FAIRCHILD

A Schlumberger Company

μA78L00 Series 3-Terminal Positive Voltage Regulators

Linear Products

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Description

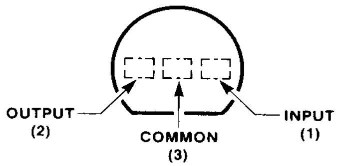
The μA78L00 series of 3-Terminal Positive Voltage Regulators is constructed using the Fairchild Planar epitaxial process. These regulators employ internal current-limiting and thermal-shutdown, making them essentially indestructible. If adequate heat sinking is provided, they can deliver up to 100 mA output current. They are intended as fixed voltage regulators in a wide range of applications including local or on-card regulation for elimination of noise and distribution problems associated with single-point regulation. In addition, they can be used with power pass elements to make high-current voltage regulators. The μA78L00 used as a Zener diode/resistor combination replacement, offers an effective output impedance improvement of typically two orders of magnitude, along with lower quiescent current and lower noise.

- **OUTPUT CURRENT UP TO 100 mA**
- **NO EXTERNAL COMPONENTS**
- **INTERNAL THERMAL OVERLOAD PROTECTION**
- **INTERNAL SHORT CIRCUIT CURRENT LIMITING**
- **AVAILABLE IN JEDEC TO-92**
- **OUTPUT VOLTAGES OF 5 V, 6.2 V, 8.2 V, 9 V, 12 V, 15 V**
- **OUTPUT VOLTAGE TOLERANCES OF ±5% OVER THE TEMPERATURE RANGE**

Absolute Maximum Ratings

Input Voltage	
5.0 V to 15 V	35 V
Internal Power Dissipation	Internally Limited
Storage Temperature Range	−55°C to + 150°C
Operating Junction Temperature Ranges	
μA78L00C (Commercial)	0°C to + 125°C
Pin Temperatures (Soldering, 10 s)	260°C

Connection Diagram
TO-92 Package

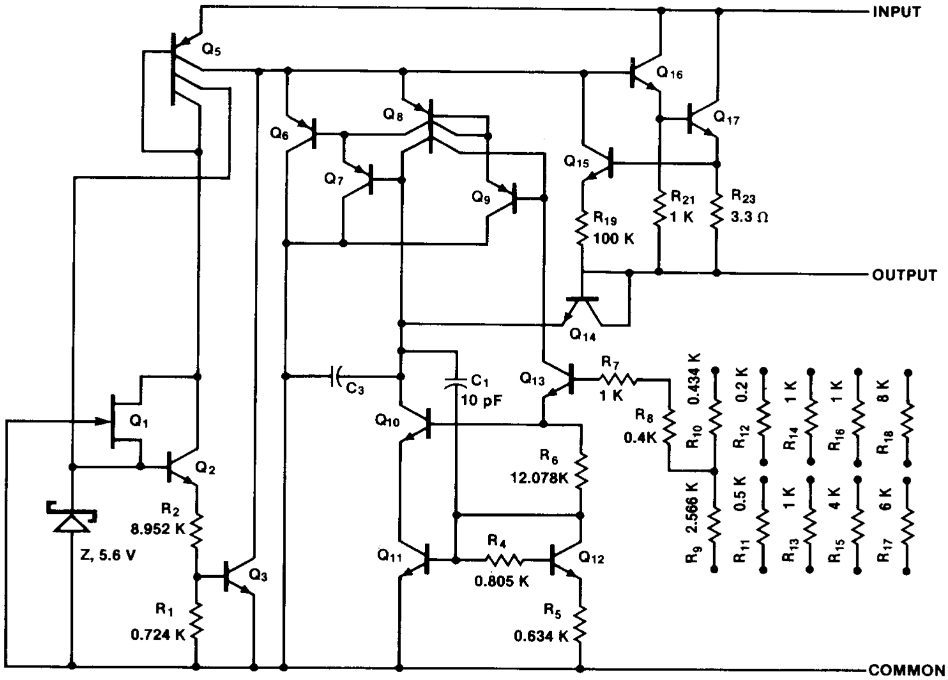


(Top View)

Order Information

Type	Package	Code	Part No.
μA78L05AC	Molded	EI	μA78L05AWC
μA78L62AC	Molded	EI	μA78L62AWC
μA78L82AC	Molded	EI	μA78L82AWC
μA78L09AC	Molded	EI	μA78L09AWC
μA78L12AC	Molded	EI	μA78L12AWC
μA78L15AC	Molded	EI	μA78L15AWC

Equivalent Circuit



μA78L05AC and μA78L05AV (Note 2)

Electrical Characteristics V_{IN} = 10 V, I_{OUT} = 40 mA, 0°C ≤ T_J ≤ 125°C, C_{IN} = 0.33 μF, C_{OUT} = 0.1 μF, unless otherwise specified. (Note 1)

Characteristic	Condition		Min	Typ	Max	Unit
Output Voltage	T_J = 25°C		4.8	5.0	5.2	V
Line Regulation	T_J = 25°C	7 V ≤ V_{IN} ≤ 20 V		55	150	mV
		8 V ≤ V_{IN} ≤ 20 V		45	100	mV
Load Regulation	T_J = 25°C	1 mA ≤ I_{OUT} ≤ 100 mA		11	60	mV
		1 mA ≤ I_{OUT} ≤ 40 mA		5.0	30	mV
Output Voltage	7 V ≤ V_{IN} ≤ 20 V	1 mA ≤ I_{OUT} ≤ 40 mA	4.75		5.25	V
	7 V ≤ V_{IN} ≤ V_{Max} (Note 3)	1 mA ≤ I_{OUT} ≤ 70 mA	4.75		5.25	V
Quiescent Current				2.0	5.5	mA
Quiescent Current Change — with line	8 V ≤ V_{IN} ≤ 20 V				1.5	mA
Quiescent Current Change — with load	1 mA ≤ I_{OUT} ≤ 40 mA				0.1	mA
Output Noise Voltage	T_A = 25°C, 10 Hz ≤ f ≤ 100 kHz			40		μV
Temperature Coefficient of V_{OUT}	I_{OUT} = 5 mA			−0.65		mV/°C
Ripple Rejection	f = 120 Hz, 8 V ≤ V_{IN} ≤ 18 V, T_J = 25°C		41	49		dB
Dropout Voltage	T_J = 25°C			1.7		V
Peak Output/Short-Circuit Current	T_J = 25°C			140		mA

Notes on μA78L15 page.

μA78L62AC
Electrical Characteristics V_{IN} = 12 V, I_{OUT} = 40 mA, 0°C ≤ T_J ≤ 125°C, C_{IN} = 0.33 μF, C_{OUT} = 0.1 μF, unless otherwise specified. (Note 1)

Characteristic		Condition		Min	Typ	Max	Unit
Output Voltage		T_J = 25°C		5.95	6.2	6.45	V
Line Regulation		T_J = 25°C	8.5 V ≤ V_{IN} ≤ 20 V		65	175	mV
			9 V ≤ V_{IN} ≤ 20 V		55	125	mV
Load Regulation		T_J = 25°C	1 mA ≤ I_{OUT} ≤ 100 mA		13	80	mV
			1 mA ≤ I_{OUT} ≤ 40 mA		6.0	40	mV
Output Voltage		8.5 V ≤ V_{IN} ≤ 20 V	1 mA ≤ I_{OUT} ≤ 40 mA	5.90		6.5	V
		8.5 V ≤ V_{IN} ≤ V_{Max} (Note 3)	1 mA ≤ I_{OUT} ≤ 70 mA	5.90		6.5	V
Quiescent Current					2.0	5.5	mA
Quiescent Current Change	with line	8.0 V ≤ V_{IN} ≤ 20 V				1.5	mA
	with load	1 mA ≤ I_{OUT} ≤ 40 mA				0.1	mA
Output Noise Voltage		T_A = 25°C, 10 Hz ≤ f ≤ 100 kHz			50		μV
Temperature Coefficient of V_{OUT}		I_{OUT} = 5 mA			−0.75		mV/°C
Ripple Rejection		f = 120 Hz, 10 V ≤ V_{IN} ≤ 20 V, T_J = 25°C		40	46		dB
Dropout Voltage		T_J = 25°C			1.7		V
Peak Output/Short-Circuit Current		T_J = 25°C			140		mA

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μA78L82AC
Electrical Characteristics V_{IN} = 14 V, I_{OUT} = 40 mA, 0°C ≤ T_J ≤ 125°C, C_{IN} = 0.33 μF, C_{OUT} = 0.1 μF, unless otherwise specified. (Note 1)

Characteristic		Condition		Min	Typ	Max	Unit
Output Voltage		T_J = 25°C		7.87	8.2	8.53	V
Line Regulation		T_J = 25°C	11 V ≤ V_{IN} ≤ 23 V		80	175	mV
			12 V ≤ V_{IN} ≤ 23 V		70	125	mV
Load Regulation		T_J = 25°C	1 mA ≤ I_{OUT} ≤ 100 mA		15	80	mV
			1 mA ≤ I_{OUT} ≤ 40 mA		8.0	40	mV
Output Voltage		11 V ≤ V_{IN} ≤ 23 V	1 mA ≤ I_{OUT} ≤ 40 mA	7.8		8.5	V
		11 V ≤ V_{IN} ≤ V_{Max} (Note 3)	1 mA ≤ I_{OUT} ≤ 70 mA	7.8		8.6	V
Quiescent Current					2.1	5.5	mA
Quiescent Current Change	with line	12 V ≤ V_{IN} ≤ 23 V				1.5	mA
	with load	1 mA ≤ I_{OUT} ≤ 40 mA				0.1	mA
Output Noise Voltage		T_A = 25°C, 10 Hz ≤ f ≤ 100 kHz			60		μV
Temperature Coefficient of V_{OUT}		I_{OUT} = 5 mA			−0.8		mV/°C
Ripple Rejection		f = 120 Hz, 12 V ≤ V_{IN} ≤ 22 V, T_J = 25°C		39	45		dB
Dropout Voltage		T_J = 25°C			1.7		V
Peak Output/Short-Circuit Current		T_J = 25°C			140		mA

Notes on μA78L15 page.

μA78L09AC

Electrical Characteristics V_{IN} = 15 V, I_{OUT} = 40 mA, 0°C ≤ T_J ≤ 125°C, C_{IN} = 0.33 μF, C_{OUT} = 0.1 μF, unless otherwise specified. (Note 1)

Characteristic		Condition		Min	Typ	Max	Unit
Output Voltage		T_J = 25°C		8.64	9.0	9.36	V
Line Regulation		T_J = 25°C	11.5 V ≤ V_{IN} ≤ 24 V		90	200	mV
			13 V ≤ V_{IN} ≤ 24 V		100	150	mV
Load Regulation		T_J = 25°C	1 mA ≤ I_{OUT} ≤ 100 mA		20	90	mV
			1 mA ≤ I_{OUT} ≤ 40 mA		10	45	mV
Output Voltage		11.5 V ≤ V_{IN} ≤ 24 V	1 mA ≤ I_{OUT} ≤ 40 mA	8.55		9.45	V
		11.5 V ≤ V_{IN} ≤ V_{Max} (Note 3)	1 mA ≤ I_{OUT} ≤ 70 mA	8.55		9.45	V
Quiescent Current					2.1	5.5	mA
Quiescent Current Change	with line	11.5 V ≤ V_{IN} ≤ 24 V				1.5	mA
	with load	1 mA ≤ I_{OUT} ≤ 40 mA				0.1	mA
Output Noise Voltage		T_A = 25°C, 10 Hz ≤ f ≤ 100 kHz			70		μV
Temperature Coefficient of V_{OUT}		I_{OUT} = 5 mA			−0.9		mV/°C
Ripple Rejection		f = 120 Hz, 15 V ≤ V_{IN} ≤ 25 V, T_J = 25°C		38	44		dB
Dropout Voltage		T_J = 25°C			1.7		V
Peak Output/Short-Circuit Current		T_J = 25°C			140		mA

μA78L12AC

Electrical Characteristics V_{IN} = 19 V, I_{OUT} = 40 mA, 0°C ≤ T_J ≤ 125°C, C_{IN} = 0.33 μF, C_{OUT} = 0.1 μF, unless otherwise specified. (Note 1)

Characteristic		Condition		Min	Typ	Max	Unit
Output Voltage		T_J = 25°C		11.5	12	12.5	V
Line Regulation		T_J = 25°C	14.5 V ≤ V_{IN} ≤ 27 V		120	250	mV
			16 V ≤ V_{IN} ≤ 27 V		100	200	mV
Load Regulation		T_J = 25°C	1 mA ≤ I_{OUT} ≤ 100 mA		20	100	mV
			1 mA ≤ I_{OUT} ≤ 40 mA		10	50	mV
Output Voltage		14.5 V ≤ V_{IN} ≤ 27 V	1 mA ≤ I_{OUT} ≤ 40 mA	11.4		12.6	V
		14.5 V ≤ V_{IN} ≤ V_{Max} (Note 3)	1 mA ≤ I_{OUT} ≤ 70 mA	11.4		12.6	V
Quiescent Current					2.1	5.5	mA
Quiescent Current Change	with line	16 V ≤ V_{IN} ≤ 27 V				1.5	mA
	with load	1 mA ≤ I_{OUT} ≤ 40 mA				0.1	mA
Output Noise Voltage		T_A = 25°C, 10 Hz ≤ f ≤ 100 kHz			80		μV
Temperature Coefficient of V_{OUT}		I_{OUT} = 5 mA			−1.0		mV/°C
Ripple Rejection		f = 120 Hz, 15 V ≤ V_{IN} ≤ 25 V, T_J = 25°C		37	42		dB
Dropout Voltage		T_J = 25°C			1.7		V
Peak Output/Short-Circuit Current		T_J = 25°C			140		mA

Notes on μA78L15 page.

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μA78L15AC

Electrical Characteristics V_{IN} = 23 V, I_{OUT} = 40 mA, 0°C ≤ T_J ≤ 125°C, C_{IN} = 0.33 μF, C_{OUT} = 0.1 μF, unless otherwise specified. (Note 1)

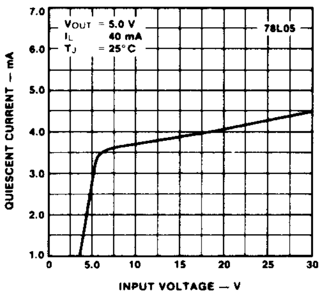
Characteristic	Condition		Min	Typ	Max	Unit
Output Voltage	T_J = 25°C		14.4	15	15.6	V
Line Regulation	T_J = 25°C	17.5 V ≤ V_{IN} ≤ 30 V		130	300	mV
		20 V ≤ V_{IN} ≤ 30 V		110	250	mV
Load Regulation	T_J = 25°C	1 mA ≤ I_{OUT} ≤ 100 mA		25	150	mV
		1 mA ≤ I_{OUT} ≤ 40 mA		12	75	mV
Output Voltage	17.5 V ≤ V_{IN} ≤ 30 V	1 mA ≤ I_{OUT} ≤ 40 mA	14.25		15.75	V
	17.5 V ≤ V_{IN} ≤ V_{Max} (Note 2)	1 mA ≤ I_{OUT} ≤ 70 mA	14.25		15.75	V
Quiescent Current				2.2	5.5	mA
Quiescent Current Change with line	20 V ≤ V_{IN} ≤ 30 V				1.5	mA
Quiescent Current Change with load	1 mA ≤ I_{OUT} ≤ 40 mA				0.1	mA
Output Noise Voltage	T_A = 25°C, 10 Hz ≤ f ≤ 100 kHz			90		μV
Temperature Coefficient of V_{OUT}	I_{OUT} = 5 mA			−1.3		mV/°C
Ripple Rejection	f = 120 Hz, 18.5 V ≤ V_{IN} ≤ 28.5 V, T_J = 25°C		34	39		dB
Dropout Voltage	T_J = 25°C			1.7		V
Peak Output/Short-Circuit Current	T_J = 25°C			140		mA

Notes

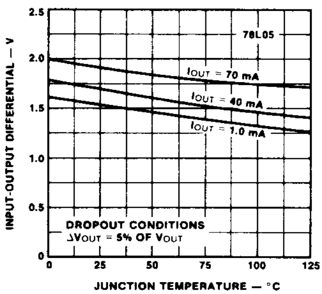
1. The maximum steady state usable output current and input voltage are very dependent on the heat sinking and/or lead length of the package. The data above represent pulse test conditions with junction temperatures as indicated at the initiation of tests.
2. Power Dissipation ≤ .75 W.

Typical Performance Curves

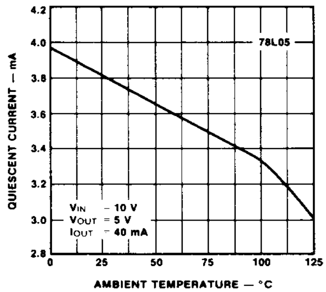
Quiescent Current as a Function of Input Voltage



Dropout Voltage as a Function of Junction Temperature



Quiescent Current as a Function of Temperature



Note

Other μA78L00 Series devices have similar curves.

μA7808

Electrical Characteristics V_{IN} = 14 V, I_{OUT} = 500 mA, −55°C ≤ T_J ≤ 150°C, C_{IN} = 0.33 μF, C_{OUT} = 0.1 μF, unless otherwise specified.

Characteristic		Condition (Note)		Min	Typ	Max	Unit
Output Voltage		T_J = 25°C		7.7	8.0	8.3	V
Line Regulation		T_J = 25°C	10.5 V ≤ V_{IN} ≤ 25 V		6.0	80	mV
			11 V ≤ V_{IN} ≤ 17 V		2.0	40	mV
Load Regulation		T_J = 25°C	5 mA ≤ I_{OUT} ≤ 1.5 A		12	100	mV
			250 mA ≤ I_{OUT} ≤ 750 mA		4.0	40	mV
Output Voltage		11.5 V ≤ V_{IN} ≤ 23 V 5 mA ≤ I_{OUT} ≤ 1.0 A P ≤ 15 W		7.6		8.4	V
Quiescent Current		T_J = 25°C			4.3	6.0	mA
Quiescent Current Change	with line	11.5 V ≤ V_{IN} ≤ 25 V				0.8	mA
	with load	5 mA ≤ I_{OUT} ≤ 1.0 A				0.5	mA
Output Noise Voltage		T_A = 25°C, 10 Hz ≤ f ≤ 100 kHz			8	40	μV/V_{OUT}
Ripple Rejection		f = 120 Hz, 11.5 V ≤ V_{IN} ≤ 21.5 V		62	72		dB
Dropout Voltage		I_{OUT} = 1.0 A, T_J = 25°C			2.0	2.5	V
Output Resistance		f = 1 kHz			16		mΩ
Short-Circuit Current		T_J = 25°C, V_{IN} = 35 V			0.75	1.2	A
Peak Output Current		T_J = 25°C		1.3	2.2	3.3	A
Average Temperature Coefficient of Output Voltage		I_{OUT} = 5 mA	−55°C ≤ T_J ≤ +25°C			0.4	mV/°C/V_{OUT}
			+25°C ≤ T_J ≤ 150°C			0.3	

μA7808C

Electrical Characteristics V_{IN} = 14 V, I_{OUT} = 500 mA, 0°C ≤ T_J ≤ 125°C, C_{IN} = 0.33 μF, C_{OUT} = 0.1 μF, unless otherwise specified.

Characteristic		Condition (Note)		Min	Typ	Max	Unit
Output Voltage		T_J = 25°C		7.7	8.0	8.3	V
Line Regulation		T_J = 25°C	10.5 V ≤ V_{IN} ≤ 25 V		6.0	160	mV
			11 V ≤ V_{IN} ≤ 17 V		2.0	80	mV
Load Regulation		T_J = 25°C	5 mA ≤ I_{OUT} ≤ 1.5 A		12	160	mV
			250 mA ≤ I_{OUT} ≤ 750 mA		4.0	80	mV
Output Voltage		10.5 V ≤ V_{IN} ≤ 23 V 5 mA ≤ I_{OUT} ≤ 1.0 A P ≤ 15 W		7.6		8.4	V
Quiescent Current		T_J = 25°C			4.3	8.0	mA
Quiescent Current Change	with line	10.5 V ≤ V_{IN} ≤ 25 V				1.0	mA
	with load	5 mA ≤ I_{OUT} ≤ 1.0 A				0.5	mA
Output Noise Voltage		T_A = 25°C, 10 Hz ≤ f ≤ 100 kHz			52		μV
Ripple Rejection		f = 120 Hz, 11.5 V ≤ V_{IN} ≤ 21.5 V		56	72		dB
Dropout Voltage		I_{OUT} = 1.0 A, T_J = 25°C			2.0		V
Output Resistance		f = 1 kHz			16		mΩ
Short-Circuit Current		T_J = 25°C, V_{IN} = 35 V			450		mA
Peak Output Current		T_J = 25°C			2.2		A
Average Temperature Coefficient of Output Voltage		I_{OUT} = 5 mA, 0°C ≤ T_J ≤ 125°C			0.8		mV/°C

The TO-92 Package
The TO-92 package thermal paths are complex. In addition to the path through the molding compound to ambient temperature, there is another path through the pins, in parallel with the case path, to ambient temperature, as shown in *Figure 1*.

The total thermal resistance in this model is then:

$$\theta_{JA} = \frac{(\theta_{JC} + \theta_{CA})(\theta_{JL} + \theta_{LA})}{\theta_{JC} + \theta_{CA} + \theta_{JL} + \theta_{LA}}$$

Where: θ_{JC} = thermal resistance of the case between the regulator die and a point on the case directly above the die location.

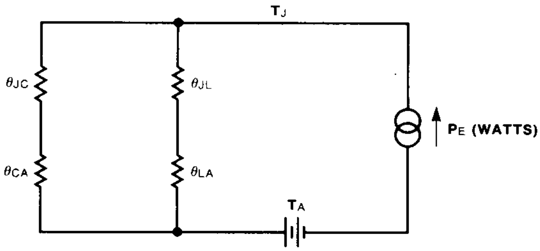
θ_{CA} = thermal resistance between the case and air at ambient temperature.

θ_{JL} = thermal resistance from transistor die through the collector lead to a point 1/16 inch below the regulator case.

θ_{LA} = total thermal resistance of the collector-base-emitter pins to ambient temperature.

θ_{JA} = junction to ambient thermal resistance.

TO-92 Thermal Equivalent Circuit
Fig. 1



Methods of Heat Sinking
With two external thermal resistances in each leg of a parallel network available to the circuit designer as variables, he can choose the method of heat sinking most applicable to his particular situation. To demonstrate, consider the effect of placing a small 72°C/W flag type heat sink, such as the Staver F1-7D-2, on the 78LXX molded case. The heat sink effectively replaces the θ_{CA} (*Figure 2*) and the new thermal resistance, θ'_{JA}, is

θ'_{JA} = 145°C/W (assuming .125 inch lead length)

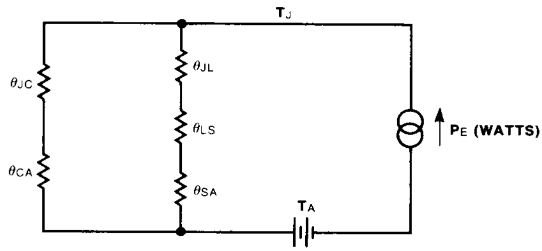
The net change of 15°C/W increases the allowable power dissipation to 0.86 W with an inserted cost of 1-2 cents. A still further decrease in θ_{JA} could be achieved by using a heat sink rated at 46°C/W, such as the Staver FS-7A. Also, if the case sinking does not provide an adequate reduction in total θ_{JA}, the other external thermal resistance, θ_{LA}, may be reduced by shortening the lead length from package base to mounting medium. However, one point must be kept in mind. The lead thermal path includes a thermal resistance, θ_{SA}, from the pins at the mounting point to ambient, that is, the mounting medium. θ_{LA} is then equal to $\theta_{LS} + \theta_{SA}$. The new model is shown in *Figure 2*.

In the case of a socket, θ_{SA} could be as high as 270°C/W, thus causing a net increase in θ_{JA} and a consequent decrease in the maximum dissipation capability. Shortening the lead length may return the net θ_{JA} to the original value, but pin sinking would not be accomplished.

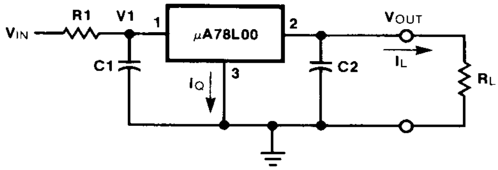
In those cases where the regulator is inserted into a copper clad printed circuit board, it is advantageous to have a maximum area of copper at the entry points of the pins. While it would be desirable to rigorously define the effect of PC board copper, the real world variables are too great to allow anything more than a few general observations.

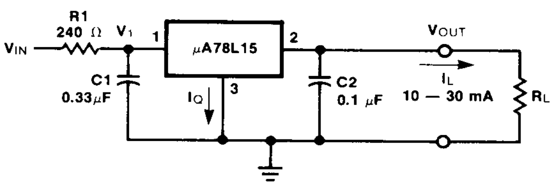
The best analogy for PC board copper is to compare it with parallel resistors. Beyond some point, additional resistors are not significantly effective; beyond some point, additional copper area is not effective.

TO-92 Thermal Equivalent Circuit
(Pin at Other Than Ambient Temperature)
Fig. 2



High Dissipation Applications





When it is necessary to operate a μA78L00 regulator with a large input-output differential voltage, the addition of series resistor R1 will extend the output current range of the device by sharing the total power dissipation between R1 and the regulator.

$$R1 = \frac{V_{IN(Min)} - V_{OUT} - 2.0\ V}{I_{L(Max)} + I_Q}$$

where I_Q is the regulator quiescent current.

Regulator power dissipation at maximum input voltage and maximum load current is now

$$P_{D(Max)} = (V_1 - V_{OUT})\, I_{L(Max)} + V_1\, I_Q$$

where

$$V_1 = V_{IN(Max)} - (I_{L(Max)} + I_Q)\, R1$$

The presence of R1 will affect load regulation according to the equation:

load regulation (at constant VIN)
= load regulation (at constant V1)
+ (line regulation, mV per V)
× (RI) × (ΔIL).

As an example, consider a 15 V regulator with a supply voltage of 30 ±5 V, required to supply a maximum load current of 30 mA. I_Q is 4.3 mA, and minimum load current is to be 10 mA.

$$R1 = \frac{25 - 15 - 2}{30 + 4.3} = \frac{34.3}{8} \simeq 240\ \Omega$$

$$V_1 = 35 - (30 + 4.3).24 = 35 - 8.2 = 26.8\ V$$

$$P_{D(Max)} = (26.8 - 15)\ 30 + 26.8\ (4.3)$$

$$= 354 + 115$$

= 470 mW, which permit operation up to 70°C in most applications.

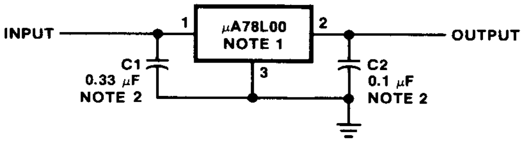
Line regulation of this circuit is typically 110 mV for an input range of 25-35 V at a constant load current; i.e. 11 mV/V.

Load regulation = constant V_1 load regulation (typically 10 mV, 10-30 mA I_L)

+ (11 mV/V) × 0.24 × 20 mA (typically 53 mV)

= 63 mV for a load current change of 20 mA at a constant V_{IN} of 30 V.

Typical Applications



Notes

1. To specify an output voltage, substitute voltage value for "00".
2. Bypass Capacitors are recommended for optimum stability and transient response and should be located as close as possible to the regulator.