.0	5.4	Vdc
Line Regulation (T_J = +25°C, I_O = 40 mA) 7.0 Vdc ≤ V_I ≤ 20 Vdc 8.0 Vdc ≤ V_I ≤ 20 Vdc	Reg_{line}	 – –	 55 45	 150 100	 – –	 55 45	 200 150	mV
Load Regulation (T_J = +25°C, 1.0 mA ≤ I_O ≤ 100 mA) (T_J = +25°C, 1.0 mA ≤ I_O ≤ 40 mA)	Reg_{load}	 – –	 11 5.0	 60 30	 – –	 11 5.0	 60 30	mV
Output Voltage (7.0 Vdc ≤ V_I ≤ 20 Vdc, 1.0 mA ≤ I_O ≤ 40 mA) (V_I = 10 V, 1.0 mA ≤ I_O ≤ 70 mA)	V_O	 4.75 4.75	 – –	 5.25 5.25	 4.5 4.5	 – –	 5.5 5.5	Vdc
Input Bias Current (T_J = +25°C) (T_J = +125°C)	I_{IB}	 – –	 3.8 –	 6.0 5.5	 – –	 3.8 –	 6.0 5.5	mA
Input Bias Current Change (8.0 Vdc ≤ V_I ≤ 20 Vdc) (1.0 mA ≤ I_O ≤ 40 mA)	ΔI_{IB}	 – –	 – –	 1.5 0.1	 – –	 – –	 1.5 0.2	mA
Output Noise Voltage (T_A = +25°C, 10 Hz ≤ f ≤ 100 kHz)	V_n	–	40	–	–	40	–	μV
Ripple Rejection (I_O = 40 mA, f = 120 Hz, 8.0 Vdc ≤ V_I ≤ 18 V, T_J = +25°C)	RR	41	49	–	40	49	–	dB
Dropout Voltage (T_J = +25°C)	$V_I – V_O$	–	1.7	–	–	1.7	–	Vdc

ELECTRICAL CHARACTERISTICS (V_I = 14 V, I_O = 40 mA, C_I = 0.33 μF, C_O = 0.1 μF, –40°C < T_J < +125°C (for MC78LXXAB), 0°C < T_J < +125°C (for MC78LXXAC), unless otherwise noted.)

Characteristics	Symbol	MC78L08AC, AB			MC78L08C			Unit
		Min	Typ	Max	Min	Typ	Max	
Output Voltage (T_J = +25°C)	V_O	7.7	8.0	8.3	7.36	8.0	8.64	Vdc
Line Regulation (T_J = +25°C, I_O = 40 mA) 10.5 Vdc ≤ V_I ≤ 23 Vdc 11 Vdc ≤ V_I ≤ 23 Vdc	Reg_{line}	 – –	 20 12	 175 125	 – –	 20 12	 200 150	mV
Load Regulation (T_J = +25°C, 1.0 mA ≤ I_O ≤ 100 mA) (T_J = +25°C, 1.0 mA ≤ I_O ≤ 40 mA)	Reg_{load}	 – –	 15 8.0	 80 40	 – –	 15 6.0	 80 40	mV
Output Voltage (10.5 Vdc ≤ V_I ≤ 23 Vdc, 1.0 mA ≤ I_O ≤ 40 mA) (V_I = 14 V, 1.0 mA ≤ I_O ≤ 70 mA)	V_O	 7.6 7.6	 – –	 8.4 8.4	 7.2 7.2	 – –	 8.8 8.8	Vdc
Input Bias Current (T_J = +25°C) (T_J = +125°C)	I_{IB}	 – –	 3.0 –	 6.0 5.5	 – –	 3.0 –	 6.0 5.5	mA
Input Bias Current Change (11 Vdc ≤ V_I ≤ 23 Vdc) (1.0 mA ≤ I_O ≤ 40 mA)	ΔI_{IB}	 – –	 – –	 1.5 0.1	 – –	 – –	 1.5 0.2	mA
Output Noise Voltage (T_A = +25°C, 10 Hz ≤ f ≤ 100 kHz)	V_n	–	60	–	–	52	–	μV
Ripple Rejection (I_O = 40 mA, f = 120 Hz, 12 V ≤ V_I ≤ 23 V, T_J = +25°C)	RR	37	57	–	36	55	–	dB
Dropout Voltage (T_J = +25°C)	$V_I – V_O$	–	1.7	–	–	1.7	–	Vdc

ELECTRICAL CHARACTERISTICS (V_I = 15 V, I_O = 40 mA, C_I = 0.33 µF, C_O = 0.1 µF, –40°C < T_J < +125°C (for MC78LXXAB), 0°C < T_J < +125°C (for MC78LXXAC), unless otherwise noted.)

Characteristics	Symbol	MC78L09AC, AB			MC78L09C			Unit
		Min	Typ	Max	Min	Typ	Max	
Output Voltage (T_J = +25°C)	V_O	8.6	9.0	9.4	8.3	9.0	9.7	Vdc
Line Regulation (T_J = +25°C, I_O = 40 mA)	Reg_{line}							mV
11.5 Vdc ≤ V_I ≤ 24 Vdc		–	20	175	–	20	200	
12 Vdc ≤ V_I ≤ 24 Vdc		–	12	125	–	12	150	
Load Regulation	Reg_{load}							mV
(T_J = +25°C, 1.0 mA ≤ I_O ≤ 100 mA)		–	15	90	–	15	90	
(T_J = +25°C, 1.0 mA ≤ I_O ≤ 40 mA)		–	8.0	40	–	6.0	40	
Output Voltage	V_O							Vdc
(11.5 Vdc ≤ V_I ≤ 24 Vdc, 1.0 mA ≤ I_O ≤ 40 mA)		8.5	–	9.5	8.1	–	9.9	
(V_I = 15 V, 1.0 mA ≤ I_O ≤ 70 mA)		8.5	–	9.5	8.1	–	9.9	
Input Bias Current	I_{IB}							mA
(T_J = +25°C)		–	3.0	6.0	–	3.0	6.0	
(T_J = +125°C)		–	–	5.5	–	–	5.5	
Input Bias Current Change	ΔI_{IB}							mA
(11 Vdc ≤ V_I ≤ 23 Vdc)		–	–	1.5	–	–	1.5	
(1.0 mA ≤ I_O ≤ 40 mA)		–	–	0.1	–	–	0.2	
Output Noise Voltage (T_A = +25°C, 10 Hz ≤ f ≤ 100 kHz)	V_n	–	60	–	–	52	–	µV
Ripple Rejection (I_O = 40 mA, f = 120 Hz, 13 V ≤ V_I ≤ 24 V, T_J = +25°C)	RR	37	57	–	36	55	–	dB
Dropout Voltage (T_J = +25°C)	$V_I – V_O$	–	1.7	–	–	1.7	–	Vdc

ELECTRICAL CHARACTERISTICS (V_I = 19 V, I_O = 40 mA, C_I = 0.33 µF, C_O = 0.1 µF, –40°C < T_J < +125°C (for MC78LXXAB), 0°C < T_J < +125°C (for MC78LXXAC), unless otherwise noted.)

Characteristics	Symbol	MC78L12AC, AB			MC78L12C			Unit
		Min	Typ	Max	Min	Typ	Max	
Output Voltage (T_J = +25°C)	V_O	11.5	12	12.5	11.1	12	12.9	Vdc
Line Regulation (T_J = +25°C, I_O = 40 mA)	Reg_{line}							mV
14.5 Vdc ≤ V_I ≤ 27 Vdc		–	120	250	–	120	250	
16 Vdc ≤ V_I ≤ 27 Vdc		–	100	200	–	100	200	
Load Regulation	Reg_{load}							mV
(T_J = +25°C, 1.0 mA ≤ I_O ≤ 100 mA)		–	20	100	–	20	100	
(T_J = +25°C, 1.0 mA ≤ I_O ≤ 40 mA)		–	10	50	–	10	50	
Output Voltage	V_O							Vdc
(14.5 Vdc ≤ V_I ≤ 27 Vdc, 1.0 mA ≤ I_O ≤ 40 mA)		11.4	–	12.6	10.8	–	13.2	
(V_I = 19 V, 1.0 mA ≤ I_O ≤ 70 mA)		11.4	–	12.6	10.8	–	13.2	
Input Bias Current	I_{IB}							mA
(T_J = +25°C)		–	4.2	6.5	–	4.2	6.5	
(T_J = +125°C)		–	–	6.0	–	–	6.0	
Input Bias Current Change	ΔI_{IB}							mA
(16 Vdc ≤ V_I ≤ 27 Vdc)		–	–	1.5	–	–	1.5	
(1.0 mA ≤ I_O ≤ 40 mA)		–	–	0.1	–	–	0.2	
Output Noise Voltage (T_A = +25°C, 10 Hz ≤ f ≤ 100 kHz)	V_n	–	80	–	–	80	–	µV
Ripple Rejection (I_O = 40 mA, f = 120 Hz, 15 V ≤ V_I ≤ 25 V, T_J = +25°C)	RR	37	42	–	36	42	–	dB
Dropout Voltage (T_J = +25°C)	$V_I – V_O$	–	1.7	–	–	1.7	–	Vdc

ELECTRICAL CHARACTERISTICS (V_I = 23 V, I_O = 40 mA, C_I = 0.33 µF, C_O = 0.1 µF, –40°C < T_J < +125°C (for MC78LXXAB), 0°C < T_J < +125°C (for MC78LXXAC), unless otherwise noted.)

Characteristics	Symbol	MC78L15AC, AB			MC78L15C			Unit
		Min	Typ	Max	Min	Typ	Max	
Output Voltage (T_J = +25°C)	V_O	14.4	15	15.6	13.8	15	16.2	Vdc
Line Regulation (T_J = +25°C, I_O = 40 mA)	Reg_{line}							mV
17.5 Vdc ≤ V_I ≤ 30 Vdc		–	130	300	–	130	300	
20 Vdc ≤ V_I ≤ 30 Vdc		–	110	250	–	110	250	
Load Regulation	Reg_{load}							mV
(T_J = +25°C, 1.0 mA ≤ I_O ≤ 100 mA)		–	25	150	–	25	150	
(T_J = +25°C, 1.0 mA ≤ I_O ≤ 40 mA)		–	12	75	–	12	75	
Output Voltage	V_O							Vdc
(17.5 Vdc ≤ V_I ≤ 30 Vdc, 1.0 mA ≤ I_O ≤ 40 mA)		14.25	–	15.75	13.5	–	16.5	
(V_I = 23 V, 1.0 mA ≤ I_O ≤ 70 mA)		14.25	–	15.75	13.5	–	16.5	
Input Bias Current	I_{IB}							mA
(T_J = +25°C)		–	4.4	6.5	–	4.4	6.5	
(T_J = +125°C)		–	–	6.0	–	–	6.0	
Input Bias Current Change	ΔI_{IB}							mA
(20 Vdc ≤ V_I ≤ 30 Vdc)		–	–	1.5	–	–	1.5	
(1.0 mA ≤ I_O ≤ 40 mA)		–	–	0.1	–	–	0.2	
Output Noise Voltage (T_A = +25°C, 10 Hz ≤ f ≤ 100 kHz)	V_n	–	90	–	–	90	–	µV
Ripple Rejection (I_O = 40 mA, f = 120 Hz, 18.5 V ≤ V_I ≤ 28.5 V, T_J = +25°C)	RR	34	39	–	33	39	–	dB
Dropout Voltage (T_J = +25°C)	$V_I – V_O$	–	1.7	–	–	1.7	–	Vdc

ELECTRICAL CHARACTERISTICS (V_I = 27 V, I_O = 40 mA, C_I = 0.33 µF, C_O = 0.1 µF, 0°C < T_J < +125°C, unless otherwise noted.)

Characteristics	Symbol	MC78L18AC			MC78L18C			Unit
		Min	Typ	Max	Min	Typ	Max	
Output Voltage (T_J = +25°C)	V_O	17.3	18	18.7	16.6	18	19.4	Vdc
Line Regulation (T_J = +25°C, I_O = 40 mA)	Reg_{line}							mV
21.4 Vdc ≤ V_I ≤ 33 Vdc					–	32	325	
20.7 Vdc ≤ V_I ≤ 33 Vdc		–	45	325				
22 Vdc ≤ V_I ≤ 33 Vdc					–	27	275	
21 Vdc ≤ V_I ≤ 33 Vdc		–	35	275				
Load Regulation	Reg_{load}							mV
(T_J = +25°C, 1.0 mA ≤ I_O ≤ 100 mA)		–	30	170	–	30	170	
(T_J = +25°C, 1.0 mA ≤ I_O ≤ 40 mA)		–	15	85	–	15	85	
Output Voltage	V_O							Vdc
(21.4 Vdc ≤ V_I ≤ 33 Vdc, 1.0 mA ≤ I_O ≤ 40 mA)					16.2	–	19.8	
(20.7 Vdc ≤ V_I ≤ 33 Vdc, 1.0 mA ≤ I_O ≤ 40 mA)		17.1	–	18.9				
(V_I = 27 V, 1.0 mA ≤ I_O ≤ 70 mA)					16.2	–	19.8	
(V_I = 27 V, 1.0 mA ≤ I_O ≤ 70 mA)		17.1	–	18.9				
Input Bias Current	I_{IB}							mA
(T_J = +25°C)		–	3.1	6.5	–	3.1	6.5	
(T_J = +125°C)		–	–	6.0	–	–	6.0	
Input Bias Current Change	ΔI_{IB}							mA
(22 Vdc ≤ V_I ≤ 33 Vdc)					–	–	1.5	
(21 Vdc ≤ V_I ≤ 33 Vdc)		–	–	1.5				
(1.0 mA ≤ I_O ≤ 40 mA)		–	–	0.1	–	–	0.2	
Output Noise Voltage (T_A = +25°C, 10 Hz ≤ f ≤ 100 kHz)	V_n	–	150	–	–	150	–	µV
Ripple Rejection (I_O = 40 mA, f = 120 Hz, 23 V ≤ V_I ≤ 33 V, T_J = +25°C)	RR	33	48	–	32	46	–	dB
Dropout Voltage (T_J = +25°C)	$V_I – V_O$	–	1.7	–	–	1.7	–	Vdc

ELECTRICAL CHARACTERISTICS (V_I = 33 V, I_O = 40 mA, C_I = 0.33 µF, C_O = 0.1 µF, 0°C < T_J < +125°C, unless otherwise noted.)

Characteristics	Symbol	MC78L24AC			MC78L24C			Unit
		Min	Typ	Max	Min	Typ	Max	
Output Voltage (T_J = +25°C)	V_O	23	24	25	22.1	24	25.9	Vdc
Line Regulation	Reg_{line}							mV
(T_J = +25°C, I_O = 40 mA)								
27.5 Vdc ≤ V_I ≤ 38 Vdc		–	–	–	–	35	350	
28 Vdc ≤ V_I ≤ 80 Vdc		–	50	300	–	30	300	
27 Vdc ≤ V_I ≤ 38 Vdc		–	60	350	–	–	–	
Load Regulation	Reg_{load}							mV
(T_J = +25°C, 1.0 mA ≤ I_O ≤ 100 mA)		–	40	200	–	40	200	
(T_J = +25°C, 1.0 mA ≤ I_O ≤ 40 mA)		–	20	100	–	20	100	
Output Voltage	V_O							Vdc
(28 Vdc ≤ V_I ≤ 38 Vdc, 1.0 mA ≤ I_O ≤ 40 mA)					21.6	–	26.4	
(27 Vdc ≤ V_I ≤ 38 Vdc, 1.0 mA ≤ I_O ≤ 40 mA)		22.8	–	25.2				
(28 Vdc ≤ V_I = 33 Vdc, 1.0 mA ≤ I_O ≤ 70 mA)					21.6	–	26.4	
(27 Vdc ≤ V_I ≤ 33 Vdc, 1.0 mA ≤ I_O ≤ 70 mA)		22.8	–	25.2				
Input Bias Current	I_{IB}							mA
(T_J = +25°C)		–	3.1	6.5	–	3.1	6.5	
(T_J = +125°C)		–	–	6.0	–	–	6.0	
Input Bias Current Change	ΔI_{IB}							mA
(28 Vdc ≤ V_I ≤ 38 Vdc)		–	–	1.5	–	–	1.5	
(1.0 mA ≤ I_O ≤ 40 mA)		–	–	0.1	–	–	0.2	
Output Noise Voltage (T_A = +25°C, 10 Hz ≤ f ≤ 100 kHz)	V_n	–	200	–	–	200	–	µV
Ripple Rejection (I_O = 40 mA, f = 120 Hz, 29 V ≤ V_I ≤ 35 V, T_J = +25°C)	RR	31	45	–	30	43	–	dB
Dropout Voltage (T_J = +25°C)	$V_I - V_O$	–	1.7	–	–	1.7	–	Vdc

Figure 1. Dropout Characteristics

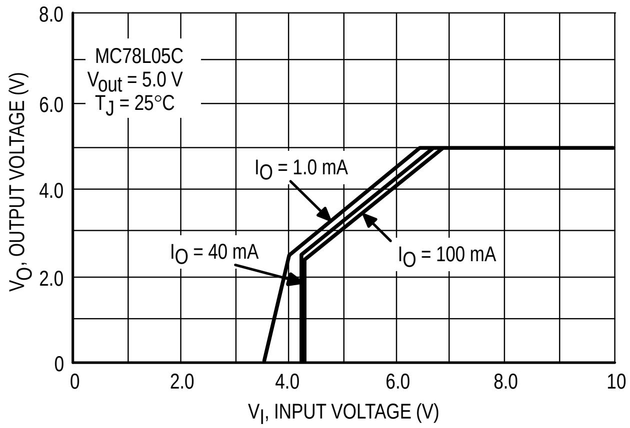


Figure 2. Dropout Voltage versus Junction Temperature

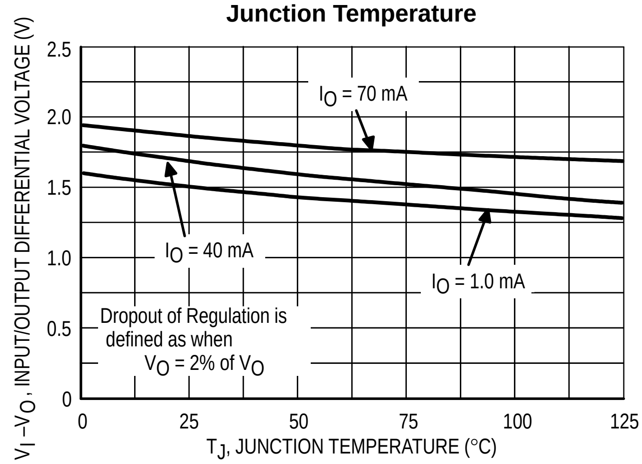


Figure 3. Input Bias Current versus Ambient Temperature

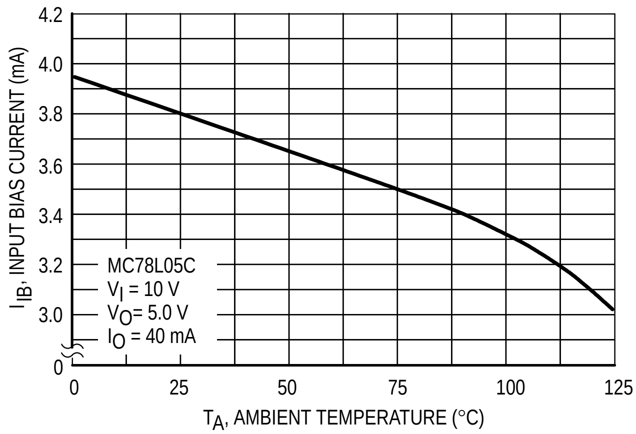


Figure 4. Input Bias Current versus Input Voltage

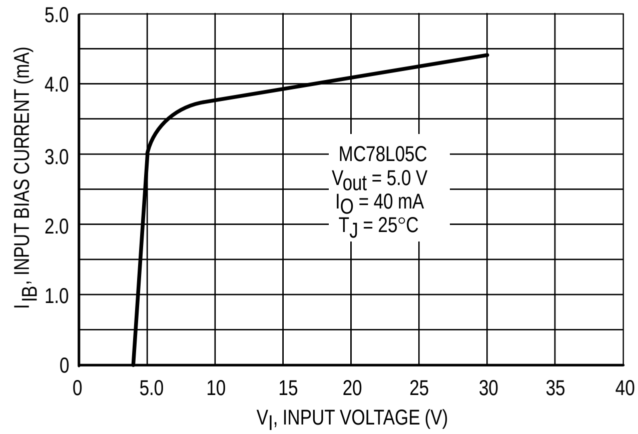


Figure 5. Maximum Average Power Dissipation versus Ambient Temperature – TO–92 Type Package

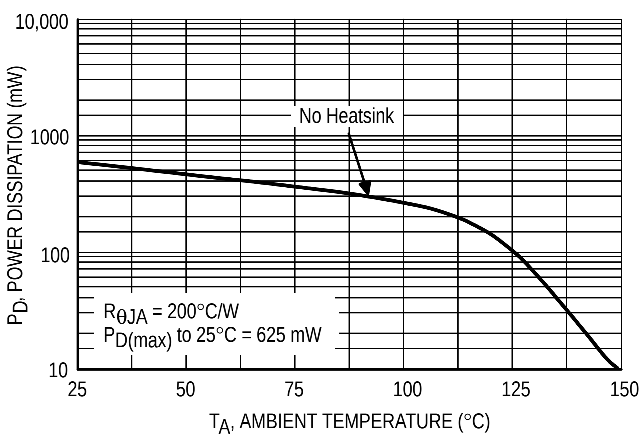
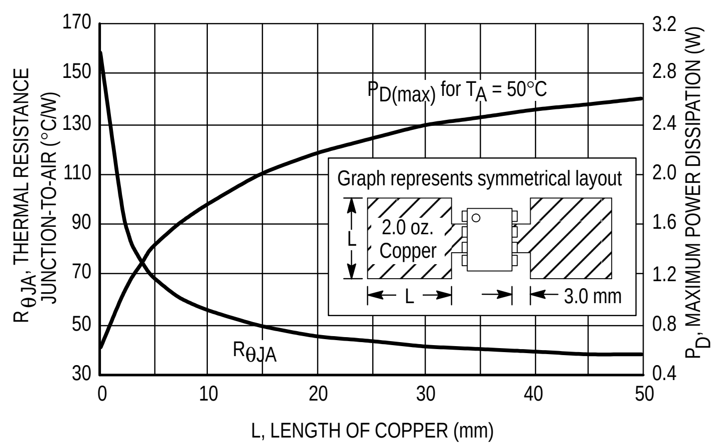


Figure 6. SOP–8 Thermal Resistance and Maximum Power Dissipation versus P.C.B. Copper Length



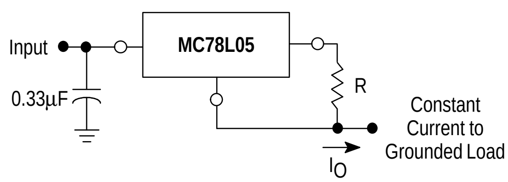
APPLICATIONS INFORMATION

Design Considerations

The MC78L00 Series of fixed voltage regulators are designed with Thermal Overload Protection that shuts down the circuit when subjected to an excessive power overload condition. Internal Short Circuit Protection limits the maximum current the circuit will pass.

In many low current applications, compensation capacitors are not required. However, it is recommended that the regulator input be bypassed with a capacitor if the regulator is connected to the power supply filter with long wire lengths, or if the output load capacitance is large. The input bypass capacitor should be selected to provide good high–frequency characteristics to insure stable operation under all load conditions. A 0.33 µF or larger tantalum, mylar, or other capacitor having low internal impedance at high frequencies should be chosen.The bypass capacitor should be mounted with the shortest possible leads directly across the regulators input terminals. Good construction techniques should be used to minimize ground loops and lead resistance drops since the regulator has no external sense lead. Bypassing the output is also recommended.

Figure 7. Current Regulator



The MC78L00 regulators can also be used as a current source when connected as above. In order to minimize dissipation the MC78L05C is chosen in this application. Resistor R determines the current as follows:

$$I_O = \frac{5.0\ V}{R} + I_B$$

I_{IB} = 3.8 mA over line and load changes

For example, a 100 mA current source would require R to be a 50 Ω, 1/2 W resistor and the output voltage compliance would be the input voltage less 7 V.

Figure 8. ± **15 V Tracking Voltage Regulator**

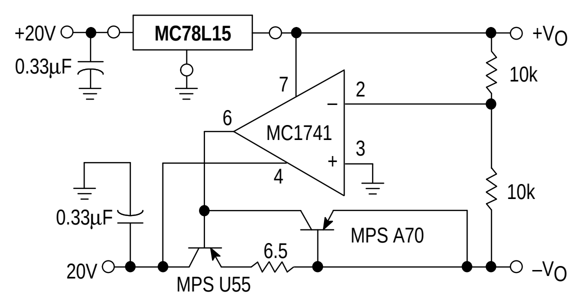
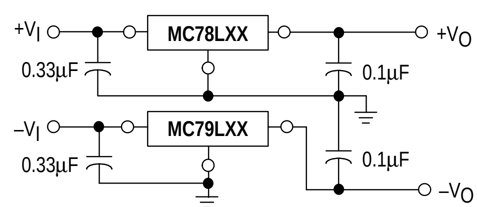
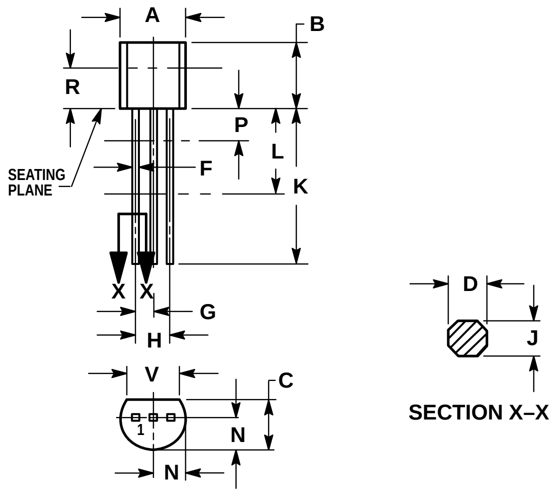


Figure 9. Positive and Negative Regulator



OUTLINE DIMENSIONS

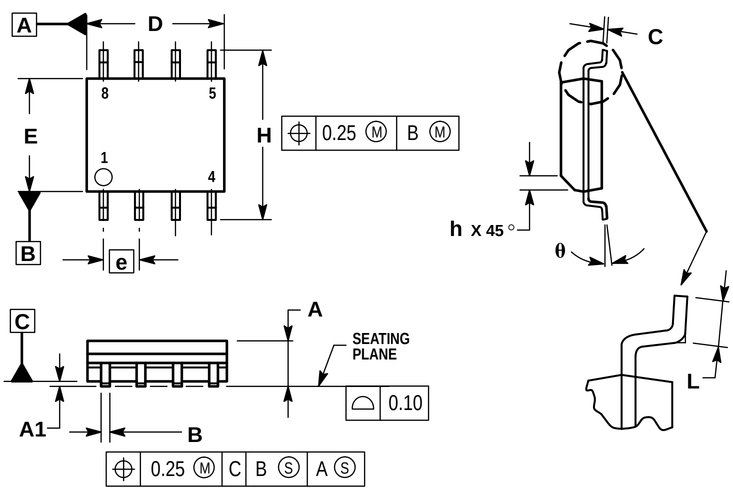
P SUFFIX
PLASTIC PACKAGE
CASE 29–04
ISSUE AD



NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. DIMENSION F APPLIES BETWEEN P AND L. DIMENSION D AND J APPLY BETWEEN L AND K MINIMUM. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

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

D SUFFIX
PLASTIC PACKAGE
CASE 751–05
(SOP–8)
ISSUE R



NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. DIMENSIONS ARE IN MILLIMETERS.
3. DIMENSION D AND E DO NOT INCLUDE MOLD PROTRUSION.
4. MAXIMUM MOLD PROTRUSION 0.15 PER SIDE.
5. DIMENSION B DOES NOT INCLUDE MOLD PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 TOTAL IN EXCESS OF THE B DIMENSION AT MAXIMUM MATERIAL CONDITION.

	MILLIMETERS	
DIM	MIN	MAX
A	1.35	1.75
A1	0.10	0.25
B	0.35	0.49
C	0.18	0.25
D	4.80	5.00
E	3.80	4.00
e	1.27 BSC	
H	5.80	6.20
h	0.25	0.50
L	0.40	1.25
θ	0°	7°

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