

## Description

The GM78L00 series in positive voltage regulators are low-cost devices providing a simple solution for a wide variety of applications, which requires a regulated supply of up to 100mA.

These virtually indestructible positive voltage regulators are protected by thermal shutdown and internal current-limiting. Most applications require no external components.

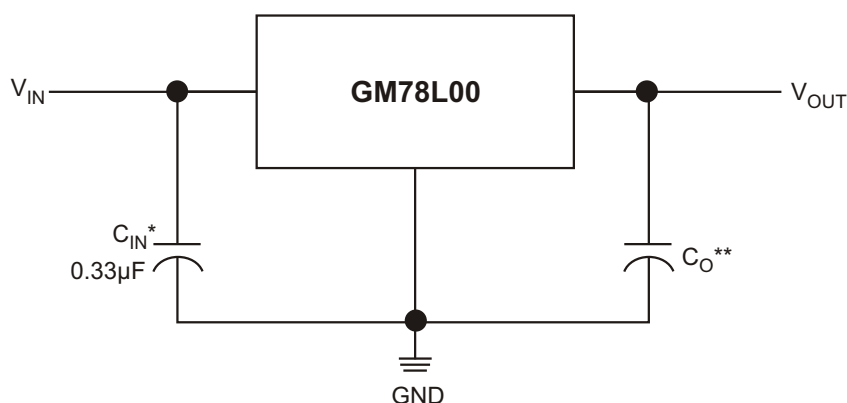
The GM78L00 is very versatile. To use them as fixed voltage regulators in a wide range of applications, including both local and on-card regulation for elimination of noise and distribution problems associated with single-point regulation. They can also be used with power pass elements to make high current voltage regulators.

The GM78L00 offers impressive performance advantages over old-fashioned zener diode-resistor combinations, providing lower output impedance and reduced quiescent cur-

## Features

- ◆ **Output Current up to 100mA**
- ◆ **Output Voltages 5V, 6V, 8V, 9V, 10V, 12V, 15V, 18V and 24V**
- ◆ **3- Terminal Regulators**
- ◆ **No External Components Required**
- ◆ **Internal Thermal Overload Protection**
- ◆ **Internal Short Circuit Current-Limiting**
- ◆ **Available in TO-92, SOT-89 and SOP-8 packages**

## TYPIC APPLICATION CIRCUITS



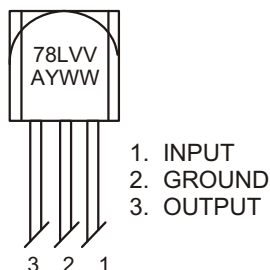
A common ground is required between the input and the output voltages. The input voltage must remain typically 2.0V above the output voltage even during the low point on the input ripple voltage.

\*  $C_{IN}$  is required if regulator is located an appreciable distance from power supply filter.

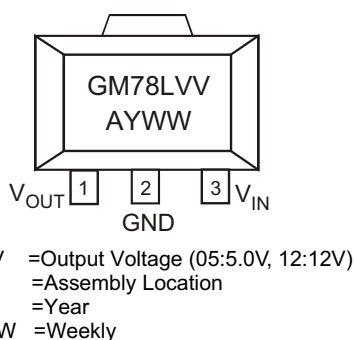
\*\*  $C_O$  is not needed for stability; however, it does improve transient response.

#### ◆ MARKING INFORMATION & PIN CONFIGURATIONS (TOP VIEW)

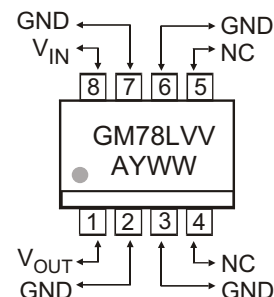
**TO-92**



**SOT-89**



**SOP-8**



#### ◆ ORDERING INFORMATION

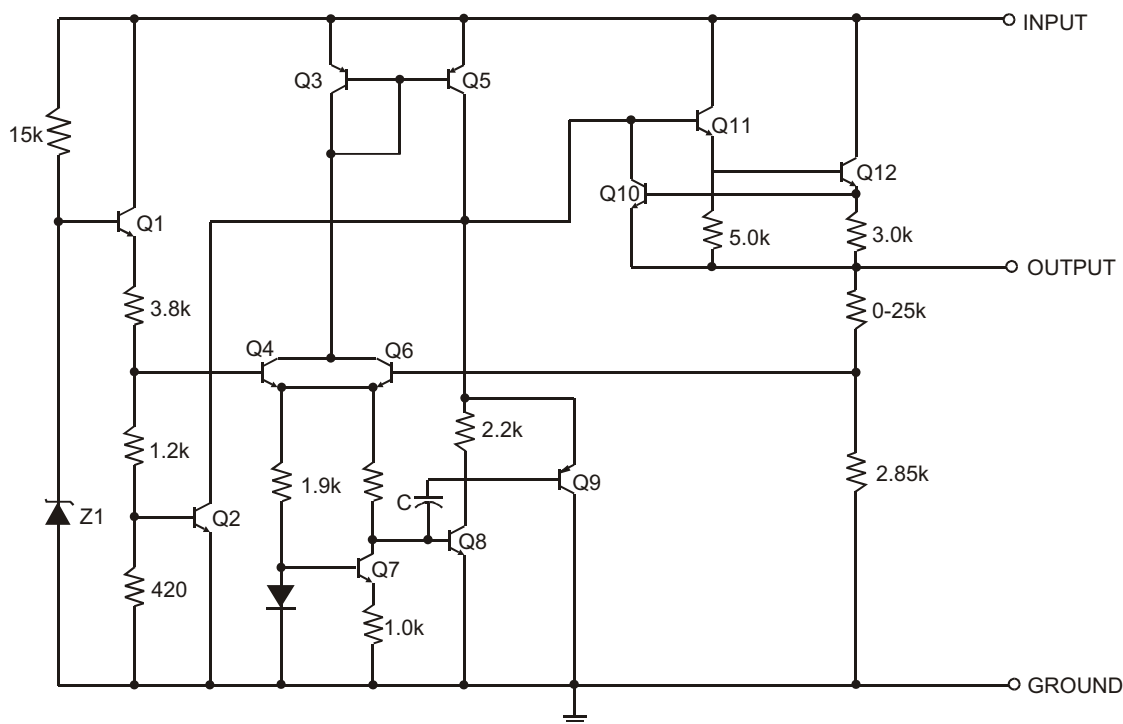
Pro Number	$V_{OUT}$	Package
GM78L05	5.0V	TO-92, SOT-89, SOP-8
GM78L06	6.0V	TO-92, SOT-89, SOP-8
GM78L08	8.0V	TO-92, SOT-89, SOP-8
GM78L09	9.0V	TO-92, SOT-89, SOP-8
GM78L10	10V	TO-92, SOT-89, SOP-8
GM78L12	12V	TO-92, SOT-89, SOP-8
GM78L15	15V	TO-92, SOT-89, SOP-8
GM78L18	18V	TO-92, SOT-89, SOP-8
GM78L24	24V	TO-92, SOT-89, SOP-8

\* For detail Ordering Number identification, please see last page.

#### ◆ RECOMMENDED OPERATING CONDITIONS ( $I_o = 1.5A$ )

PARAMETER		MIN	MAX	UNIT
Input Voltage $V_I$	GM78L05	7	20	V
	GM78L06	8	20	
	GM78L08	10.5	23	
	GM78L09	11.5	24	
	GM78L10	12.5	25	
	GM78L12	14.5	27	
	GM78L15	17.5	30	
	GM78L18	21	33	
	GM78L24	27	39	
Output Current, $I_o$			100	mA
Operating virtual junction temperature, $T_J$		0	125	°C

#### ◆ BLOCK DIAGRAM



#### ◆ ABSOLUTE MAXIMUM RATINGS

PARAMETER	SYMBOL	VALUE	UNITS
Input Voltage	$V_I$	30	V
GM78L05 to GM78L10		35	
GM78L12 to GM78L18		40	
GM78L24			
Power Dissipation	$P_D$	Internally limited	W
Operating Junction Temperature Range	$T_J$	0 to +150	°C
Storage Temperature Range	$T_{stg}$	-65 to +150	°C
Lead Temperature 1.6mm (1/16 inch) from case for 10 sec.	$T_L$	260	°C

**◆ ELECTRICAL CHARACTERISTICS at specified Junction Temperature**
**GM78L05:**  $V_I = 10V$ ,  $I_O = 40mA$ , (unless otherwise noted)

CHARACTERISTICS	TEST CONDITIONS *		MIN	TYP	MAX	UNIT
Output Voltage **		25°C	4.8	5.0	5.2	V
	$I_O = 1mA$ to 40mA $V_I = 7V$ to 20V	0°C to 125°C	4.75	5.0	5.25	
	$I_O = 1mA$ to 70mA		4.75	5.0	5.25	
Input Regulation	$V_I = 7V$ to 20V	25°C		32	150	mV
	$V_I = 8V$ to 20V			26	100	
Ripple Rejection	$V_I = 8V$ to 18V, $f = 120Hz$	25°C	41	49		dB
Output Regulation	$I_O = 1mA$ to 100mA	25°C		15	60	mV
	$I_O = 1mA$ to 40mA			8	30	
Output Resistance	$f = 10Hz$ to 100kHz	25°C		42		μV
Dropout Voltage		25°C		1.7		V
Bias Current		25°C		3.8	6	mA
		125°C			5.5	
Bias Current	$V_I = 8V$ to 20V	0°C to 125°C			1.5	mA
	$I_O = 1mA$ to 40mA				0.1	

**GM78L06:**  $V_I = 11V$ ,  $I_O = 40mA$ , (unless otherwise noted)

CHARACTERISTICS	TEST CONDITIONS *		MIN	TYP	MAX	UNIT
Output Voltage **		25°C	5.75	6.0	6.25	V
	$I_O = 1mA$ to 40mA $V_I = 8V$ to 20V	0°C to 125°C	5.7	6.0	6.3	
	$I_O = 1mA$ to 70mA		5.7	6.0	6.3	
Input Regulation	$V_I = 8V$ to 20V	25°C		35	175	mV
	$V_I = 9V$ to 20V			29	125	
Ripple Rejection	$V_I = 9V$ to 19V, $f = 120Hz$	25°C	40	48		dB
Output Regulation	$I_O = 1mA$ to 100mA	25°C		16	80	mV
	$I_O = 1mA$ to 40mA			9	40	
Output Resistance	$f = 10Hz$ to 100kHz	25°C		46		μV
Dropout Voltage		25°C		1.7		V
Bias Current		25°C		3.9	6	mA
		125°C			5.5	
Bias Current	$V_I = 9V$ to 20V	0°C to 125°C			1.5	mA
	$I_O = 1mA$ to 40mA				0.1	

\*Pulse testing techniques are used to maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account.

\*\* The specification applies only for DC power dissipation permitted by absolute maximum ratings

#### ◆ ELECTRICAL CHARACTERISTICS at specified Junction Temperature

**GM78L08:**  $V_I = 14V$ ,  $I_O = 40mA$ , (unless otherwise noted)

CHARACTERISTICS	TEST CONDITIONS *		MIN	TYP	MAX	UNIT
Output Voltage **		25°C	7.7	8.0	8.3	V
	$I_O = 1mA$ to 40mA $V_I = 10.5V$ to 23V	0°C to 125°C	7.6	8.0	8.4	
	$I_O = 1mA$ to 70mA		7.6	8.0	8.4	
Input Regulation	$V_I = 10.5V$ to 23V	25°C		42	175	mV
	$V_I = 11V$ to 23V			36	125	
Ripple Rejection	$V_I = 13V$ to 23V, $f = 120Hz$	0°C to 125°C	37	46		dB
Output Regulation	$I_O = 1mA$ to 100mA	25°C		18	80	mV
	$I_O = 1mA$ to 40mA			10	40	
Output Resistance	$f = 10Hz$ to 100kHz	25°C		54		μV
Dropout Voltage		25°C		1.7		V
Bias Current		25°C		4	6	mA
		125°C			5.5	
Bias Current	$V_I = 11V$ to 23V	0°C to 125°C			1.5	mA
	$I_O = 1mA$ to 40mA				0.1	

**GM78L09:**  $V_I = 16V$ ,  $I_O = 40mA$ , (unless otherwise noted)

CHARACTERISTICS	TEST CONDITIONS *		MIN	TYP	MAX	UNIT
Output Voltage **		25°C	8.6	9.0	9.4	V
	$I_O = 1mA$ to 40mA $V_I = 12V$ to 24V	0°C to 125°C	8.55	9.0	9.45	
	$I_O = 1mA$ to 70mA		8.55	9.0	9.45	
Input Regulation	$V_I = 12V$ to 24V	25°C		45	175	mV
	$V_I = 13V$ to 24V			40	125	
Ripple Rejection	$V_I = 15V$ to 25V, $f = 120Hz$	25°C	38	45		dB
Output Regulation	$I_O = 1mA$ to 100mA	25°C		19	90	mV
	$I_O = 1mA$ to 40mA			11	40	
Output Resistance	$f = 10Hz$ to 100kHz	25°C		58		μV
Dropout Voltage		25°C		1.7		V
Bias Current		25°C		4.1	6	mA
		125°C			5.5	
Bias Current	$V_I = 13V$ to 20V	0°C to 125°C			1.5	mA
	$I_O = 1mA$ to 40mA				0.1	

\*Pulse testing techniques are used to maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account.

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**◆ ELECTRICAL CHARACTERISTICS at specified Junction Temperature**
**GM78L10:**  $V_I = 17V$ ,  $I_O = 40mA$ , (unless otherwise noted)

CHARACTERISTICS	TEST CONDITIONS *		MIN	TYP	MAX	UNIT
Output Voltage **		25°C	9.6	10	10.4	V
	$I_O = 1mA$ to 40mA $V_I = 13V$ to 25V	0°C to 125°C	9.5	10	10.5	
	$I_O = 1mA$ to 70mA		9.5	10	10.5	
Input Regulation	$V_I = 13V$ to 25V	25°C		51	175	mV
	$V_I = 14V$ to 25V			42	125	
Ripple Rejection	$V_I = 15V$ to 25V, $f = 120Hz$	0°C to 125°C	37	44		dB
Output Regulation	$I_O = 1mA$ to 100mA	25°C		20	90	mV
	$I_O = 1mA$ to 40mA			11	40	
Output Resistance	$f = 10Hz$ to 100kHz	25°C		62		μV
Dropout Voltage		25°C		1.7		V
Bias Current		25°C		4	6	mA
		125°C			5.5	
Bias Current	$V_I = 14V$ to 25V	0°C to 125°C			1.5	mA
	$I_O = 1mA$ to 40mA				0.1	

**GM78L12:**  $V_I = 19V$ ,  $I_O = 40mA$ , (unless otherwise noted)

CHARACTERISTICS	TEST CONDITIONS *		MIN	TYP	MAX	UNIT
Output Voltage **		25°C	11.5	12	12.5	V
	$I_O = 1mA$ to 40mA $V_I = 14.5V$ to 27V	0°C to 125°C	11.4	12	12.6	
	$I_O = 1mA$ to 70mA		11.4	12	12.6	
Input Regulation	$V_I = 14.5V$ to 27V	25°C		55	250	mV
	$V_I = 16V$ to 27V			49	200	
Ripple Rejection	$V_I = 15V$ to 25V, $f = 120Hz$	25°C	37	42		dB
Output Regulation	$I_O = 1mA$ to 100mA	25°C		22	100	mV
	$I_O = 1mA$ to 40mA			13	50	
Output Resistance	$f = 10Hz$ to 100kHz	25°C		70		μV
Dropout Voltage		25°C		1.7		V
Bias Current		25°C		4.3	6.5	mA
		125°C			6.0	
Bias Current	$V_I = 16V$ to 27V	0°C to 125°C			1.5	mA
	$I_O = 1mA$ to 40mA				0.1	

\*Pulse testing techniques are used to maintain the junction temperature as close to the ambient temperature as possible.  
Thermal effects must be taken into account.

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#### ◆ ELECTRICAL CHARACTERISTICS at specified Junction Temperature

**GM78L15:**  $V_I = 23V$ ,  $I_O = 40mA$ , (unless otherwise noted)

CHARACTERISTICS	TEST CONDITIONS *		MIN	TYP	MAX	UNIT
Output Voltage **		25°C	14.4	15	15.6	V
	$I_O = 1mA$ to 40mA $V_I = 17.5V$ to 30V	0°C to 125°C	14.25	15	15.75	
	$I_O = 1mA$ to 70mA		14.25	15	15.75	
Input Regulation	$V_I = 17.5V$ to 30V	25°C		65	300	mV
	$V_I = 19V$ to 30V			58	250	
Ripple Rejection	$V_I = 18.5V$ to 28.5V, $f = 120Hz$	0°C to 125°C	34	39		dB
Output Regulation	$I_O = 1mA$ to 100mA	25°C		25	150	mV
	$I_O = 1mA$ to 40mA			15	75	
Output Resistance	$f = 10Hz$ to 100kHz	25°C		82		μV
Dropout Voltage		25°C		1.7		V
Bias Current		25°C		4.6	6.5	mA
		125°C			6.0	
Bias Current	$V_I = 14V$ to 25V	0°C to 125°C			1.5	mA
	$I_O = 1mA$ to 40mA				0.1	

**GM78L18:**  $V_I = 26V$ ,  $I_O = 40mA$ , (unless otherwise noted)

CHARACTERISTICS	TEST CONDITIONS *		MIN	TYP	MAX	UNIT
Output Voltage **		25°C	17.3	18	18.7	V
	$I_O = 1mA$ to 40mA $V_I = 20.5V$ to 33V	0°C to 125°C	17.1	18	18.9	
	$I_O = 1mA$ to 70mA		17.1	18	18.9	
Input Regulation	$V_I = 20.5V$ to 33V	25°C		70	360	mV
	$V_I = 22V$ to 33V			64	300	
Ripple Rejection	$V_I = 21.5V$ to 31.5V, $f = 120Hz$	25°C	32	36		dB
Output Regulation	$I_O = 1mA$ to 100mA	25°C		27	180	mV
	$I_O = 1mA$ to 40mA			19	90	
Output Resistance	$f = 10Hz$ to 100kHz	25°C		89		μV
Dropout Voltage		25°C		1.7		V
Bias Current		25°C		4.7	6.5	mA
		125°C			6.0	
Bias Current	$V_I = 22V$ to 33V	0°C to 125°C			1.5	mA
	$I_O = 1mA$ to 40mA				0.1	

\*Pulse testing techniques are used to maintain the junction temperature as close to the ambient temperature as possible. Thermal effects must be taken into account.

\*\* The specification applies only for DC power dissipation permitted by absolute maximum ratings

**◆ ELECTRICAL CHARACTERISTICS at specified Junction Temperature**
**GM78L24:**  $V_I = 32V$ ,  $I_O = 40mA$ , (unless otherwise noted)

CHARACTERISTICS	TEST CONDITIONS *		MIN	TYP	MAX	UNIT
Output Voltage **		25°C	23	24	25	V
	$I_O = 1mA$ to 40mA $V_I = 26.5V$ to 39V	0°C to 125°C	22.8	24	25.2	
	$I_O = 1mA$ to 70mA		22.8	24	25.2	
Input Regulation	$V_I = 26.5V$ to 39V	25°C		95	480	mV
	$V_I = 29V$ to 39V			78	400	
Ripple Rejection	$V_I = 27.5V$ to 37.5V, $f = 120Hz$	0°C to 125°C	30	33		dB
Output Regulation	$I_O = 1mA$ to 100mA	25°C		41	240	mV
	$I_O = 1mA$ to 40mA			28	120	
Output Resistance	$f = 10Hz$ to 100kHz	25°C		97		μV
Dropout Voltage		25°C		1.7		V
Bias Current		25°C		4.8	6.5	mA
		125°C			6.0	
Bias Current	$V_I = 28V$ to 39V	0°C to 125°C			1.5	mA
	$I_O = 1mA$ to 40mA				0.1	

\*Pulse testing techniques are used to maintain the junction temperature as close to the ambient temperature as possible.  
Thermal effects must be taken into account.

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#### ◆ TYPICAL PERFORMANCE CHARACTERISTICS

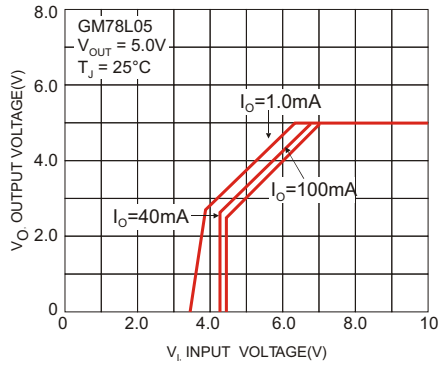


Figure 1. Dropout Characteristics

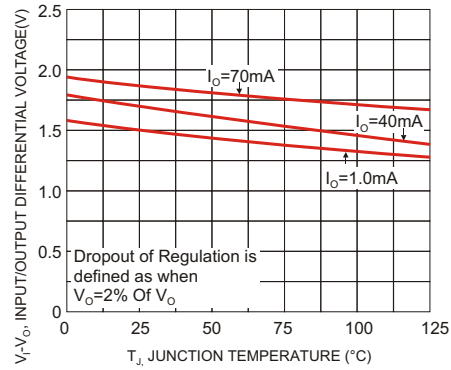


Figure 2. Dropout Voltage versus Junction Temperature

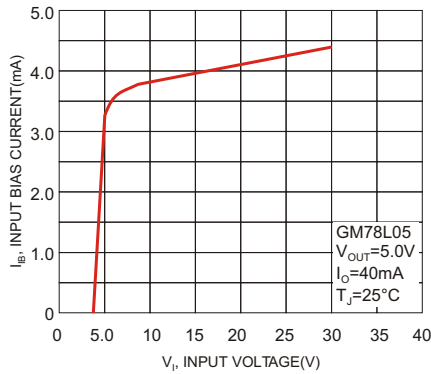


Figure 3. Input Bias Current versus Input Voltage

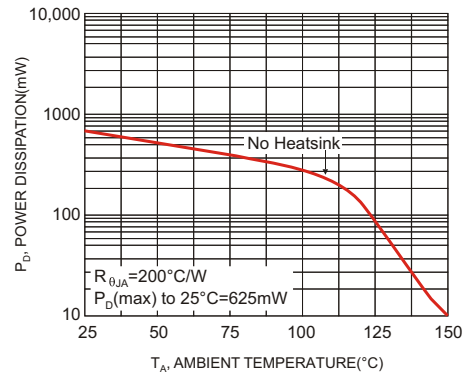


Figure 4. Maximum Average Power Dissipation versus Ambient Temperature-TO-92 Type Package

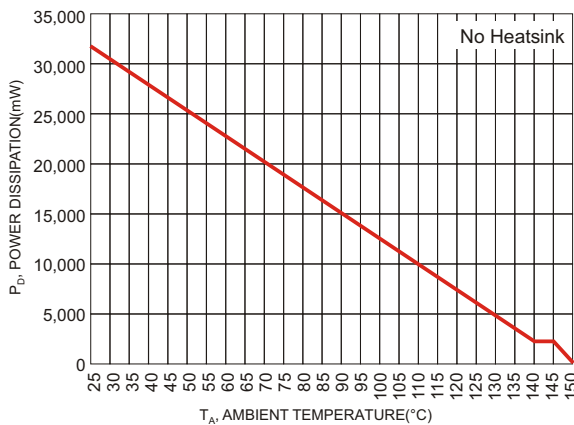


Figure 5. Maximum Average Power Dissipation versus Ambient Temperature SOT-89 Type Package

#### ◆ APPLICATION INFORMATION

##### Design Considerations

The GM78L00 series regulators have thermal overload protection from excessive power, internal short-circuit protection limits each circuit's maximum current, and output transistor safe-area protection for reducing the output current as the voltage across each pass transistor is increased.

Although the internal power dissipation is limited, the junction temperature must be kept below the maximum specified temperature (125°C) in order to meet data sheet specifications.

##### Thermal Considerations

The TO-92 molded package is capable of unusual high power dissipation due to the lead frame design. However, its thermal capabilities are generally overlooked because of a lack of understanding of the thermal paths from the semiconductor junction to ambient temperature.

While thermal resistance is normally specified for the device mounted 1cm above an infinite heat sink, very little has been mentioned of the options available to improve the conservatively rated thermal capability. An explanation of the thermal paths of the TO-92 will allow the designer to determine the thermal stress which is applying in any given application.

##### 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 leads, in parallel with the case path, to ambient temperature, as shown in Figure 5.

The total thermal resistance in this model is then:

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

Where:

$\theta_{JC}$  = thermal resistance of the case between the regulator die and a point on the case directly above the die location.

$\theta_{CA}$  = thermal resistance between the case and air at ambient temperature.

$\theta_{JL}$  = thermal resistance from regulator die through the input lead to a point 1/16 inch below the regulator case.

$\theta_{LA}$  = total thermal resistance of the input/output ground leads to ambient temperature.

$\theta_{JA}$  = junction to ambient thermal resistance.

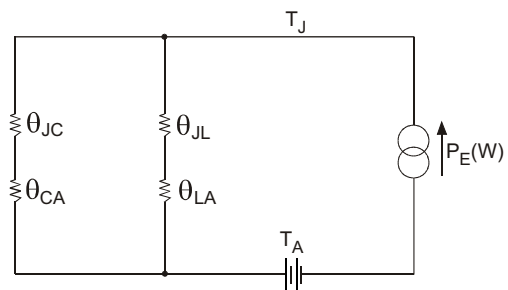
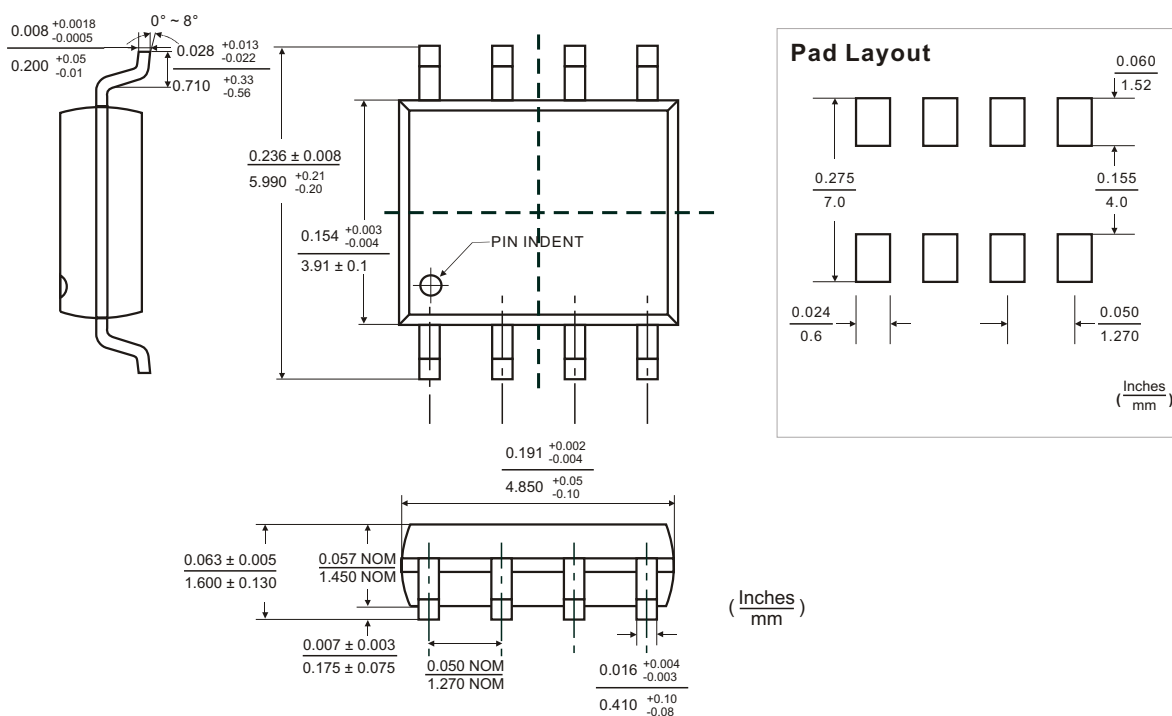
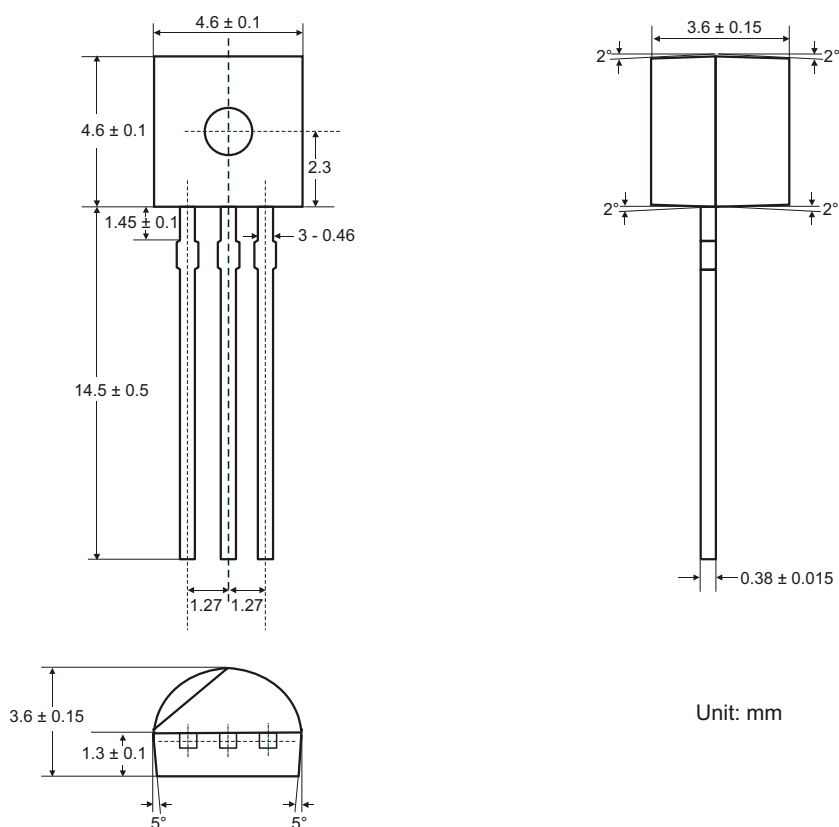


Figure 5. TO-92 Thermal Equivalent Circuit

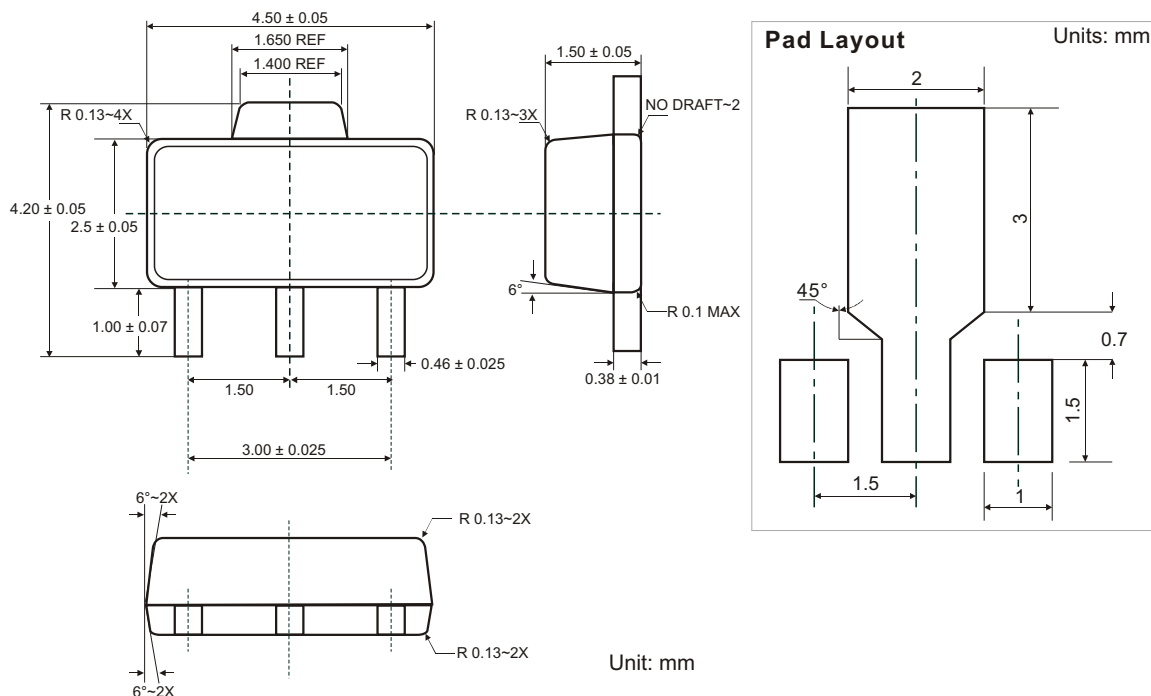
## ◆ SOP-8 PACKAGE OUTLINE DIMENSIONS



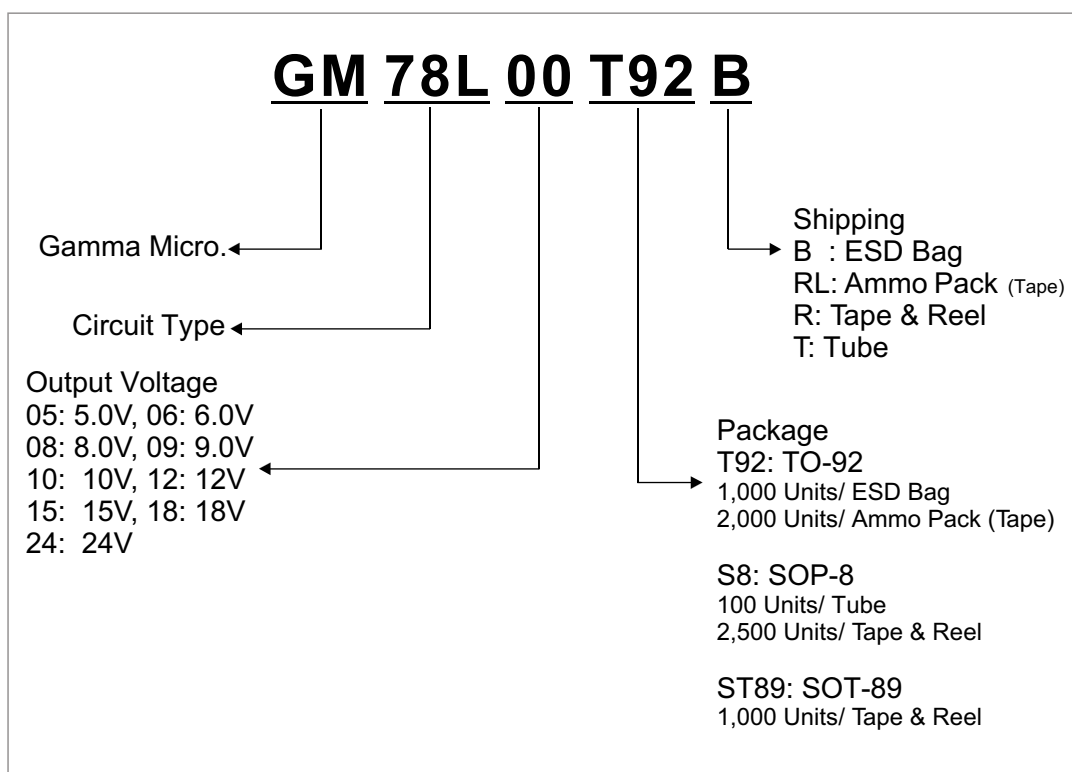
## ◆ TO-92 PACKAGE OUTLINE DIMENSIONS





### ◆ SOT-89 PACKAGE OUTLINE DIMENSIONS



### ◆ ORDERING NUMBER



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