

## GENERAL DESCRIPTION

The SPX3940 is a 1A, accurate voltage regulator with a low drop out voltage of 280mV (typical) at 1A.

These regulators are specifically designed for low voltage applications that require a low dropout voltage and a fast transient response. They are fully fault protected against over-current, reverse battery, and positive and negative voltage transients.

The SPX3940 is offered in 3-pin SOT223 and TO-263 packages. For a 3A version, refer to the SPX29300 data sheet.

## APPLICATIONS

- **Power Supplies**
- **LCD Monitors**
- **Portable Instrumentation**
- **Medical and Industrial Equipment**

## FEATURES

- **Guaranteed 1.5A Peak Current**
- **1% Output Accuracy SPX3940A**
- **Low Quiescent Current**
- **Low Dropout Voltage of 280mV at 1A**
- **Extremely Tight Load and Line Regulation**
- **Extremely Fast Transient Response**
- **Reverse-battery Protection**
- **Internal Thermal Protection**
- **Internal Short Circuit Current Limit**
- **Replacement for LM3940**
- **Standard SOT223 & TO-263 packages**

## TYPICAL APPLICATION DIAGRAM

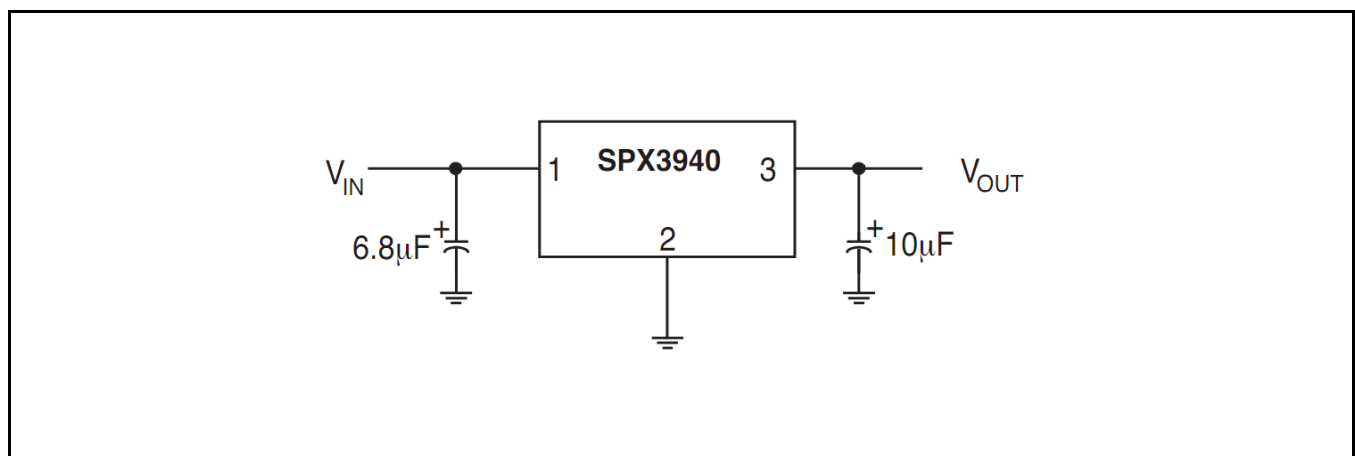


Fig. 1: SPX3940 Application Diagram – Fixed Output Linear Regulator

# 1A Low Dropout Voltage Regulator

## ABSOLUTE MAXIMUM RATINGS

These are stress ratings only and functional operation of the device at these ratings or any other above those indicated in the operation sections of the specifications below is not implied. Exposure to absolute maximum rating conditions for extended periods of time may affect reliability.

Input Voltage  $V_{IN}$  ..... 20V<sup>1</sup>  
 Storage Temperature ..... -65°C to 150°C  
 Lead Temperature (Soldering, 5 sec) ..... 260°C

## OPERATING RATINGS

Input Voltage  $V_{IN}$  ..... 16V  
 Junction Temperature Range ..... -40°C to 125°C  
 Packages Thermal Resistance  
     SOT-223 Junction to Case (at  $T_A$ ) ..... 15°C/W  
     SOT-223 Junction to Ambient ..... 62.3°C/W  
     TO-263 Junction to Case (at  $T_A$ ) ..... 3°C/W  
     TO-263 Junction to Ambient ..... 31.4°C/W

Note 1: Maximum positive supply voltage of 20V must be of limited duration (<100ms) and duty cycle (<1%). The maximum continuous supply voltage is 16V.

## ELECTRICAL SPECIFICATIONS

Specifications with standard type are for an Operating Ambient Temperature of  $T_A = 25^\circ\text{C}$  only; limits applying over the full Operating Junction Temperature range are denoted by a “•”. Minimum and Maximum limits are guaranteed through test, design, or statistical correlation. Typical values represent the most likely parametric norm at  $T_A = 25^\circ\text{C}$ , and are provided for reference purposes only. Unless otherwise indicated,  $V_{IN} = V_{IN} + 1V$ ,  $I_{OUT} = 10\text{mA}$ ,  $C_{IN} = 6.8\mu\text{F}$ ,  $C_{OUT} = 10\mu\text{F}$ ,  $T_A = 25^\circ\text{C}$ .

Parameter	Min.	Typ.	Max.	Units		Conditions
1.8V version						
Output Voltage - SPX3940A (1%)	1.782	1.8	1.818	V		I <sub>OUT</sub> =10mA 10mA≤I <sub>OUT</sub> ≤1A, 6V≤V <sub>IN</sub> ≤16V
	1.755	1.8	1.845		•	
Output Voltage - SPX3940 (2%)	1.764	1.8	1.836	V		
	1.737	1.8	1.863		•	
2.5V version						
Output Voltage - SPX3940A (1%)	2.475	2.5	2.525	V		I <sub>OUT</sub> =10mA 10mA≤I <sub>OUT</sub> ≤1A, 6V≤V <sub>IN</sub> ≤16V
	2.437	2.5	2.563		•	
Output Voltage - SPX3940 (2%)	2.450	2.5	2.550	V		
	2.412	2.5	2.588		•	
3.3V version						
Output Voltage - SPX3940A (1%)	3.267	3.3	3.333	V		I <sub>OUT</sub> =10mA 10mA≤I <sub>OUT</sub> ≤1A, 6V≤V <sub>IN</sub> ≤16V
	3.217	3.3	3.383		•	
Output Voltage - SPX3940 (2%)	3.234	3.3	3.366	V		
	3.184	3.3	3.416		•	
5.0V version						
Output Voltage - SPX3940A (1%)	4.950	5.0	5.050	V		I <sub>OUT</sub> =10mA 10mA≤I <sub>OUT</sub> ≤1A, 6V≤V <sub>IN</sub> ≤16V
	4.875	5.0	5.125		•	
Output Voltage - SPX3940 (2%)	4.900	5.0	5.100	V		
	4.825	5.0	5.175		•	
All Voltage Options						
Line Regulation		0.2	1.0	%		I <sub>OUT</sub> =10mA, (V <sub>OUT</sub> +1V)≤V <sub>IN</sub> ≤16V
Load Regulation		0.3	1.5	%		V <sub>IN</sub> = V <sub>OUT</sub> +1V,10mA≤I <sub>OUT</sub> ≤1A
$\frac{\Delta V}{\Delta T}$ - Output Voltage temperature Coefficient		20	100	ppm/°C	•	
Dropout Voltage <sup>2</sup> (except 1.8V version)		70	200	mV	•	I <sub>OUT</sub> =100mA
		280	550	mV	•	I <sub>OUT</sub> =1A
Ground Current <sup>3</sup>		12	25	mA	•	I <sub>OUT</sub> =750mA, V <sub>IN</sub> = V <sub>OUT</sub> +1V
		18		mA		I <sub>OUT</sub> =1A
I <sub>GNDDO</sub> Ground Pin Current at Dropout		1.2		mA		V <sub>IN</sub> = 0.1V less than specified V <sub>OUT</sub> I <sub>OUT</sub> =10mA,
Current Limit	1.5	2.2		A		V <sub>OUT</sub> = 0V <sup>4</sup>
Output Noise Voltage		400		μV <sub>RMS</sub>		10Hz-100KHz, I <sub>L</sub> =100mA, C <sub>L</sub> =10μF
		260		μV <sub>RMS</sub>		10Hz-100KHz, I <sub>L</sub> =100mA, C <sub>L</sub> =33μF

## 1A Low Dropout Voltage Regulator

Note 2: Dropout voltage is defined as the input to output differential when the output voltage drops to 99% of its normal value.

Note 3: Ground pin current is the regulator quiescent current. The total current drawn from the source is the sum of the load current to the ground current.

Note 4:  $V_{IN} = V_{OUT(NOMINAL)} + 1V$ . For example, use  $V_{IN} = 4.3V$  for a 3.3V regulator. Employ pulse-testing procedures to minimize temperature rise.

### BLOCK DIAGRAM

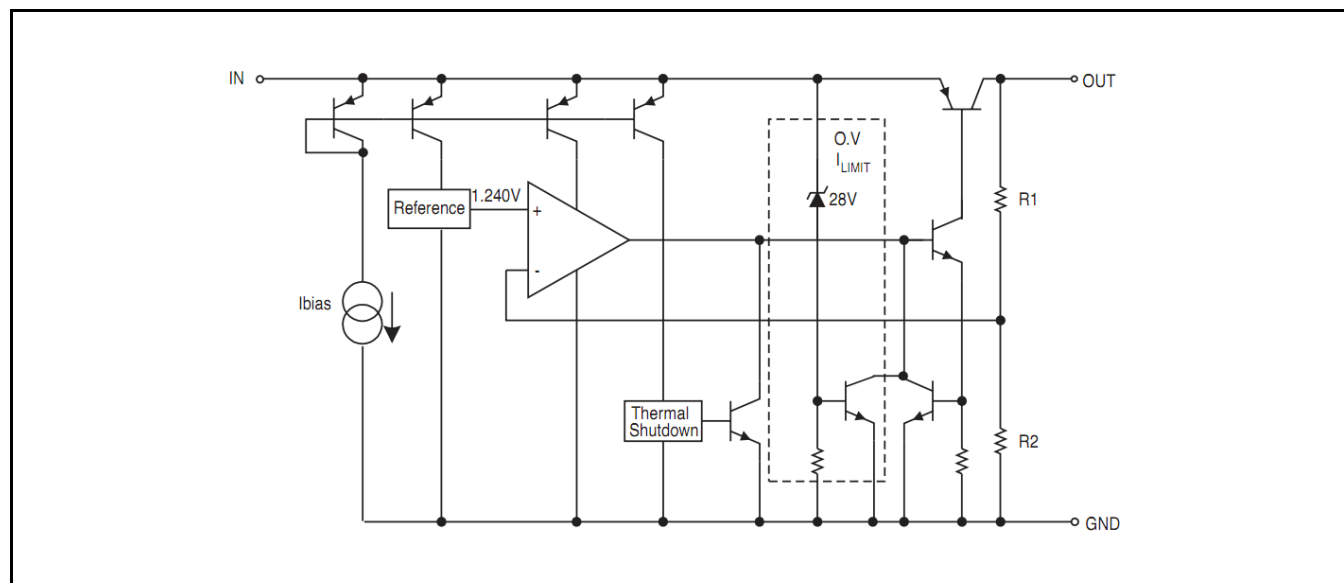


Fig. 2: SPX3940 Block Diagram

### PIN ASSIGNMENT

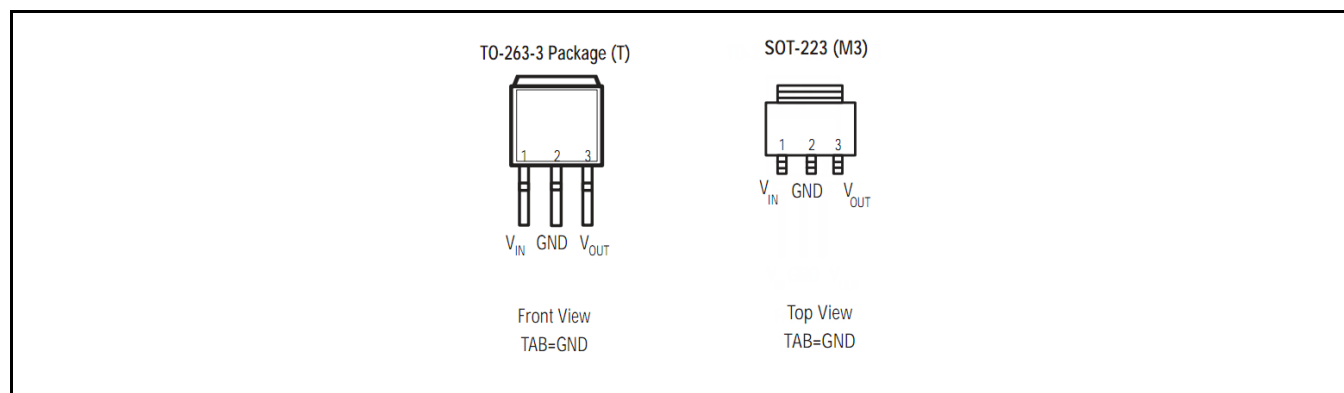


Fig. 3: SPX3940 Pin Assignment

**ORDERING INFORMATION**

Part Number	Temperature Range	Package	Package Method	Lead Free	Note 2
SPX3940AM3-L-3-3/TR	$-40^{\circ}\text{C} \leq T_J \leq +125^{\circ}\text{C}$	3-pin SOT-223	2.5k/Tape & Reel	Yes	3.3V Output Voltage – 1%
SPX3940AM3-L-5-0-TR	$-40^{\circ}\text{C} \leq T_J \leq +125^{\circ}\text{C}$	3-pin SOT-223	2.5k/Tape & Reel	Yes	5.0V Output Voltage – 1%
SPX3940AT-L-3-3/TR	$-40^{\circ}\text{C} \leq T_J \leq +125^{\circ}\text{C}$	3-pin TO-263	500/Tape & Reel	Yes	3.3V Output Voltage – 1%
SPX3940M3-L-2-5/TR	$-40^{\circ}\text{C} \leq T_J \leq +125^{\circ}\text{C}$	3-pin SOT-223	2.5k/Tape & Reel	Yes	2.5V Output Voltage – 2%
SPX3940M3-L-5-0/TR	$-40^{\circ}\text{C} \leq T_J \leq +125^{\circ}$	3-pin SOT-223	2.5k/Tape & Reel	Yes	5.0V Output Voltage – 2%
SPX3940T-L-3-3/TR	$-40^{\circ}\text{C} \leq T_J \leq +125^{\circ}$	3-pin TO-263	500/Tape & Reel	Yes	3.3V Output Voltage – 2%

**NOTE:** For more information about part numbers, as well as the most up-to-date ordering information and additional information on environment rating, go to [www.maxlinear.com/SPX3940](http://www.maxlinear.com/SPX3940)

## TYPICAL PERFORMANCE CHARACTERISTICS

Schematic and BOM from Application Information section of this datasheet.

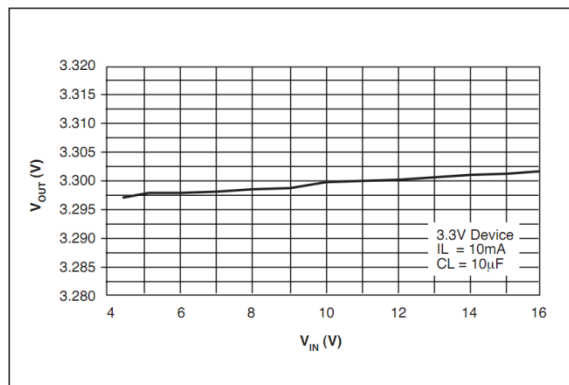


Fig. 4: Line Regulation

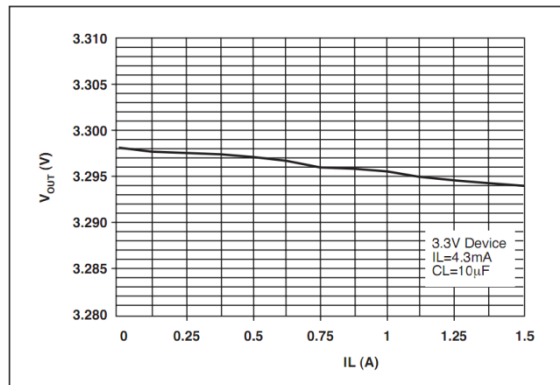


Fig. 5: Load Regulation

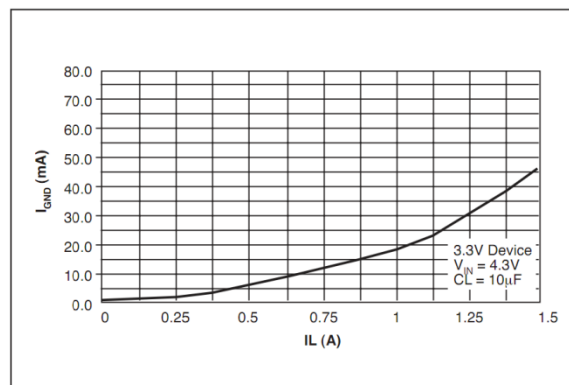


Fig. 6: Ground Current vs Load Current

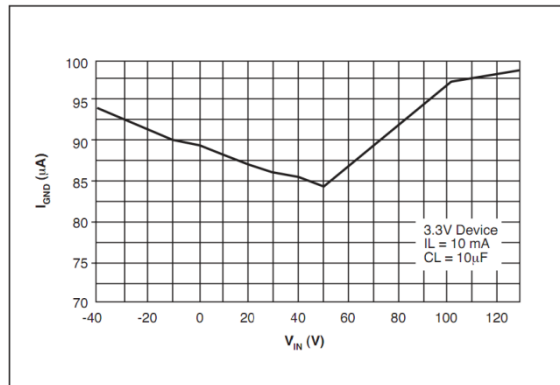


Fig. 7: Ground Current vs Input Voltage

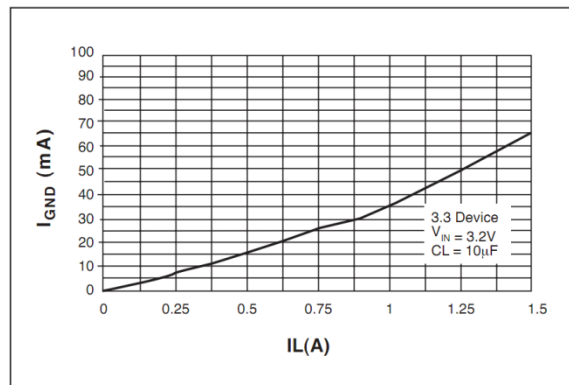


Fig. 8: Ground Current vs Load Current in Dropout

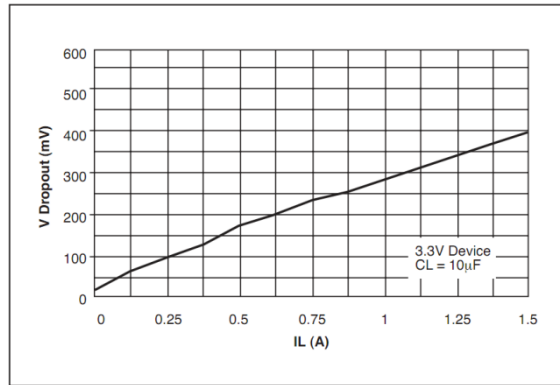


Fig. 9: Dropout Voltage vs Load Current

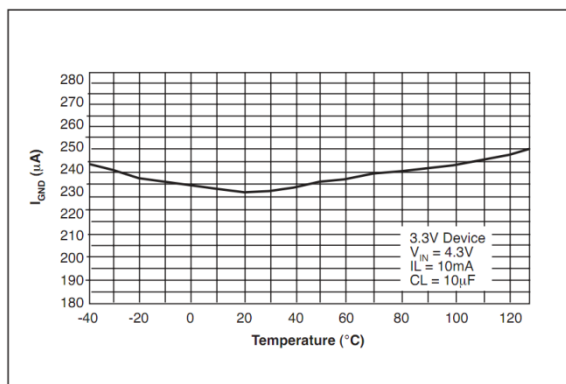


Fig. 10: Ground Current vs Temperature  
 $I_{LOAD}=100mA$

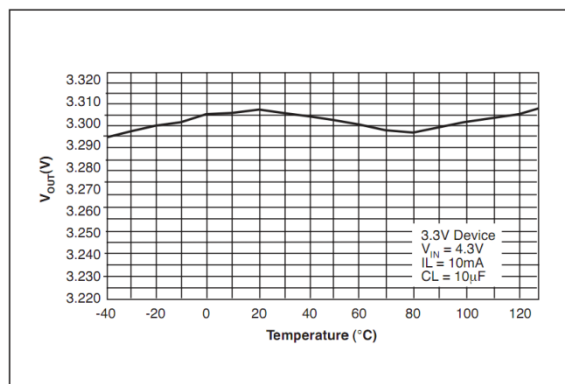


Fig. 11: Output Voltage vs Temperature  
 $I_{LOAD}=100mA$

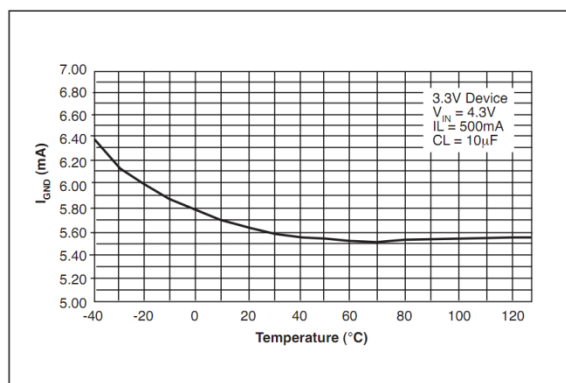


Fig. 12: Ground Current vs Temperature  
 $I_{LOAD}=500mA$

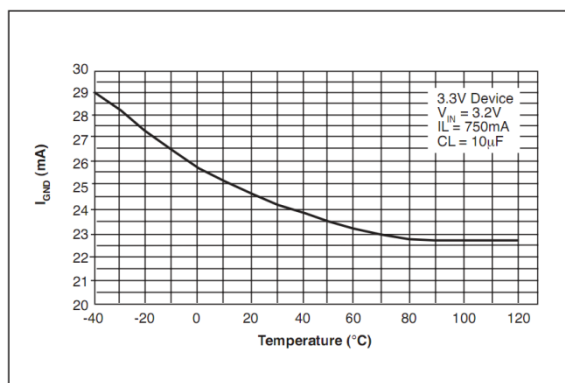


Fig. 13: Ground Current vs Temperature  
Dropout,  $I_{LOAD}=750mA$

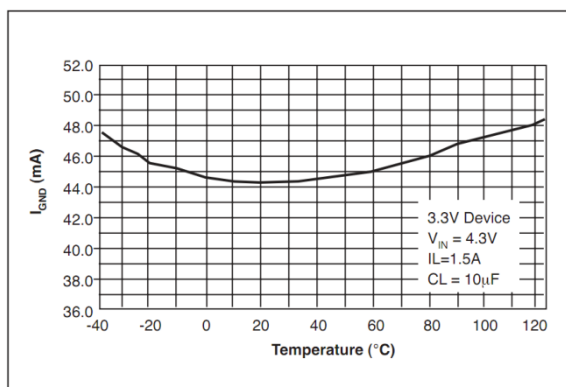


Fig. 14: Ground Current vs Temperature  
 $I_{LOAD}=1.5A$

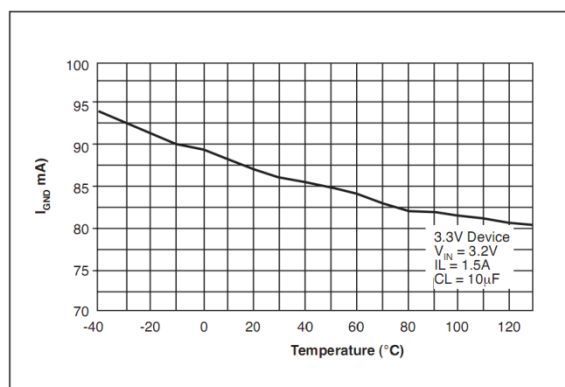


Fig. 15: Ground Current vs Temperature  
Dropout,  $I_{LOAD}=1.5A$

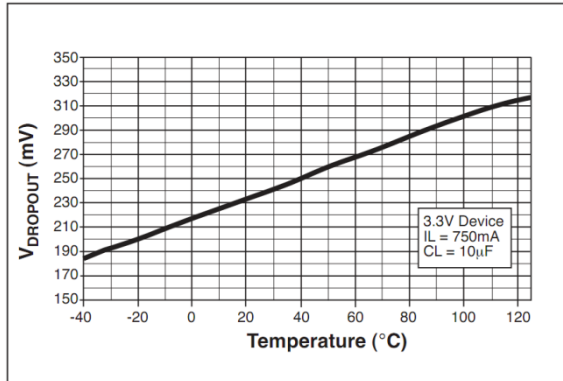


Fig. 16: Dropout Voltage vs Temperature  
 $I_{LOAD} = 750\text{mA}$

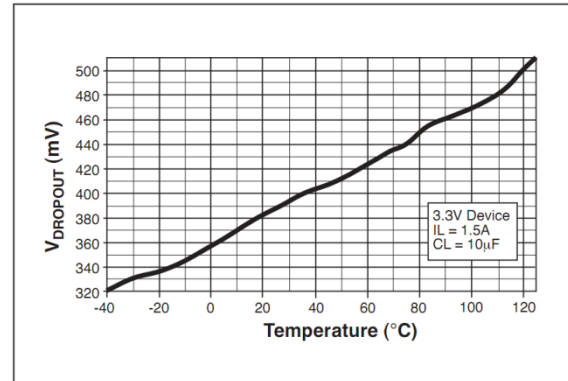


Fig. 17: Dropout Voltage vs Temperature  
 $I_{LOAD} = 1.5\text{A}$

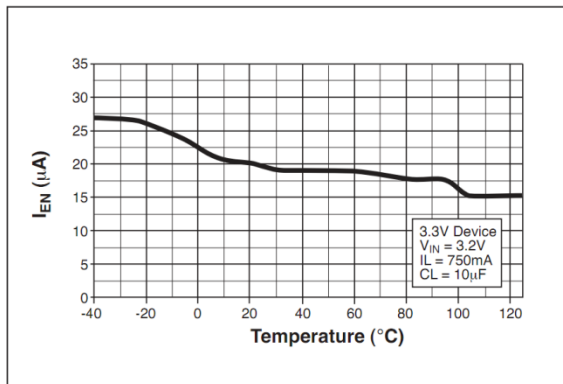


Fig. 18: Enable Current vs Temperature  
 $V_{EN} = 16\text{V}$

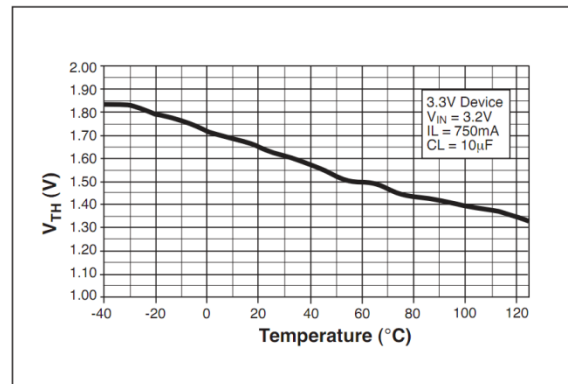


Fig. 19: Enable Threshold vs Temperature

## 1A Low Dropout Voltage Regulator

### THEORY OF OPERATION

The SPX3940 incorporates protection against over-current faults, reversed load insertion, over temperature operation, and positive and negative transient voltage.

### THERMAL CONSIDERATIONS

Although the SPX3940 offers limiting circuitry for overload conditions, it is still necessary to insure that the maximum junction temperature is not exceeded in the application. Heat will flow through the lowest resistance path, the junction-to-case path. In order to insure the best thermal flow of the component, proper mounting is required. Consult heatsink manufacturer for thermal resistance and design of heatsink.

#### TO-220 Design Example:

Assume that  $V_{IN} = 10V$ ,  $V_{OUT} = 5V$ ,  $I_{OUT} = 1.5A$ ,  $T_A = 50^{\circ}C/W$ ,  $\theta_{HA} = 1^{\circ}C/W$ ,  $\theta_{CH} = 2^{\circ}C/W$ , and  $\theta_{JC} = 3^{\circ}C/W$ .

Where  $T_A$  = ambient temperature

$\theta_{HA}$  = heatsink to ambient thermal resistance

$\theta_{CH}$  = case to heatsink thermal resistance

$\theta_{JC}$  = junction to case thermal resistance

The power calculated under these conditions is:

$$P_D = (V_{IN} - V_{OUT}) * I_{OUT} = 7.5W.$$

And the junction temperature is calculated as

$$T_J = T_A + P_D * (\theta_{HA} + \theta_{CH} + \theta_{JC}) \text{ or}$$

$$T_J = 50 + 7.5 * (1 + 2 + 3) = 95^{\circ}C$$

Reliable operation is insured.

### CAPACITOR REQUIREMENTS

The output capacitor is needed to insure stability and minimize the output noise. The value of the capacitor varies with the load. However, a minimum value of  $10\mu F$  aluminum capacitor will guarantee stability over all load conditions. A tantalum capacitor is recommended if a faster load transient response is needed.

If the power source has a high AC impedance, a  $0.1\mu F$  ceramic capacitor between input & ground is recommended.

### MINIMUM LOAD CURRENT

To ensure a proper behavior of the regulator under light load, a minimum load of 5mA for SPX3940 is required.

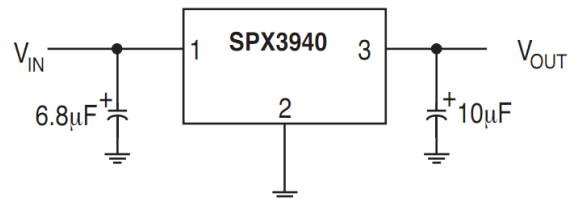
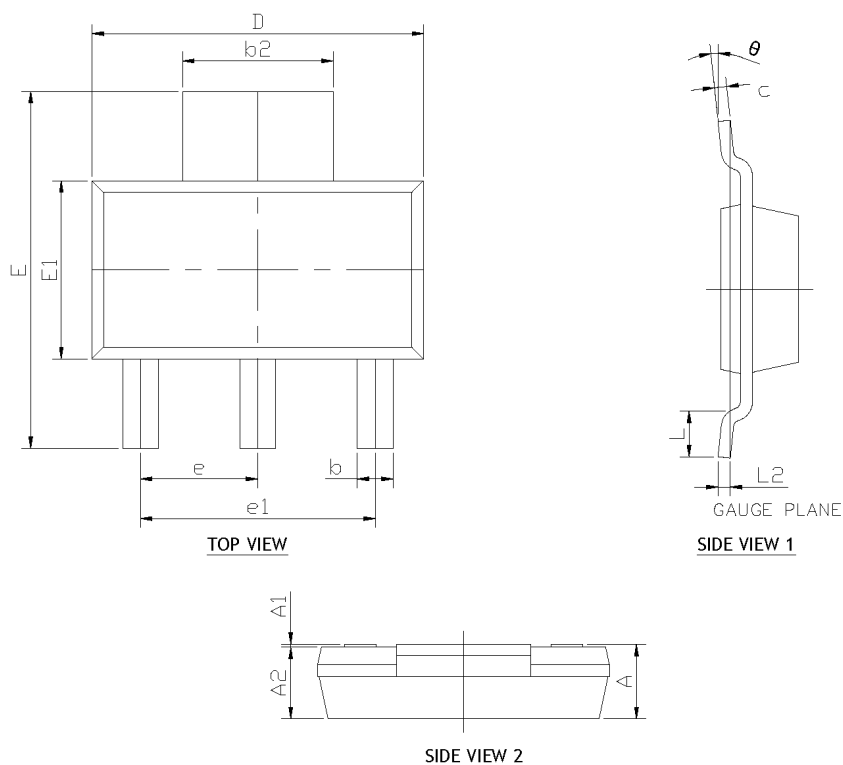


Fig. 20: Fixed Output Linear Regulator



**PACKAGE SPECIFICATION**
**3-PIN SOT-223**


DIM SYMBOL	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 BSC		
e1	4.60 BSC		
L	0.75	-	-
L2	0.25 BSC		
$\theta$	0°	-	10°
N	3		

**TERMINAL DETAILS**

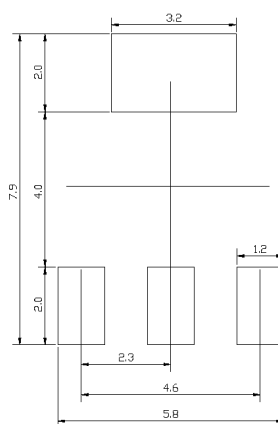
NOTE : ALL DIMENSIONS ARE IN MILLIMETERS, ANGLES ARE IN DEGREES.

Drawing No.: POD-00000098

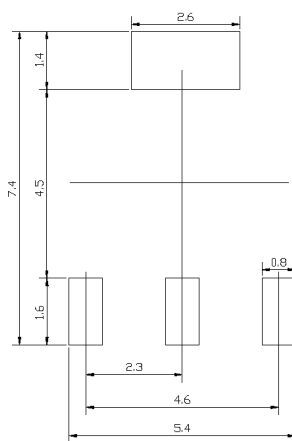
Revision: C

**RECOMMENDED LAND PATTERN AND STENCIL**

**3-PIN SOT-223**



TYPICAL RECOMMENDED LAND PATTERN

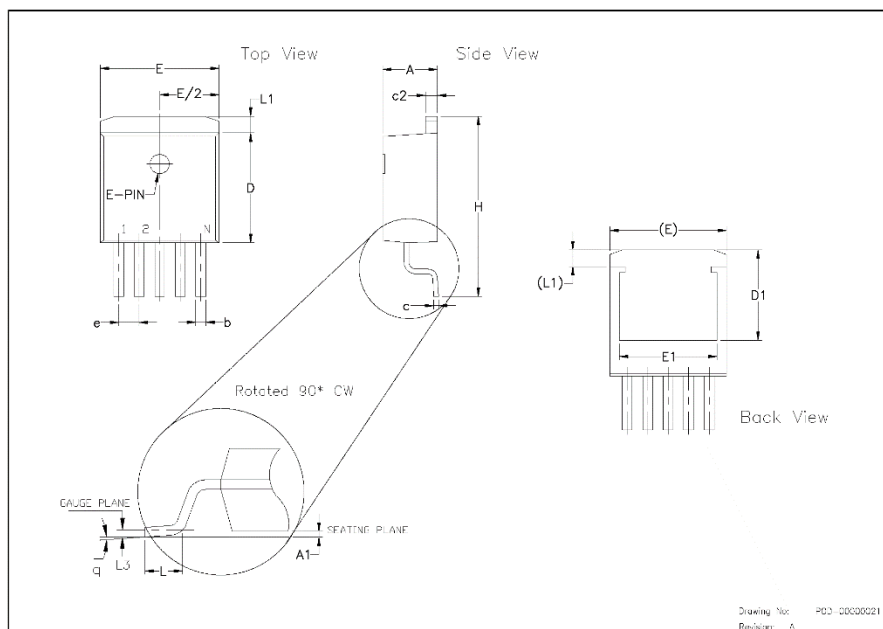


TYPICAL RECOMMENDED STENCIL

NOTE : ALL DIMENSIONS ARE IN MILLIMETERS, ANGLES ARE IN DEGREES.

Drawing No.: POD-00000098

Revision: C

**PACKAGE SPECIFICATION**
**3-PIN TO-263**


3 Pin TO-263 JEDEC TO-263 Variation AA							5 Pin TO-263 JEDEC TO-263 Variation BA						
SYMBOLS	DIMENSIONS IN INCH (Control Unit)			DIMENSIONS IN MM (Reference Unit)			SYMBOLS	DIMENSIONS IN INCH (Control Unit)			DIMENSIONS IN MM (Reference Unit)		
	MIN	NOM	MAX	MIN	NOM	MAX		MIN	NOM	MAX	MIN	NOM	MAX
A	0.160	—	0.190	4.06	—	4.83	A	0.160	—	0.190	4.06	—	4.83
A1	0.000	—	0.010	0.00	—	0.25	A1	0.000	—	0.010	0.00	—	0.25
b	0.020	—	0.039	0.51	—	0.99	b	0.020	—	0.039	0.51	—	0.99
b2	0.045	—	0.070	1.14	—	1.78	b2	0.045	—	0.070	1.14	—	1.78
c	0.015	—	0.029	0.38	—	0.74	c	0.015	—	0.029	0.38	—	0.74
c2	0.045	—	0.065	1.14	—	1.65	c2	0.045	—	0.065	1.14	—	1.65
D	0.330	—	0.380	8.38	—	9.65	D	0.330	—	0.380	8.38	—	9.65
D1	0.270	—	—	6.86	—	—	D1	0.270	—	—	6.86	—	—
E	0.380	—	0.420	9.65	—	10.67	E	0.380	—	0.420	9.65	—	10.67
E1	0.245	—	—	6.22	—	—	E1	0.245	—	—	6.22	—	—
e	0.100 BSC			2.54 BSC			e	0.067 BSC			1.70 BSC		
H	0.575	—	0.625	14.61	—	15.88	H	0.575	—	0.625	14.61	—	15.88
L	0.070	—	0.110	1.78	—	2.79	L	0.070	—	0.110	1.78	—	2.79
L1	—	—	0.066	—	—	1.68	L1	—	—	0.066	—	—	1.68
L3	0.010 BSC			0.25 BSC			L3	0.010 BSC			0.25 BSC		
q	0°	—	8°	0°	—	8°	q	0°	—	8°	0°	—	8°
N	3			3			N	5			5		

Drawing No: P03-0000021  
Revision: A

**REVISION HISTORY**

Revision	Date	Description
A	04/14/2006	
1.0.0	02/29/2012	Reformat of Datasheet Package drawing corrections
1.0.1	July 3, 2023	<b>Updated:</b> <ul style="list-style-type: none"><li>In "Ordering Information" table, removed SPX3940AM3-L-1-8, SPX3940AM3-L-1-8/TR, SPX3940AM3-L-2-5, SPX3940AM3-L-2-5/TR, SPX3940AM3-L-3-3, SPX3940AM3-L-5-0, SPX3940AT-L-1-8, SPX3940AT-L-1-8/TR, SPX3940AT-L-3-3, SPX3940AT-L-5-0, SPX3940AT-L-5-0/TR, SPX3940M3-L-2-5, SPX3940M3-L-3-3, SPX3940M3-L-3-3/TR, SPX3940M3-L-5-0, SPX3940T-L-3-3, SPX3940T-L-5-0, and SPX3940T-L-5-0/TR obsolete part numbers.</li><li>"Package Specification 3-Pin SOT-223" figure.</li><li>"Recommended Land Pattern and Stencil 3-Pin SOT-223" figure.</li><li>"Package Specification 3-Pin TO-263" figures.</li></ul>

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