

# 600mA Low Dropout Linear Regulator

## FEATURES

- Guaranteed 600mA Output
- Three Terminal Adjustable or Fixed 2.5V, 3V and 3.3V
- Low Quiescent Current
- Low Dropout Voltage of 1.1V at Full Load
- 0.2% Line and 0.3% Load Regulation
- Voltage Temperature Stability 0.05%
- Overcurrent and Thermal Protection
- Available Packages: SOT-223, TO-252, TO-220, and TO-263

## APPLICATIONS

- SCSI-II Active Terminator
- Portable/ Palm Top / Notebook Computers
- Battery Chargers
- Disk Drives
- Portable Consumer Equipment
- Portable Instrumentation
- SMPS Post-Regulator

*Now Available in Lead Free Packaging*

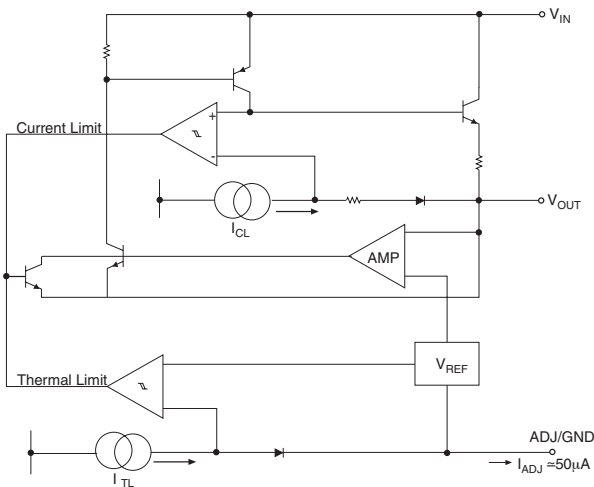
Refer to page 6 for pinouts.

## DESCRIPTION

The SPX1202 is a low power positive-voltage regulator designed to satisfy moderate power requirements with a cost effective, small footprint solution. This device is an excellent choice for use in battery-powered applications and portable computers. The SPX1202 features very low quiescent current and a low dropout voltage of 1.1V at a full load. As output current decreases, quiescent current flows into the load, increasing efficiency. SPX1202 is available in adjustable or fixed 2.5V, 3V and 3.3V output voltages.

The SPX1202 is offered in several 3-pin surface mount packages: SOT-223, TO-252, TO-220 and TO-263. An output capacitor of 10 $\mu$ F provides unconditional stability while a smaller 2.2 $\mu$ F capacitor is sufficient for most applications.

## BLOCK DIAGRAM



## ABSOLUTE MAXIMUM RATINGS

Power Dissipation ..... Internally Limited  
 Lead Temperature (soldering, 5 seconds) ..... 260°C  
 Storage Temperature Range ..... -65°C to +150°C

Operating Junction Temperature Range ..... -40°C to +125°C  
 Input Supply Voltage ..... +20V  
 ESD Rating ..... 2kV min

## ELECTRICAL CHARACTERISTICS

at  $V_{IN} = V_{OUT} + 1.5V$ ,  $T_A = 25^\circ C$ ,  $C_{IN} = C_{OUT} = 10\mu F$ , unless otherwise specified. Limits in **Boldface** applies over the full operating temperature range.

PARAMETER	CONDITIONS	TYP	MIN	MAX	UNITS
<b>2.5V Version</b>					
Output Voltage	$I_{OUT} = 10mA, V_{IN} = 5.00V$ $0 \leq I_{OUT} \leq 600mA, 4.50V \leq V_{IN} \leq 10V$	2.475 <b>2.450</b>	2.500	2.525 <b>2.550</b>	V
<b>3.0V Version</b>					
Output Voltage	$I_{OUT} = 10mA, V_{IN} = 5.00V$ $0 \leq I_{OUT} \leq 600mA, 4.50V \leq V_{IN} \leq 10V$	2.970 <b>2.940</b>	3.000	3.030 <b>3.060</b>	V
<b>3.3V Version</b>					
Output Voltage	$I_{OUT} = 10mA, V_{IN} = 5.00V$ $0 \leq I_{OUT} \leq 600mA, 4.50V \leq V_{IN} \leq 10V$	3.267 <b>3.234</b>	3.300	3.333 <b>3.366</b>	V
<b>All Output Options</b>					
Reference Voltage	$I_{OUT}=10mA, (V_{IN} - V_{OUT}) = 2V$ $10 \leq I_{OUT} \leq 600mA, 1.4V \leq (V_{IN} - V_{OUT}) \leq 10V$	1.238 <b>1.225</b>	1.250	1.262 <b>1.270</b>	V
Output Voltage Temperature Stability	(Note 1)			<b>0.05</b>	%
Line Regulation	$4.50V \leq V_{IN} \leq 12V, V_{OUT}=3.00, I_{OUT}=0$ $4.80V \leq V_{IN} \leq 12V, V_{OUT}=3.30, I_{OUT}=0$ $6.50V \leq V_{IN} \leq 12V, V_{OUT}=5.00, I_{OUT}=0$		1.00 1.00 1.00	7.00 7.00 10.00	mV
Load Regulation	$0 \leq I_{OUT} \leq 600mA, V_{IN}=4.50V, V_{OUT}=3.00$ $0 \leq I_{OUT} \leq 600mA, V_{IN}=4.80V, V_{OUT}=3.30$ $0 \leq I_{OUT} \leq 600mA, V_{IN}=6.50V, V_{OUT}=5.0$		1.00 1.00 1.00	12.00 12.00 15.00	mV
Dropout Voltage (Note 2)	$I_L=100mA$ $I_L=600mA$		1.00 1.05	1.10 1.15	V
Quiescent Current	$4.25V \leq V_{IN} \leq 6.5V$		5.00	10.00	mA
Adjust Pin Current			50		$\mu A$
Current Limit	$(V_{IN} - V_{OUT}) = 5V$		.850	1.0	A
Thermal Regulation	25°C, 30mS Pulse		0.01	0.1	%/W
Ripple Rejection	$f_{RIPPLE}=120Hz, (V_{IN}-V_{OUT})=3V,$ $V_{RIPPLE}=1V_{PP}$		60	75	dB
Long Term Stability	125°C, 1000Hrs			0.03	%
RMS Output Noise	% of $V_{OUT}$ , 10Hz $\leq f \leq$ 10kHz			0.003	%
Thermal Resistance	Junction to Case, at tab			15	°C/W

### NOTES:

Note 1: Output temperature coefficient is defined as the worst case voltage change divided by the total temperature range.

Note 2: Dropout voltage is defined as the input to output differential at which the output voltage drops 100mV below its nominal value measured at 1V differential at very low values of programmed output voltage, the minimum input supply voltage of 2V (2.3V over temperature) must be taken into account.

Note 3: Thermal regulation is defined as the change in output voltage at a time T after a change in power dissipation is applied excluding load or line regulation effect.

# TYPICAL PERFORMANCE CHARACTERISTICS

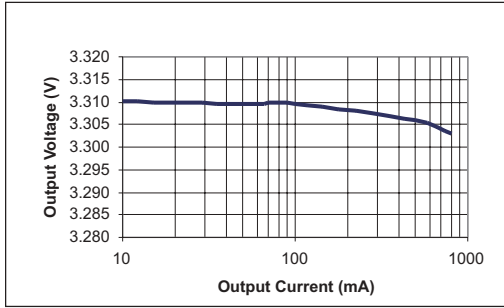


Figure 1. Load Regulation for SPX1202M3-3.3;  
 $V_{IN}=4.8V$ ,  $C_{OUT}=2.2\mu F$

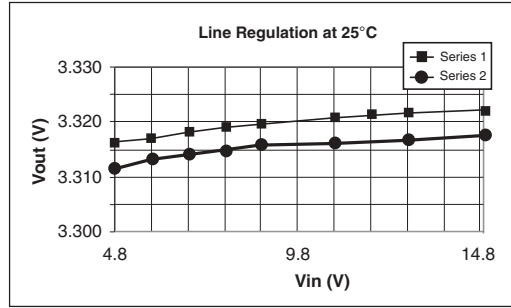


Figure 2. Line Regulation for SPX1202M3-3.3;  
 $V_{IN}=4.8V$  to  $16V$ ,  $C_{OUT}=2.2\mu F$

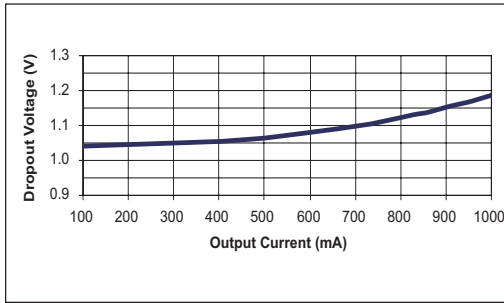


Figure 3. Dropout Voltage vs Output Current for SPX1202M3-3.3;  $V_{IN}=4.89V$ ,  $C_{OUT}=2.2\mu F$

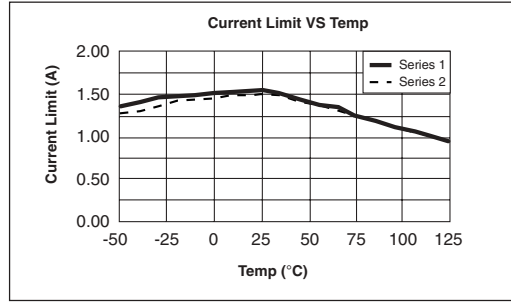


Figure 4. Current Limit for SPX1202M3-3.3;  $V_{IN}=4.8V$ ,  
 $C_{IN}=C_{OUT}=1.0\mu F$ ,  $I_{OUT}$  pulsed from 10mA to Current Limit

**SCOPE TRACING MISSING**

Figure 5. Current Limit for SPX1202M3-3.3, Output Voltage Deviation with  $I_{OUT}=10mA$  to 1A Step.

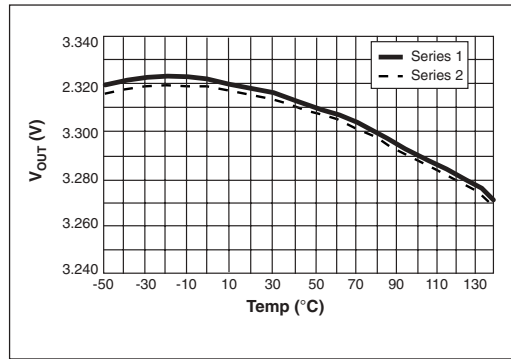


Figure 6.  $V_{OUT}$  vs Temperature  $I_{OUT}$  pulsed from 10mA to Current Limit

## APPLICATION INFORMATION

### Output Capacitor

To ensure the stability of the SPX1202, an output capacitor of at least 10 $\mu$ F (tantalum or ceramic) or 50 $\mu$ F (aluminum) is required. The value may change based on the application requirements of the output load or temperature range. The value of ESR can vary based on the type of capacitor used in the applications. The recommended value for ESR is 0.5 $\Omega$  or less. A larger value of output capacitance (up to 100 $\mu$ F) can improve the load transient response.

### SOLDERING METHODS

The SPX1202 SOT-223 package is designed to be compatible with infrared reflow or vapor-phase reflow soldering techniques. During soldering, the non-active or mildly active fluxes may be used. The SPX1202 die is attached to the heatsink lead which exits opposite the input, output, and ground pins.

Hand soldering and wave soldering should be avoided since these methods can cause damage to the device with excessive thermal gradients on the package. The SOT-223 recommended soldering method are as follows: vapor phase reflow and infrared reflow with the component preheated to within 65 $^{\circ}$ C of the soldering temperature range

### THERMAL CHARACTERISTICS

The thermal resistance of SPX1202 depends on the type of package and PC board layout as shown in Table 1. The SPX1202 features the internal thermal limiting to protect the device during overload conditions. Special care needs to be taken during continuous load conditions such that the maximum junction temperature does not exceed 125 $^{\circ}$ C. Thermal protection is activated at >144 $^{\circ}$ C and deactivated at <137 $^{\circ}$ C.

Taking the FR-4 printed circuit board and 1/16 thick with 1 ounce copper foil as an experiment, the PCB material is effective at transmitting heat with the tab attached to the pad area and a ground plane layer on the backside of the substrate. Refer to table 1 for the results of the experiment.

The thermal interaction from other components

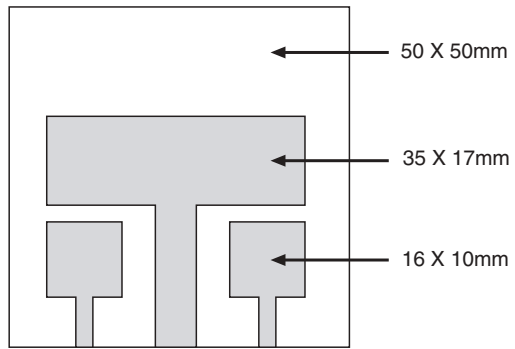


Figure 7. Substrate Layout for SOT-223

in the application can effect the thermal resistance of the SPX1202. The actual thermal resistance can be determined with experimentation.

SPX1202 power dissipation is calculated as follows:

$$P_D = (V_{IN} - V_{OUT})(I_{OUT})$$

Maximum Junction Temperature range:

$$T_J = T_{AMBIENT}(\max) + P_D * (\text{Thermal Resistance}) \\ (\text{Junction-to-ambient})$$

Maximum junction temperature must not exceed the 125 $^{\circ}$ C.

### Ripple Rejection

Ripple rejection can be improved by adding a capacitor between the ADJ pin and ground as shown in Figure 7. When ADJ pin bypassing is used, the value of the output capacitor required increases to its maximum. If the ADJ pin is not bypassed, the value of the output capacitor can be lowered to 10 $\mu$ F for an electrolytic aluminum capacitor or 2.2 $\mu$ F for a solid tantalum capacitor (Fig 10).

However the value of the ADJ-bypass capacitor should be chosen with respect to the following equation:

$$C = 1 / (6.28 * F_R * R_1)$$

Where C = value of the capacitor in Farads (select an equal or larger standard value),

$$F_R = \text{ripple frequency in Hz,} \\ R_1 = \text{value of resistor } R_1 \text{ in Ohms.}$$

If an ADJ-bypass capacitor is used, the ampli-

tude of the output ripple will be independent of the output voltage. If an ADJ-bypass capacitor is not used, the output ripple will be proportional to the ratio of the output voltage to the reference voltage:

$$M = V_{OUT} / V_{REF}$$

Where M = multiplier for the ripple seen when the ADJ pin is optimally bypassed.

$$V_{REF} = 1.25V$$

## Output Voltage

The output of the adjustable regulator can be set to any voltage between 1.25V and 15V. The value of  $V_{OUT}$  can be quickly approximated using the formula. (Figure 9)

$$V_{OUT} = 1.25 * (R_1 + R_2) / R_1.$$

A small correction to this formula is required depending on the values of resistors R1 and R2, since adjustable pin current (approx 50µA) flows through R2. When  $I_{ADJ}$  is taken into account, the formula becomes

$$V_{OUT} = V_{REF} (1 + (R_2 / R_1)) + I_{ADJ} * R_2,$$

where  $V_{REF} = 1.25V$ .

PC BOARD AREA mm <sup>2</sup>	TOPSIDE COPPER AREA mm <sup>2</sup>	BACKSIDE COPPER AREA mm <sup>2</sup>	THERMAL RESISTANCE JUNCTION TO AMBIENT °C/W
2500	2500	2500	46
2500	1250	2500	47
2500	950	2500	49
2500	2500	0	51
2500	1800	0	53
1600	600	1600	55
2500	1250	0	58
2500	915	0	59
1600	600	0	67
900	240	900	72
900	240	0	85

Table 1

## TYPICAL APPLICATIONS

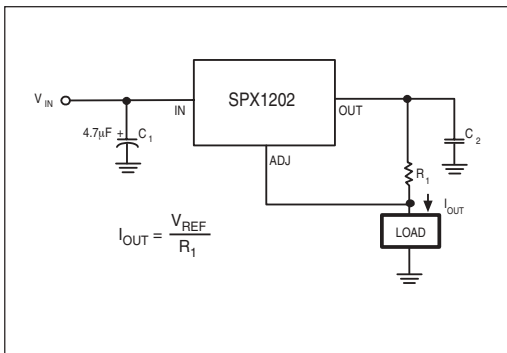


Figure 8. 600mA Current Source

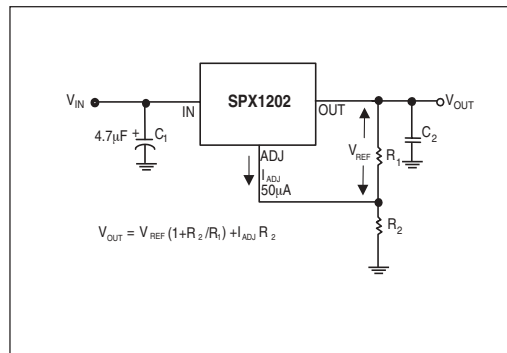


Figure 9. Typical Adjustable Regulator

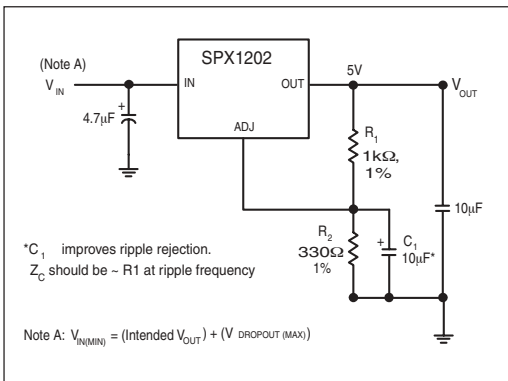


Figure 10. Improving Ripple Rejection

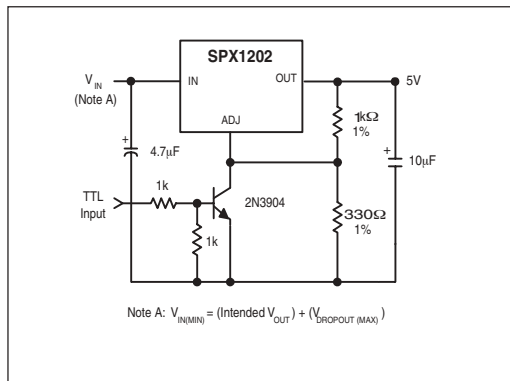


Figure 11. 5V Regulator with Shutdown

## LAYOUT CONSIDERATIONS

Parasitic line resistance can degrade load regulation. In order not to affect the behavior of the regulator, it is best to connect  $R_1$  to the case as illustrated in Figure 12. For the same reason,  $R_2$  should be connected to the negative side of the load.

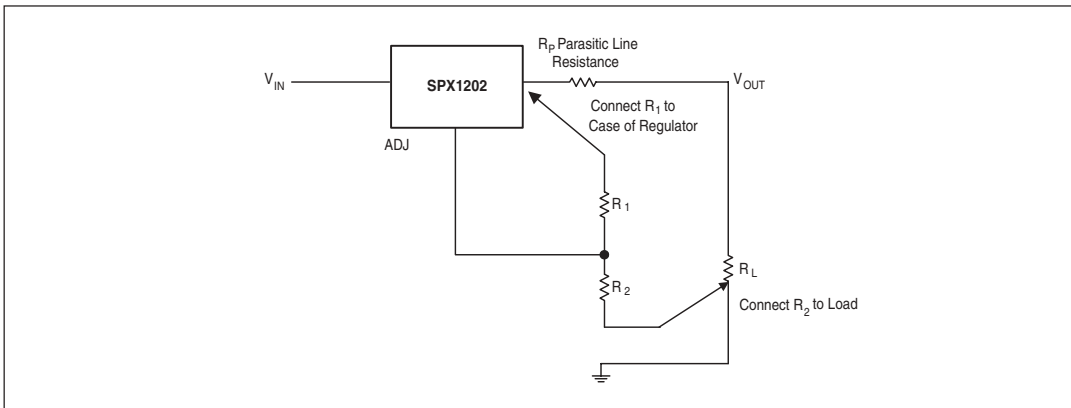
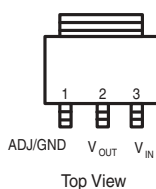


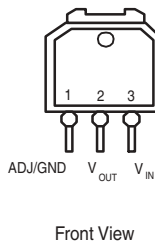
Figure 12. Recommended Connections for Best Results

## PACKAGE PINOUTS

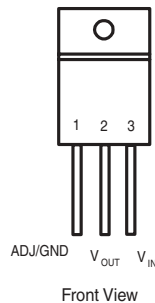
SOT-223 (M3)



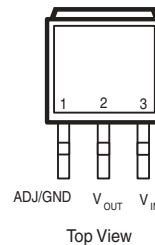
TO-252 (R)

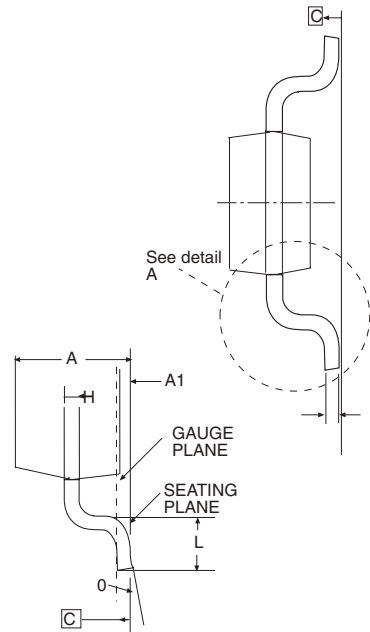
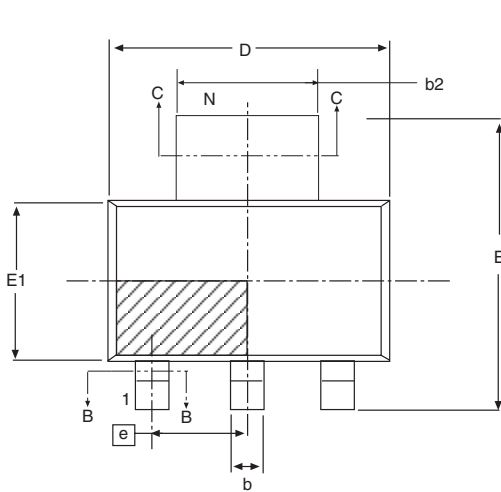


TO-220-3 (U)

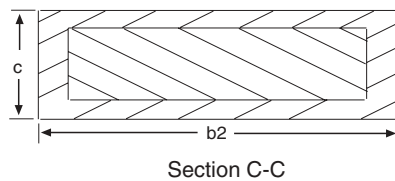
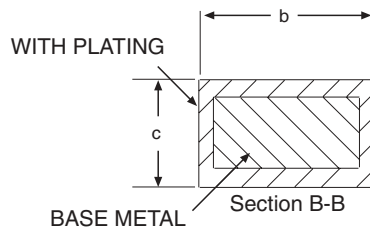


TO-263-3 (T)

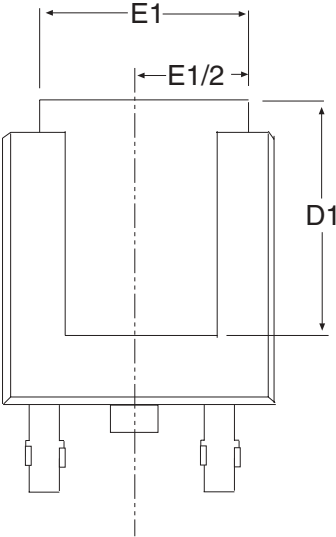
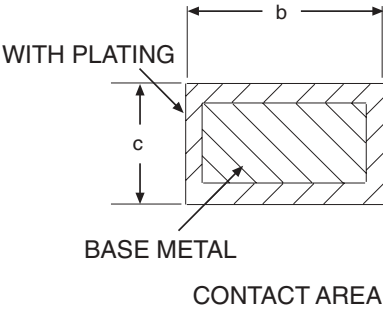
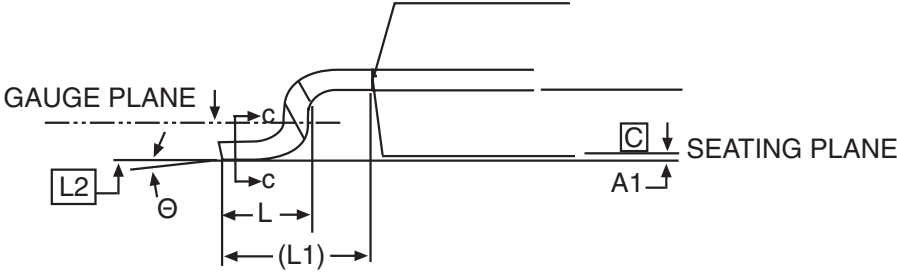




3 PIN SOT-223 JEDEC TO-261 (AA) Variation	Dimensions in (mm)		
	MIN	NOM	MAX
A	-	-	1.80
A1	0.02	-	0.10
A2	1.50	1.60	1.70
b	0.66	0.76	0.84
b2	2.90	3.00	3.10
c	0.23	0.30	0.35
D	6.30	6.50	6.70
E	6.70	7.00	7.30
E1	3.30	3.50	3.70
e	2.30 BASIC		
e1	4.60 BASIC		
L	0.75	-	-
φ	0°	-	10°



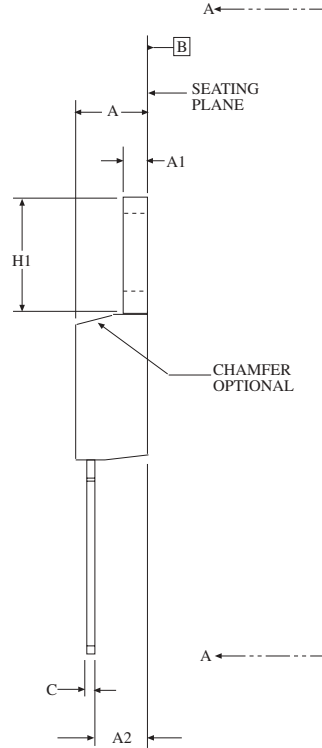
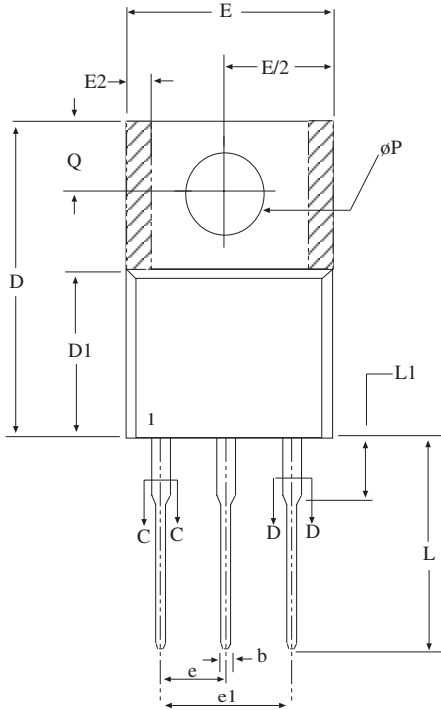
**3 PIN SOT-223**



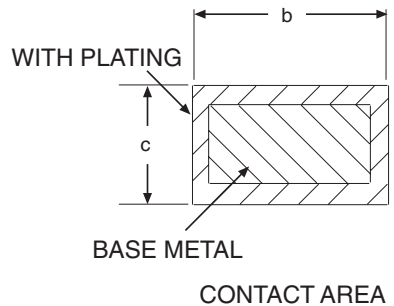
3 PIN TO-252 JEDEC TO-252 (AA) Variation	Dimensions in inches		
	MIN	NOM	MAX
A1	-	-	.005
c	.018	-	.024
D1	.205	-	-
E1	.170	-	-
H	.370	-	.410
L	.055	.060	.070
L1	.108 REF		
L2	.020 BSC		

**3 PIN TO-252**

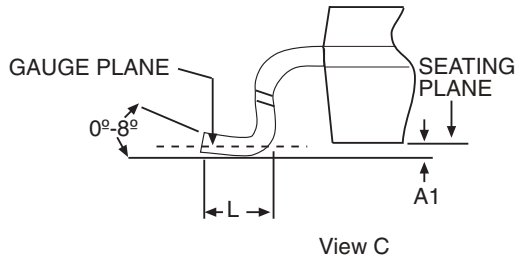
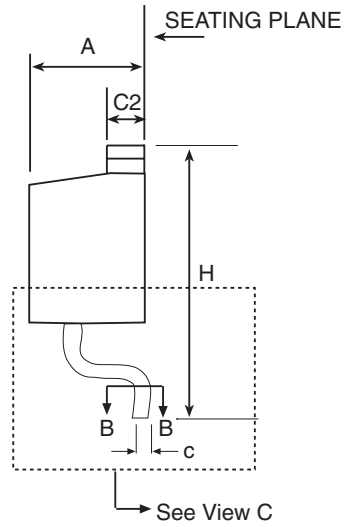
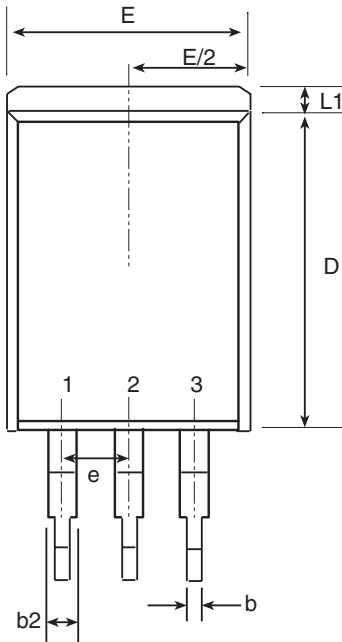




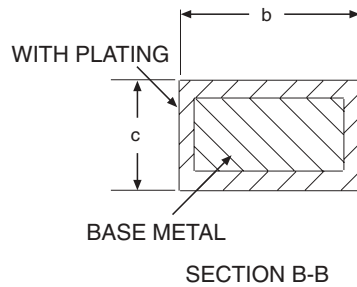
Dimensions in (mm)	3 PIN TO-220 JEDEC TO-220 (AB) Variation		
	MIN	NOM	MAX
A	.140	-	.190
A1	.020	-	.055
A2	.080	-	.115
b	.015	.027	.040
b2	.045	-	.070
c	.014	-	.024
D	.560	-	.650
D1	.330	-	.355
D2	.480	-	.507
E	.380	-	.420
E1	.270	-	.350
E2	-	-	.030
e	.100 BSC		
e1	.200 BSC		
H1	.230	-	.270
L1	-	-	.250
L2	-	-	-
$\Delta P$	.139	-	.161
Q	.100	-	.135



**3 PIN TO-220**



3-PIN TO-263 JEDEC TO-263 (AA) Variation	Dimensions in inches		
	MIN	NOM	MAX
A	.160	-	.190
A1	.000	-	.010
b	.020	-	.039
c	.015	-	.029
D	.330	-	.380
D1	.270	-	-
E	.380	-	.420
E1	.245	-	-
e	.100 BSC		
H	.575	-	.625
L	.070	-	.110
L1	-	-	.066
L2	-	-	.070
L3	.010 BSC		



**3 PIN TO-263**

<b>PART NUMBER</b>	<b>ACC.</b>	<b>OUTPUT VOLTAGE</b>	<b>PACKAGE</b>
SPX1202U	1%	Adj	3 Pin TO220
SPX1202U-2.5	1%	2.5V	3 Pin TO220
SPX1202U-3.0	1%	3.0V	3 Pin TO220
SPX1202U-3.3	1%	3.3V	3 Pin TO220
SPX1202T	1%	Adj	3 Pin TO-263
SPX1202T/TR	1%	Adj	3 Pin TO-263
SPX1202T-2.5	1%	2.5V	3 Pin TO-263
SPX1202T-2.5/TR	1%	2.5V	3 Pin TO-263
SPX1202T-3.0	1%	3.0V	3 Pin TO-263
SPX1202T-3.0/TR	1%	3.0V	3 Pin TO-263
SPX1202T-3.3	1%	3.3V	3 Pin TO-263
SPX1202T-3.3/TR	1%	3.3V	3 Pin TO-263
SPX1202M3	1%	Adj	3 Pin SOT-223
SPX1202M3/TR	1%	Adj	3 Pin SOT-223
SPX1202M3-2.5	1%	2.5V	3 Pin SOT-223
SPX1202M3-2.5/TR	1%	2.5V	3 Pin SOT-223
SPX1202M3-3.0	1%	3.0V	3 Pin SOT-223
SPX1202M3-3.0/TR	1%	3.0V	3 Pin SOT-223
SPX1202M3-3.3	1%	3.3V	3 Pin SOT-223
SPX1202M3-3.3/TR	1%	3.3V	3 Pin SOT-223
SPX1202R	1%	Adj	3 Pin TO-252
SPX1202R/TR	1%	Adj	3 Pin TO-252
SPX1202R-2.5	1%	2.5V	3 Pin TO-252
SPX1202R-2.5/TR	1%	2.5V	3 Pin TO-252
SPX1202R-3.0	1%	3.0V	3 Pin TO-252
SPX1202R-3.0/TR	1%	3.0V	3 Pin TO-252
SPX1202R-3.3	1%	3.3V	3 Pin TO-252
SPX1202R-3.3/TR	1%	3.3V	3 Pin TO-252

Available in lead free packaging. To order add "-L" suffix to part number.  
 Example: SPX1587AT-5.0/TR = standard; SPX1587AT-5.0-L/TR = lead free

/TR = Tape and Reel

Pack quantity is 500 for TO-263, 2,000 for TO-252 and 2,500 for SOT-223.



**Sipex Corporation**  
**Headquarters**  
 233 South Hillview Drive  
 Milpitas, CA 95035  
 TEL: (408) 934-7500  
 FAX: (408) 935-7600