

## Three-Terminal Low Current Positive Voltage Regulator

### Features

- 3-Terminal Regulators
- Maximum Input Voltage : 30V
- Output Voltages of 5V,12V
- Output Current Up to 100mA
- No External Components
- Internal Thermal Overload Protection
- Internal Short-Circuit Limiting
- Output Voltage Offered in 4% tolerance
- SOP-8, SOT-89 and TO-92 Packages.

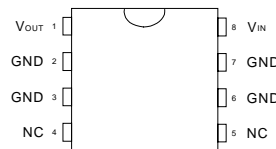
### Applications

- Battery-Powered Circuitry
- Post Regulator for Switching Power Supply

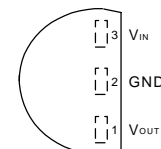
### General Description

This series of fixed-voltage monolithic integrated-circuit voltage regulators is designed for a wide range of applications. These applications include 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. Each of these regulators can deliver up to 100mA of output current. The internal limiting and ternal shutdown features of these regulators make them essentially immune to overload. When used as a replacement for a Zener diode-resistor combination, an effective improvement in output impedance can be obtained together with lower-bias current.

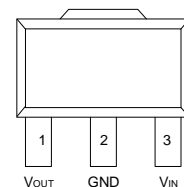
### Pin Description



SOP-8 (Top View)



TO-92 (Top View)



SOT-89 (Front View)

### Ordering and Marking Information

<p>APL78L05/12 - <span style="border: 1px solid black; padding: 2px;">□□-□□□</span></p> <p style="margin-left: 40px;"> <span style="border: 1px solid black; padding: 2px;">□□□</span> Lead Free Code  <span style="border: 1px solid black; padding: 2px;">□□</span> Handling Code  <span style="border: 1px solid black; padding: 2px;">□</span> Temp. Range  <span style="border: 1px solid black; padding: 2px;">□</span> Package Code         </p>	<p>Package Code            E : TO-92      K : SOP-8      D : SOT-89</p> <p>Temp. Range            C : 0 to 70 °C</p> <p>Handling Code            TU : Tube    TR : Tape &amp; Reel    PB : Plastic Bag            TB : Tape &amp; Box</p> <p>Lead Free Code            L : Lead Free Device    Blank : Original Device</p>
<p>APL78L05/12 E : <span style="border: 1px solid black; padding: 2px;">APL 78L05/12 XXXXX</span>    XXXXX - Date Code</p>	<p>APL78L05/12 D/K : <span style="border: 1px solid black; padding: 2px;">APL78L05/12 XXXXX</span>    XXXXX - Date Code</p>

ANPEC reserves the right to make changes to improve reliability or manufacturability without notice, and advise customers to obtain the latest version of relevant information to verify before placing orders.

## Absolute Maximum Ratings

Symbol	Parameter	Rating	Unit
$V_{IN}$	Input Voltage	30	V <sub>DC</sub>
$T_J$	Operating Junction Temperature Range Control Section Power Transistor	0 to 125 0 to 150	°C
$T_{STG}$	Storage Temperature Range	-65 to +150	°C
$\theta_{JA}$	Thermal Resistance from Junction to Ambient in Free Air SOP-8 SOT-89/TO-92	160 180	°C/W

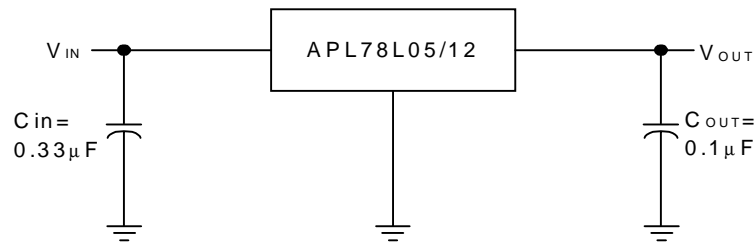
## Electrical Characteristics

$V_{IN}=10V$ ,  $I_{OUT}=40mA$ ,  $T_J=25^\circ C$ ,  $C_{IN}=0.33\mu F$ ,  $C_{OUT}=0.1\mu F$ , unless otherwise specified

Symbol	Parameter	Test Condition	APL78L05			Unit
			Min.	Typ.	Max.	
$V_O$	Output Voltage		4.8	5.0	5.2	Vdc
$V_O$	Output Voltage (0° to +125°C)	$1.0mA \leq I_{OUT} \leq 40mA$	4.75	5	5.25	Vdc
		$7.0Vdc \leq V_{IN} \leq 20Vdc$				
		$V_{IN}=10V$ , $1.0mA \leq I_{OUT} \leq 40mA$				
$Reg_{line}$	Line Regulation	$7.0Vdc \leq V_{IN} \leq 20Vdc$		29	150	mV
		$8.0Vdc \leq V_{IN} \leq 20Vdc$		26	100	
$Reg_{load}$	Load Regulation	$1.0mA \leq I_{OUT} \leq 100mA$		9	60	mV
		$1.0mA \leq I_{OUT} \leq 40mA$		5	30	
$I_B$	Quiescent Current			2.8	6.0	mA
$\Delta I_B$	Quiescent Current Change	$8.0Vdc \leq V_{IN} \leq 20Vdc$		0.15	1.5	mA
		$1.0mA \leq I_{OUT} \leq 40mA$		0.08	0.1	
$V_{IN}-V_O$	Dropout Voltage	$I_{OUT}=100mA$		1.9		Vdc

Symbol	Parameter	Test Condition	APL78L12			Unit
			Min.	Typ.	Max.	
$V_O$	Output Voltage		11.5	12	12.5	Vdc
$V_O$	Output Voltage (0° to +125°C)	$1.0mA \leq I_{OUT} \leq 40mA$	11.4	12	12.6	Vdc
		$14Vdc \leq V_{IN} \leq 27Vdc$				
		$V_{IN}=19V$ , $1.0mA \leq I_{OUT} \leq 40mA$				
$Reg_{line}$	Line Regulation	$14.5Vdc \leq V_{IN} \leq 27Vdc$			250	mV
$Reg_{load}$	Load Regulation	$1.0mA \leq I_{OUT} \leq 100mA$			100	mV
		$1.0mA \leq I_{OUT} \leq 40mA$			50	
$I_B$	Quiescent Current				6.5	mA
$\Delta I_B$	Quiescent Current Change	$16Vdc \leq V_{IN} \leq 27Vdc$			1.5	mA
		$1.0mA \leq I_{OUT} \leq 40mA$				
$V_{IN}-V_O$	Dropout Voltage	$I_{OUT}=100mA$		1.9		Vdc

## Application Circuit

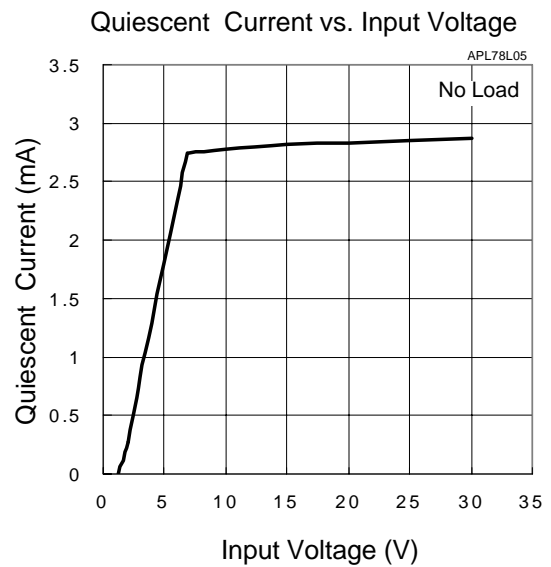
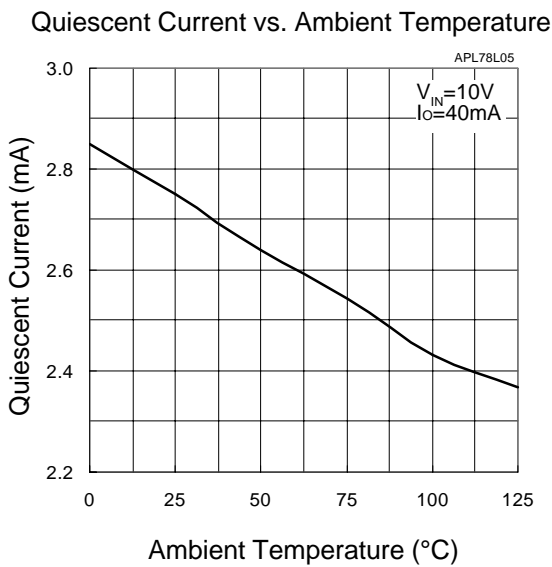
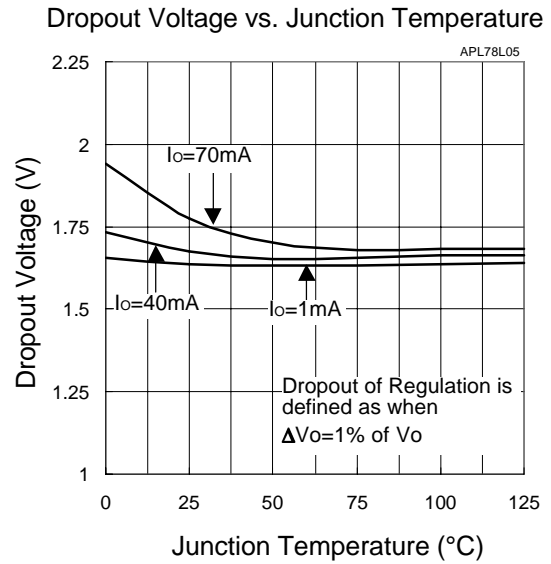
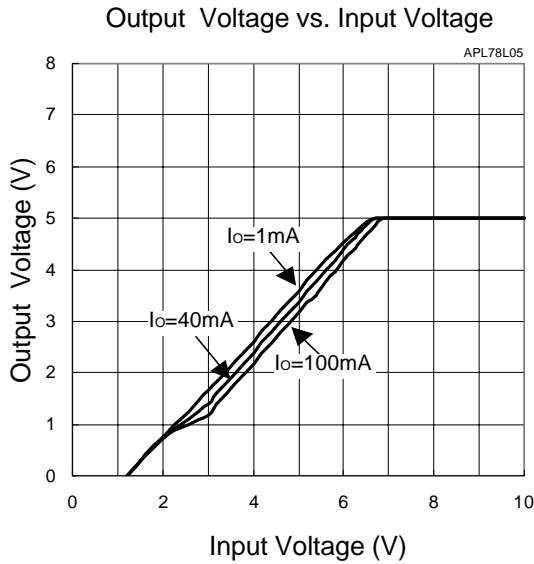


Note1 : A common ground is required between the input and the output voltage. The input voltage must remain typically 2V above the output voltage even during the low point on the input ripple voltage.

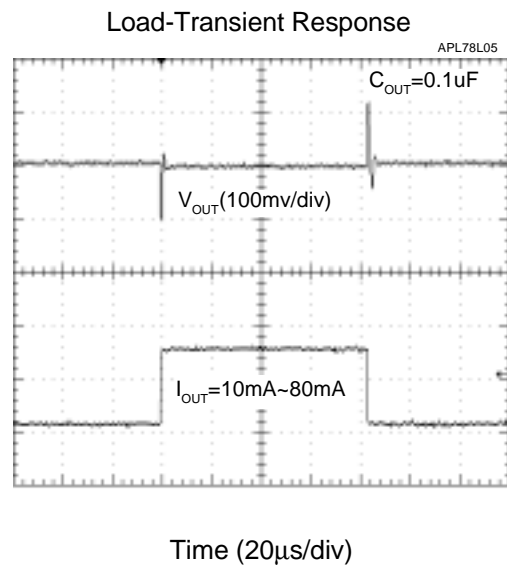
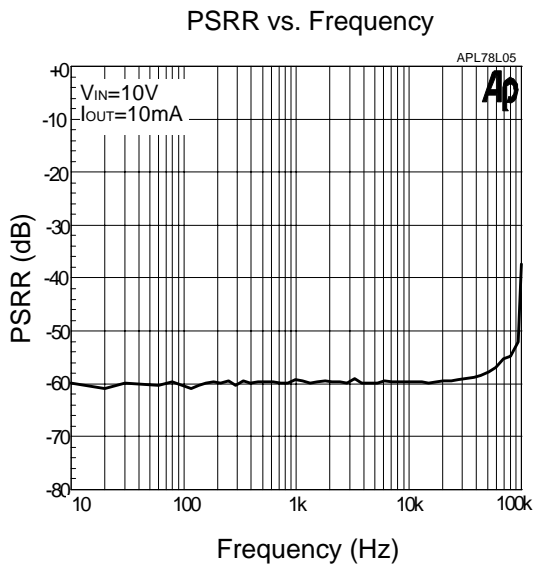
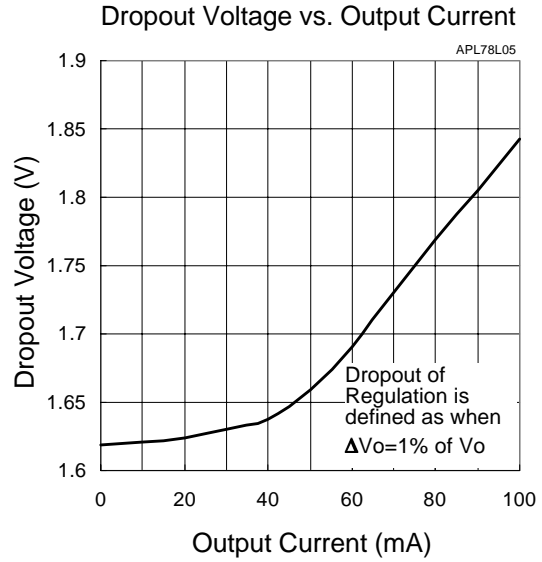
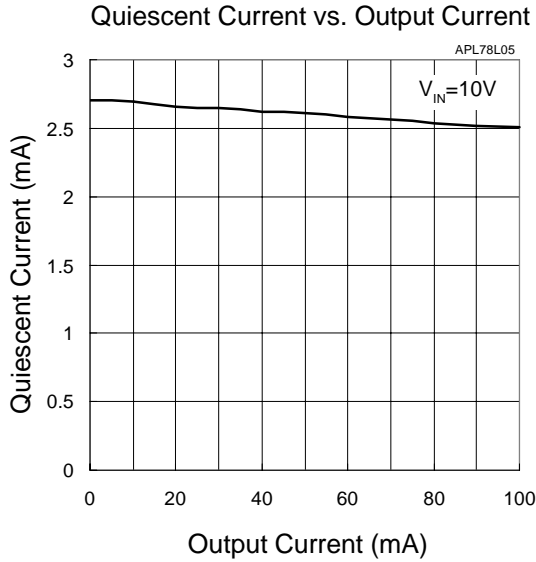
Note2 :  $C_{in}$  is required if regulator is located an appreciable distance from power supply filter.

Note3 :  $C_{OUT}$  is not needed for stability; however, it does improve transient response.

## Typical Characteristics

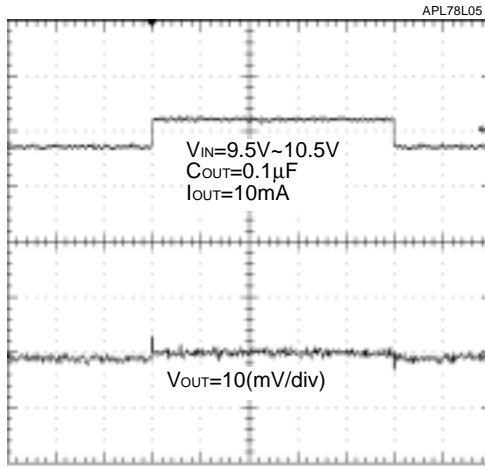


Typical Characteristics (Cont.)



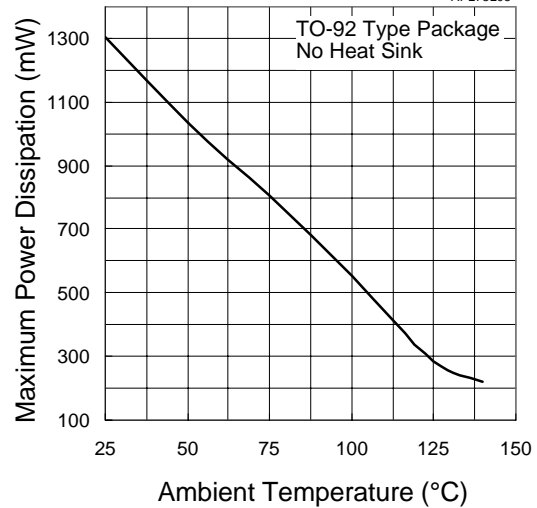
Typical Characteristics (Cont.)

Line Transient Response

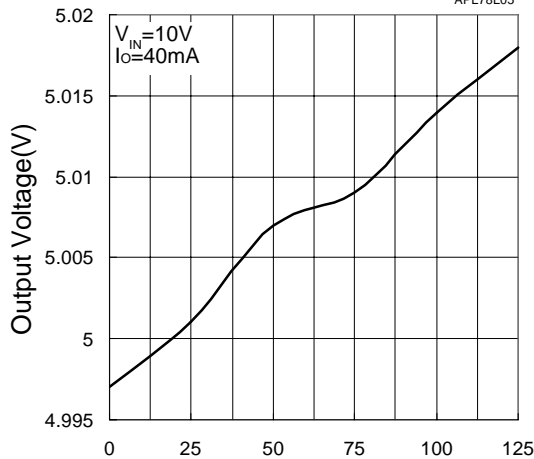


Time (100us/div)

Maximum Power Dissipation vs. Ambient Temperature

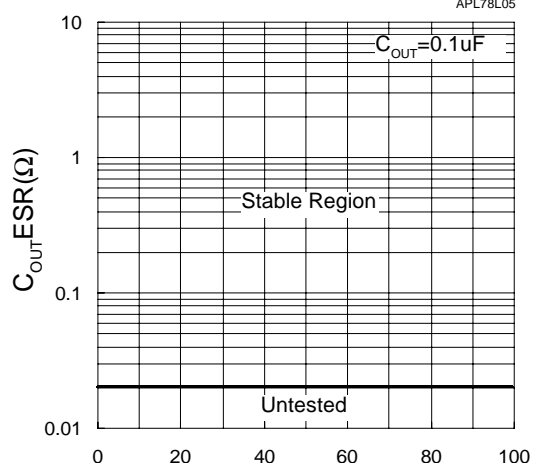


Output Voltage vs. Ambient Temperature



Ambient Temperature (°C)

Region of Stable ESR vs. Output Current



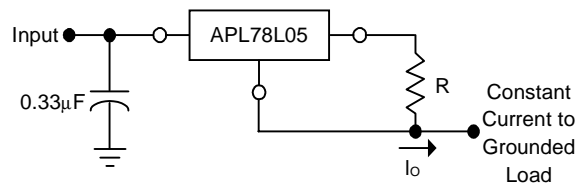
Output Current(mA)

## Typical Characteristics

The APL78L05/12 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 0.33μF 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 1. Current Regulator



The APL78L00 regulators can also be used as a current source when connected as above. In order to minimize dissipation the APL78L05 is chosen in this application. Resistor R determines the current as follows :

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

$$I_B = 3.8mA \text{ over line and load changes}$$

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

Figure 2. ±15V Tracking Voltage Regulator

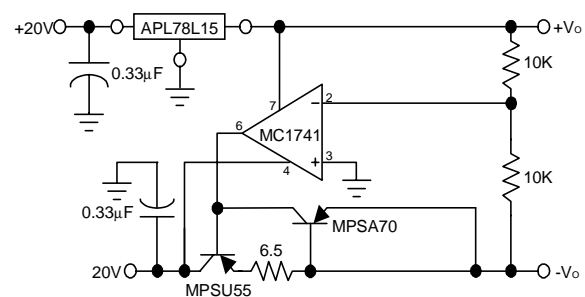
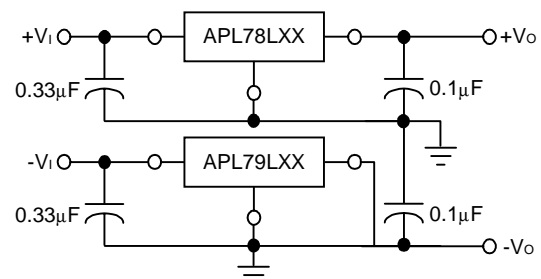
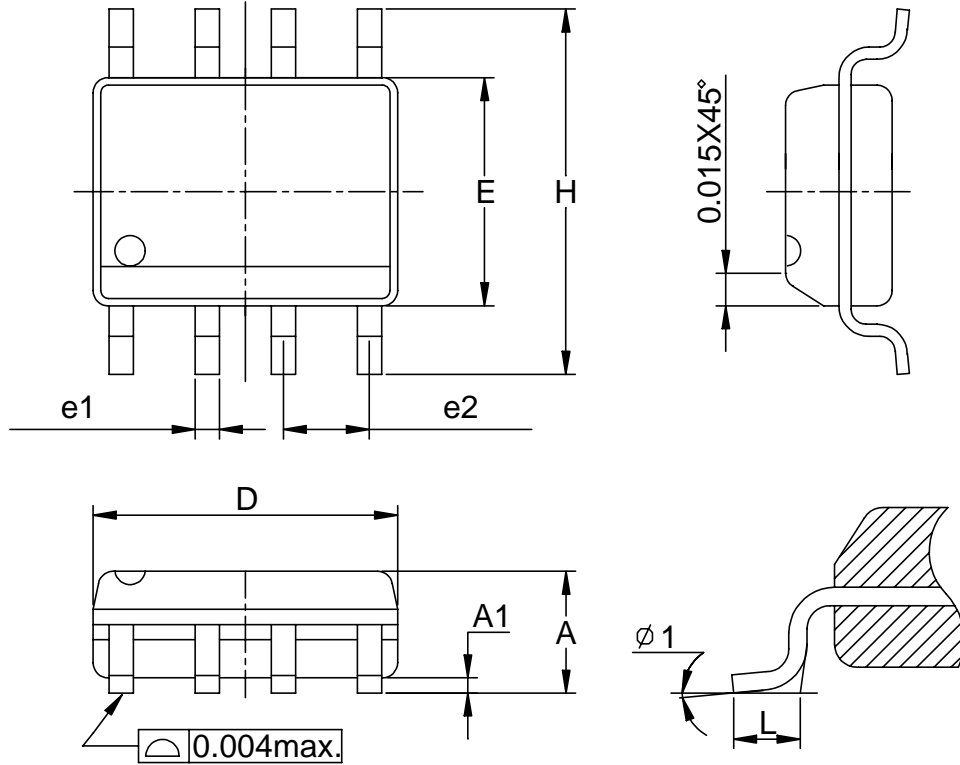


Figure 3. Positive and Negative Regulator



## Packaging Information

SOP-8 pin ( Reference JEDEC Registration MS-012)

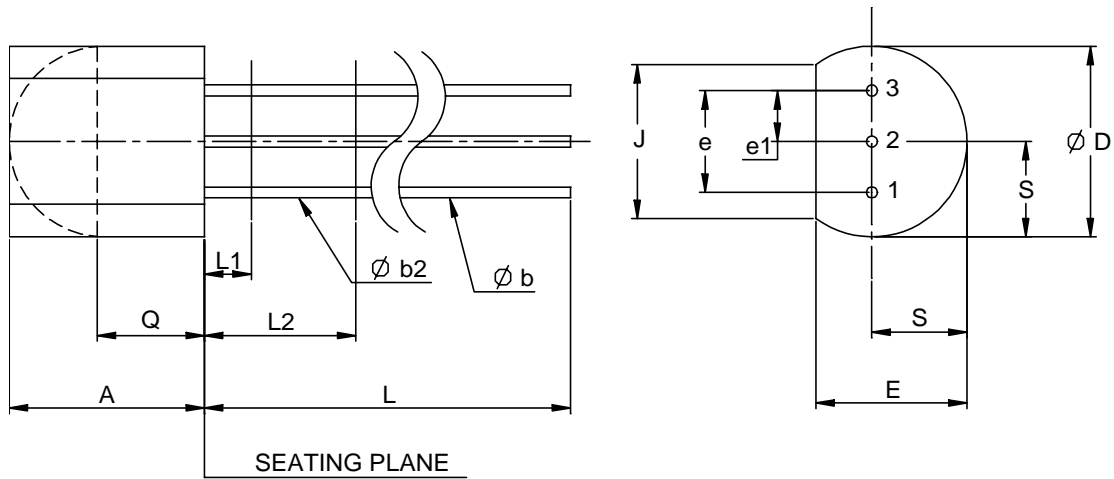


Dim	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	1.35	1.75	0.053	0.069
A1	0.10	0.25	0.004	0.010
D	4.80	5.00	0.189	0.197
E	3.80	4.00	0.150	0.157
H	5.80	6.20	0.228	0.244
L	0.40	1.27	0.016	0.050
e1	0.33	0.51	0.013	0.020
e2	1.27BSC		0.50BSC	
φ 1	8°		8°	



Package Information

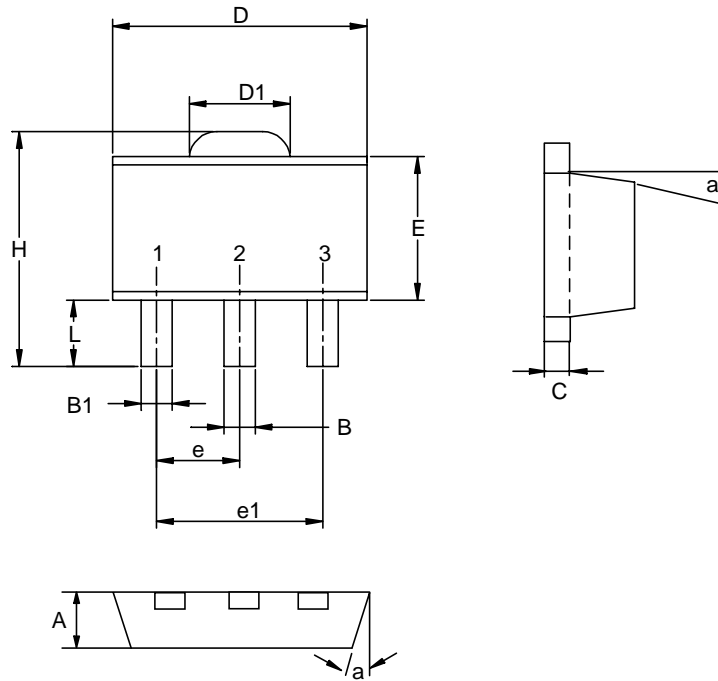
TO-92



Dim	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	4.58	5.33	0.170	0.210
φ b	0.41	0.53	0.160	0.021
φ b2	0.41	0.48	0.160	0.019
φ D	4.96	5.20	0.175	0.205
E	3.94	4.19	0.125	0.165
e	2.42	2.66	0.095	0.105
e1	1.15	1.39	0.045	0.055
J	3.43		0.135	
L	12.70		0.500	
L1		1.27		0.050
L2	6.35		0.250	
Q	2.93		0.115	
S	2.42	2.66	0.080	0.105

## Package Information

SOT-89 (Reference EIAJ ED-7500A Registration SC-62)

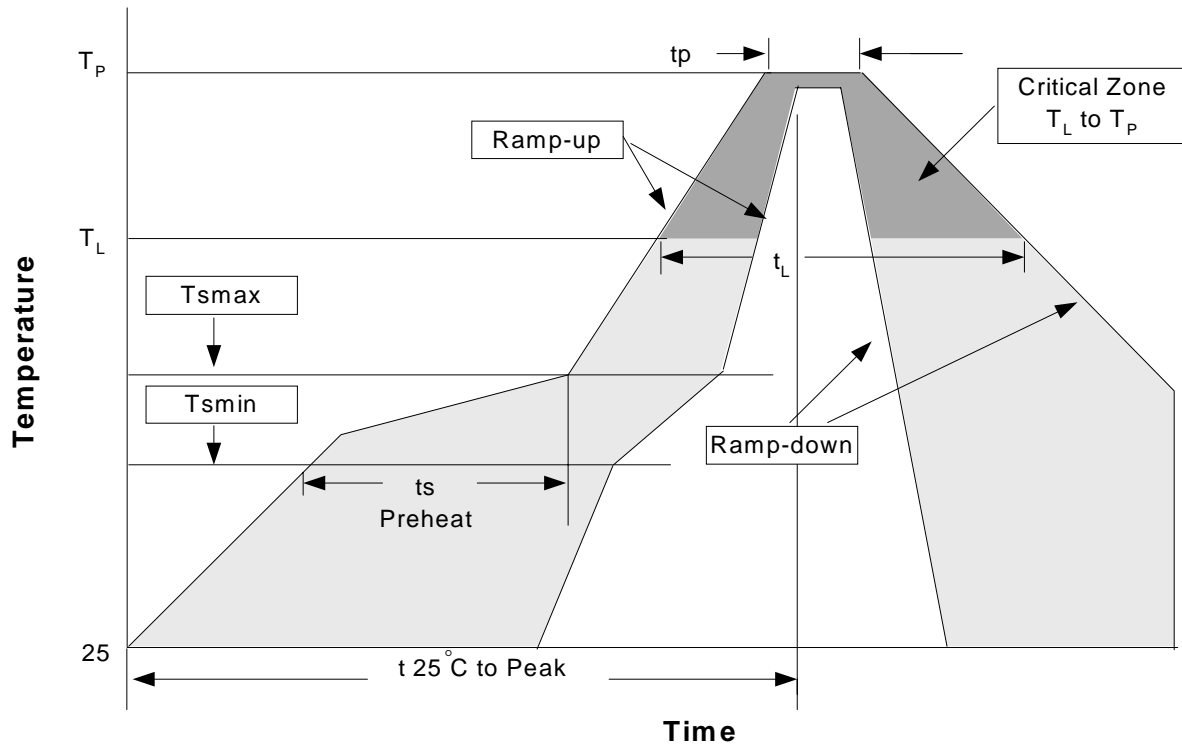


Dim	Millimeters		Inches	
	Min.	Max.	Min.	Max.
A	1.40	1.60	0.055	0.063
B	0.40	0.56	0.016	0.022
B1	0.35	0.48	0.014	0.019
C	0.35	0.44	0.014	0.017
D	4.40	4.60	0.173	0.181
D1	1.35	1.83	0.053	0.072
e	1.50 BSC		0.059 BSC	
e1	3.00 BSC		0.118 BSC	
E	2.29	2.60	0.090	0.102
H	3.75	4.25	0.148	0.167
L	0.80	1.20	0.031	0.047
α		10°		10°

## Physical Specifications

Terminal Material	Solder-Plated Copper (Solder Material : 90/10 or 63/37 SnPb), 100%Sn
Lead Solderability	Meets EIA Specification RSI86-91, ANSI/J-STD-002 Category 3.

### Reflow Condition (IR/Convection or VPR Reflow)



### Classification Reflow Profiles

Profile Feature	Sn-Pb Eutectic Assembly	Pb-Free Assembly
Average ramp-up rate ( $T_L$ to $T_P$ )	3°C/second max.	3°C/second max.
Preheat		
- Temperature Min ( $T_{smin}$ )	100°C	150°C
- Temperature Max ( $T_{smax}$ )	150°C	200°C
- Time (min to max) ( $t_s$ )	60-120 seconds	60-180 seconds
Time maintained above:		
- Temperature ( $T_L$ )	183°C	217°C
- Time ( $t_L$ )	60-150 seconds	60-150 seconds
Peak/Classification Temperature ( $T_p$ )	See table 1	See table 2
Time within 5°C of actual Peak Temperature ( $t_p$ )	10-30 seconds	20-40 seconds
Ramp-down Rate	6°C/second max.	6°C/second max.
Time 25°C to Peak Temperature	6 minutes max.	8 minutes max.

Notes: All temperatures refer to top side of the package .Measured on the body surface.

## Classification Reflow Profiles(Cont.)

Table 1. SnPb Eutectic Process – Package Peak Reflow Temperatures

Package Thickness	Volume mm <sup>3</sup> <350	Volume mm <sup>3</sup> ≥350
<2.5 mm	240 +0/-5°C	225 +0/-5°C
≥2.5 mm	225 +0/-5°C	225 +0/-5°C

Table 2. Pb-free Process – Package Classification Reflow Temperatures

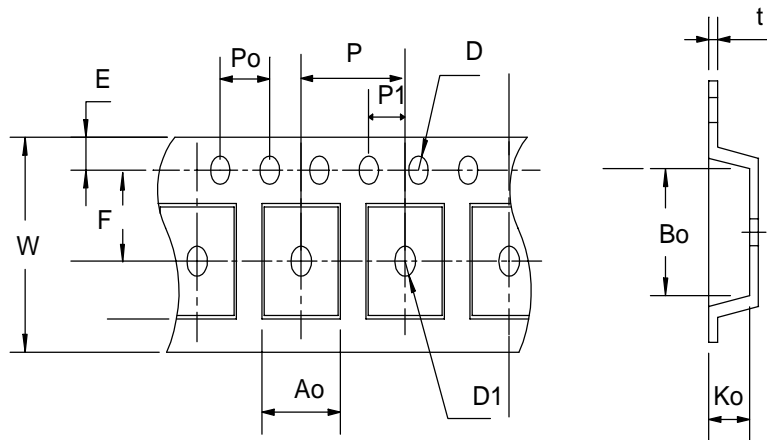
Package Thickness	Volume mm <sup>3</sup> <350	Volume mm <sup>3</sup> 350-2000	Volume mm <sup>3</sup> >2000
<1.6 mm	260 +0°C*	260 +0°C*	260 +0°C*
1.6 mm – 2.5 mm	260 +0°C*	250 +0°C*	245 +0°C*
≥2.5 mm	250 +0°C*	245 +0°C*	245 +0°C*

\*Tolerance: The device manufacturer/supplier **shall** assure process compatibility up to and including the stated classification temperature (this means Peak reflow temperature +0°C. For example 260°C+0°C) at the rated MSL level.

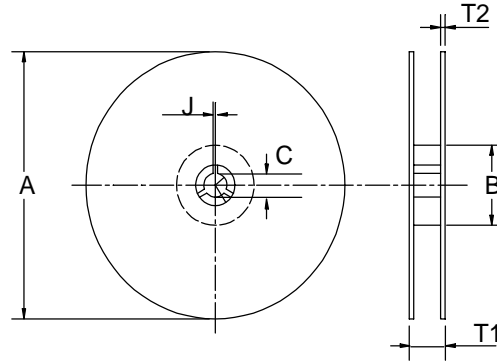
## Reliability test program

Test item	Method	Description
SOLDERABILITY	MIL-STD-883D-2003	245°C , 5 SEC
HOLT	MIL-STD-883D-1005.7	1000 Hrs Bias @ 125 °C
PCT	JESD-22-B, A102	168 Hrs, 100 % RH , 121°C
TST	MIL-STD-883D-1011.9	-65°C ~ 150°C, 200 Cycles
ESD	MIL-STD-883D-3015.7	VHBM > 2KV, VMM > 200V
Latch-Up	JESD 78	10ms , I <sub>tr</sub> > 100mA

## Carrier Tape & Reel Dimensions

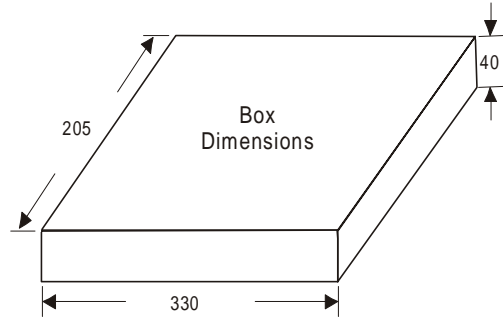
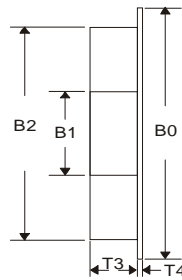
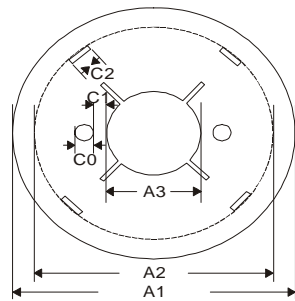
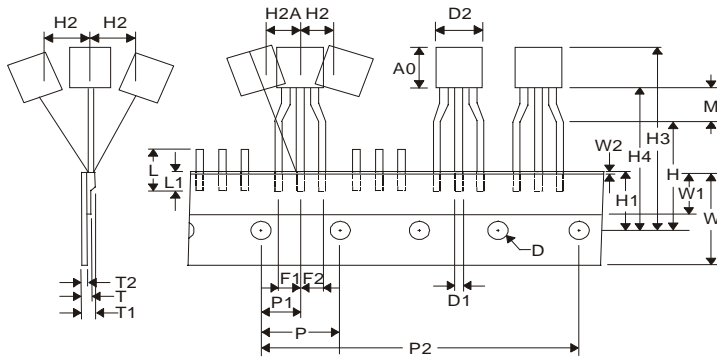


Carrier Tape & Reel Dimensions(Cont.)



Application	A	B	C	J	T1	T2	W	P	E
SOP-8	330±1	62 ± 1.5	12.75 + 0.15	2 + 0.5	12.4 +0.2	2± 0.2	12 + 0.3 - 0.1	8± 0.1	1.75± 0.1
	F	D	D1	Po	P1	Ao	Bo	Ko	t
	5.5 ± 0.1	1.55±0.1	1.55+ 0.25	4.0 ± 0.1	2.0 ± 0.1	6.4 ± 0.1	5.2± 0.1	2.1± 0.1	0.3±0.013

(mm)



UNIT : mm

## Carrier Tape & Reel Dimensions(Cont.)

Application	A	A1	A2	A3	B0	B1	B2	C0	C1
TO-92	3.18~12	90±1	76±1	30±1	90±1	31±1	76±1	5.8	3.8
	C2	H3	H4	L	L1	P	P1	P2	T
	7.8	27.0 MAX	20.0 MAX	11.0 MAX	2.5 MIN	12.7±0.2	6.35±0.4	50.8±0.5	0.55 MAX
	T1	T2	T3	T4	W	W1	W2		
	1.42 MAX	0.36~0.68	15	1.7	17.5~19	5.0~7.0	0.5 MAX		

(mm)

## Cover Tape Dimensions

Application	Carrier Width	Cover Tape Width	Devices Per Reel
SOP- 8	12	9.3	2500
TO-92	17.5~19	5.0~7.0	2000

## Customer Service

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