

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

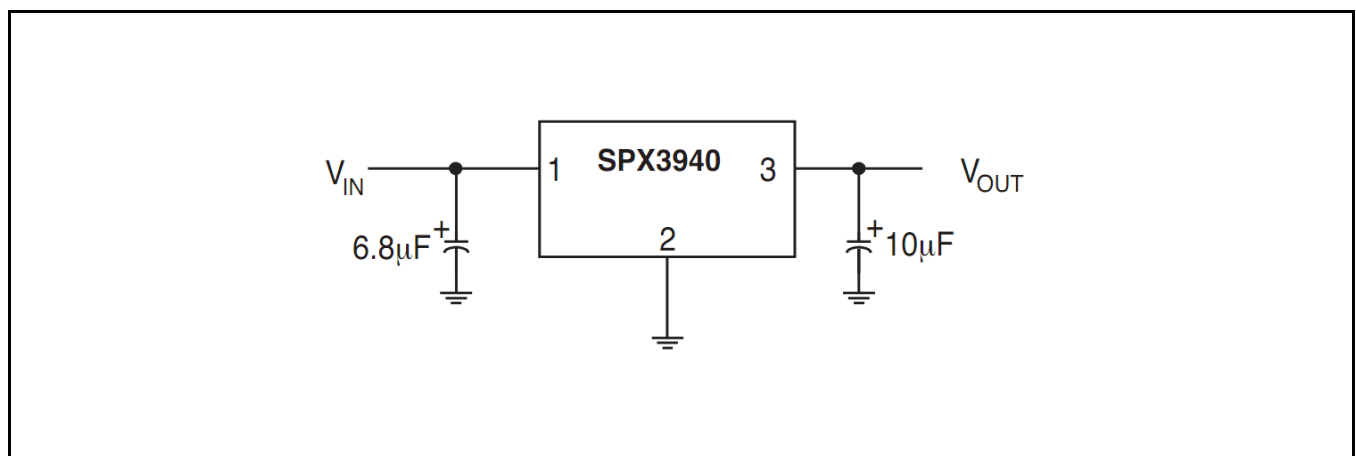


Fig. 1: SPX3940 Application Diagram – Fixed Output Linear Regulator

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} 20V¹
 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		$I_{OUT}=10mA$ $10mA \leq I_{OUT} \leq 1A$, $6V \leq V_{IN} \leq 16V$
	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		$I_{OUT}=10mA$ $10mA \leq I_{OUT} \leq 1A$, $6V \leq V_{IN} \leq 16V$
	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		$I_{OUT}=10mA$ $10mA \leq I_{OUT} \leq 1A$, $6V \leq V_{IN} \leq 16V$
	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		$I_{OUT}=10mA$ $10mA \leq I_{OUT} \leq 1A$, $6V \leq V_{IN} \leq 16V$
	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	%		$I_{OUT}=10mA$, $(V_{OUT} + 1V) \leq V_{IN} \leq 16V$
Load Regulation		0.3	1.5	%		$V_{IN} = V_{OUT} + 1V, 10mA \leq I_{OUT} \leq 1A$
$\frac{\Delta V}{\Delta T}$ - Output Voltage temperature Coefficient		20	100	ppm/°C	•	
Dropout Voltage ² (except 1.8V version)		70	200	mV	•	$I_{OUT}=100mA$
		280	550	mV	•	$I_{OUT}=1A$
Ground Current ³		12	25	mA	•	$I_{OUT}=750mA$, $V_{IN} = V_{OUT} + 1V$
		18		mA		$I_{OUT}=1A$
I_{GNDDO} Ground Pin Current at Dropout		1.2		mA		$V_{IN} = 0.1V$ less than specified V_{OUT} $I_{OUT}=10mA$,
Current Limit	1.5	2.2		A		$V_{OUT} = 0V^4$
Output Noise Voltage		400		μV_{RMS}		10Hz-100KHz, $I_L=100mA$, $C_L=10\mu F$
		260		μV_{RMS}		10Hz-100KHz, $I_L=100mA$, $C_L=33\mu F$

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

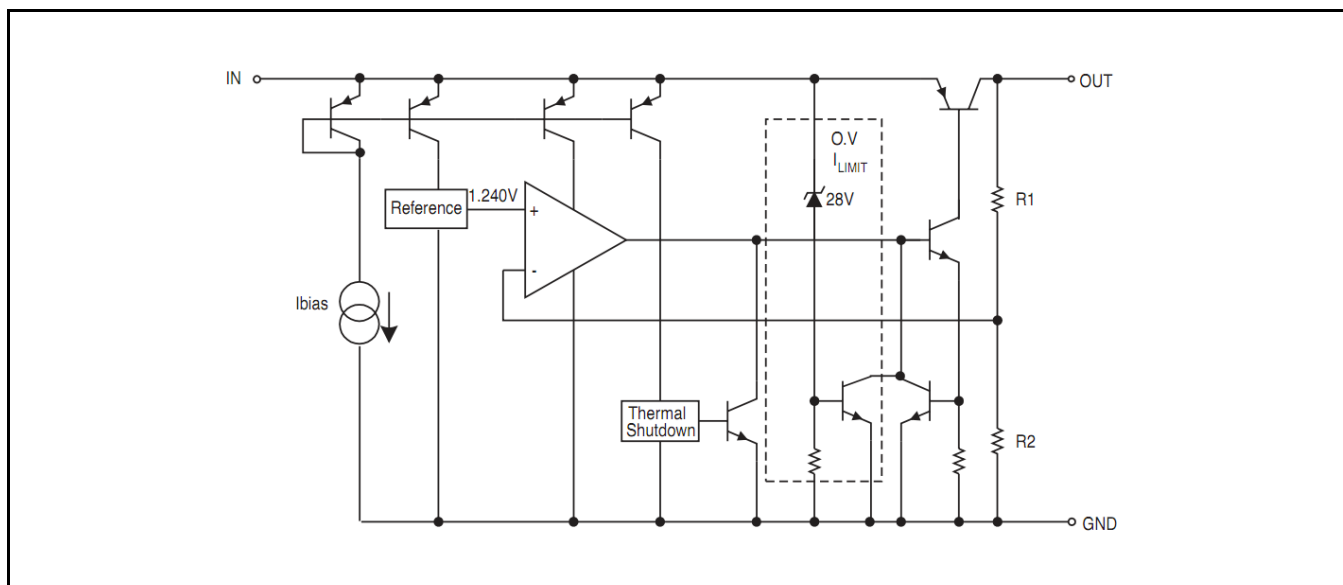


Fig. 2: SPX3940 Block Diagram

PIN ASSIGNMENT

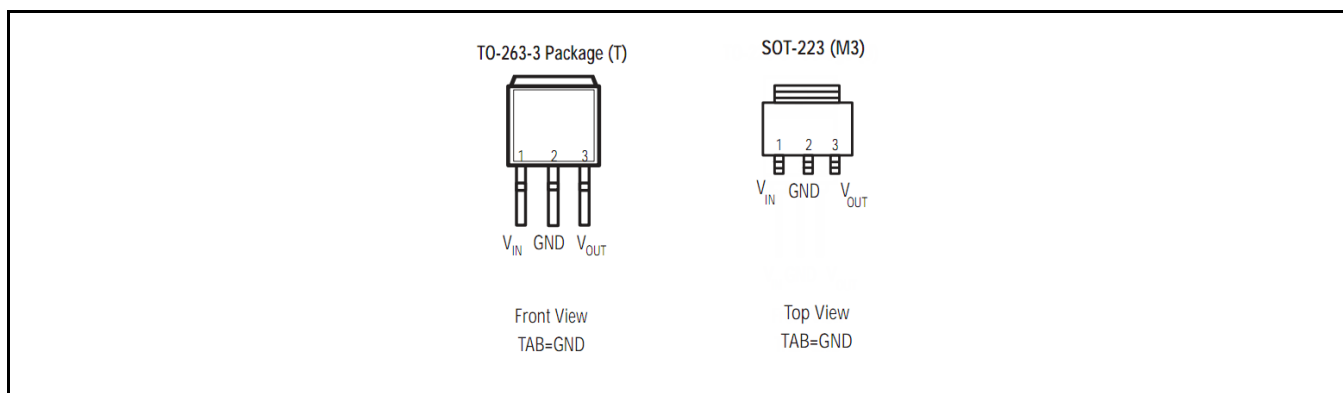


Fig. 3: SPX3940 Pin Assignment

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

TYPICAL PERFORMANCE CHARACTERISTICS

Schematic and BOM from Application Information section of this datasheet.

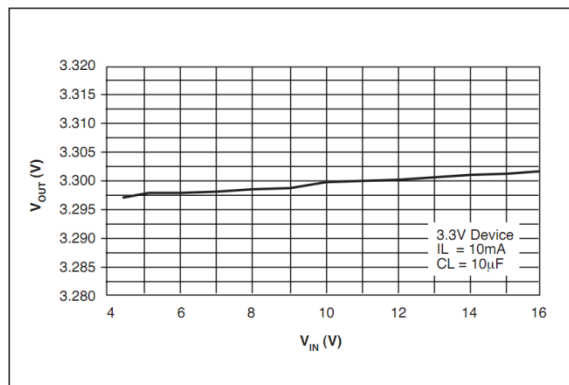


Fig. 4: Line Regulation

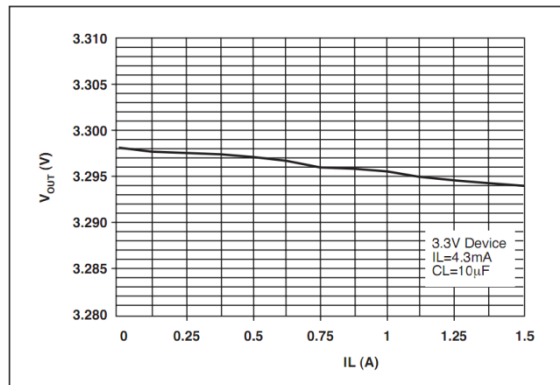


Fig. 5: Load Regulation

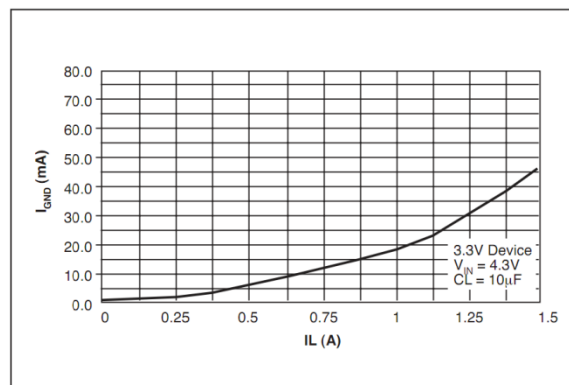


Fig. 6: Ground Current vs Load Current

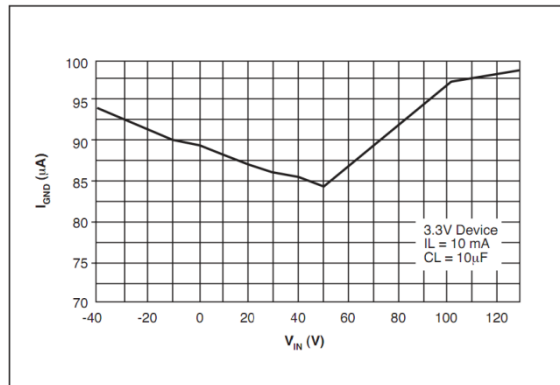


Fig. 7: Ground Current vs Input Voltage

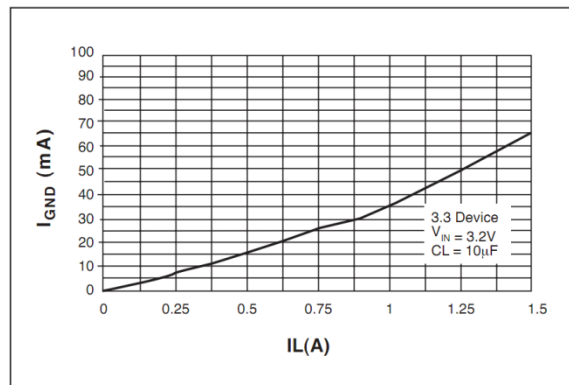


Fig. 8: Ground Current vs Load Current in Dropout

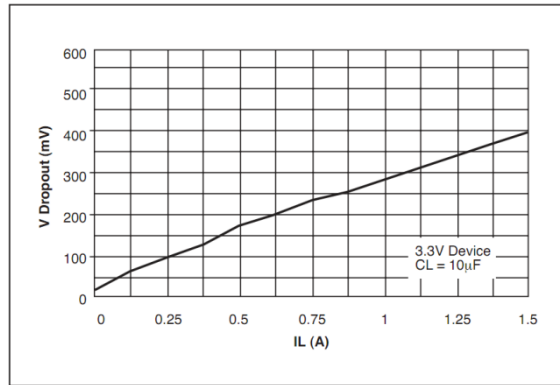


Fig. 9: Dropout Voltage vs Load Current

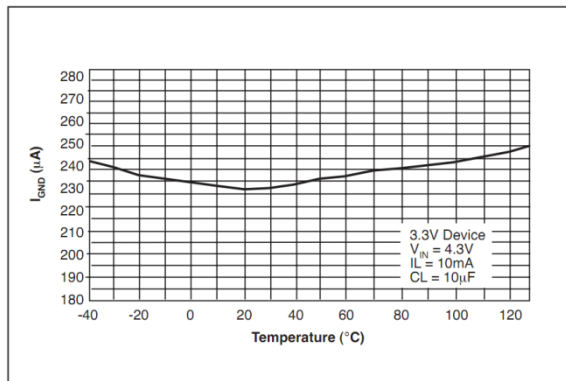


Fig. 10: Ground Current vs Temperature
 $I_{LOAD}=100mA$

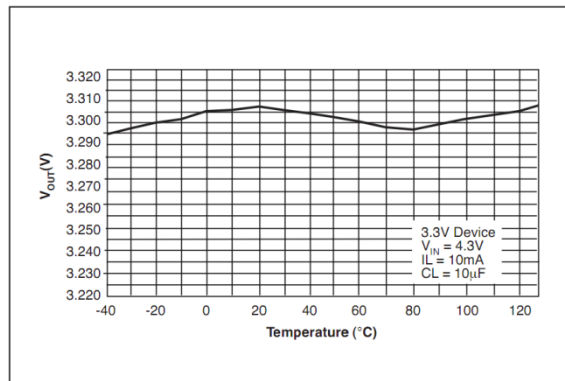


Fig. 11: Output Voltage vs Temperature
 $I_{LOAD}=100mA$

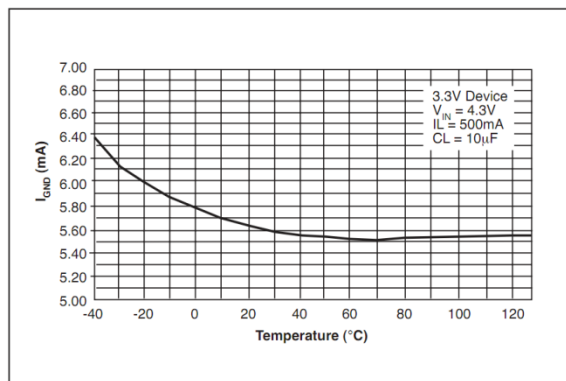


Fig. 12: Ground Current vs Temperature
 $I_{LOAD}=500mA$

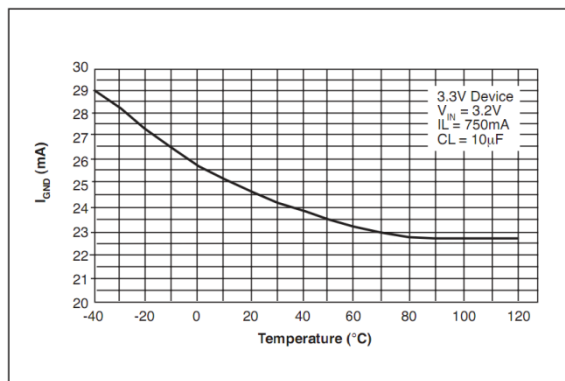


Fig. 13: Ground Current vs Temperature
Dropout, $I_{LOAD}=750mA$

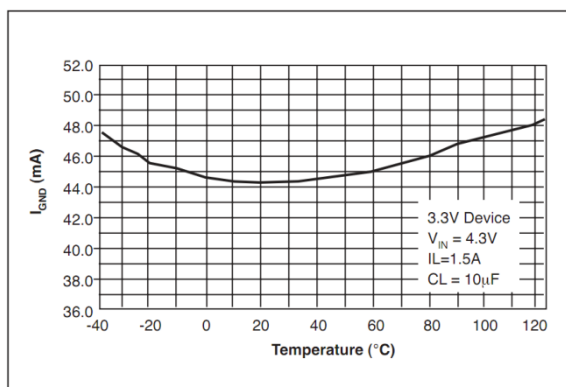


Fig. 14: Ground Current vs Temperature
 $I_{LOAD}=1.5A$

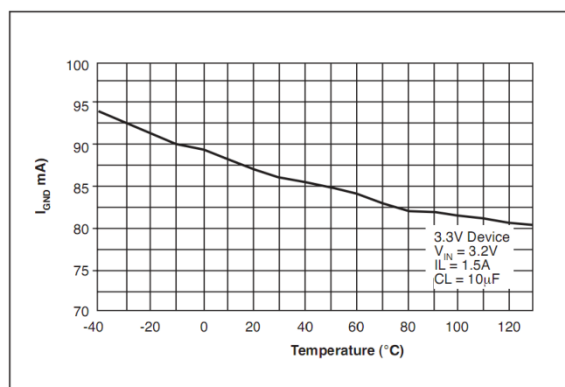


Fig. 15: Ground Current vs Temperature
Dropout, $I_{LOAD}=1.5A$

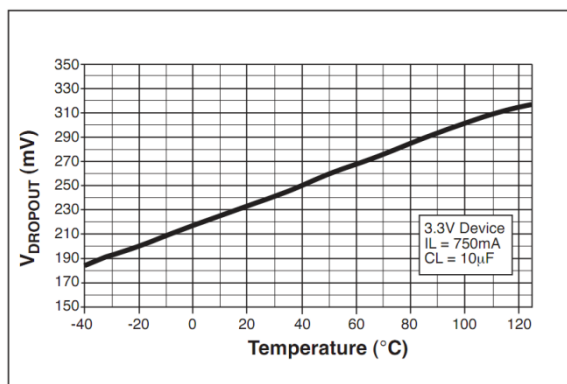


Fig. 16: Dropout Voltage vs Temperature
 $I_{LOAD} = 750mA$

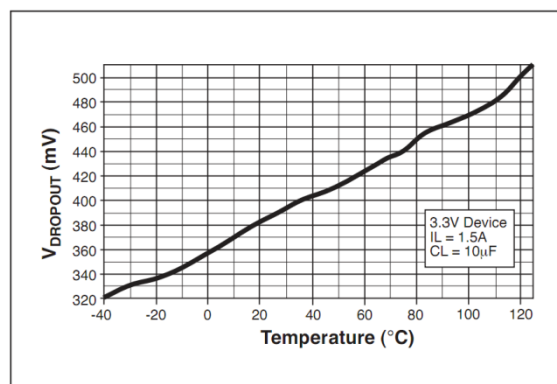


Fig. 17: Dropout Voltage vs Temperature
 $I_{LOAD} = 1.5A$

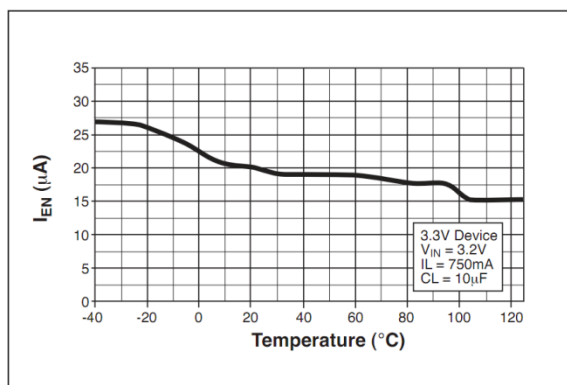


Fig. 18: Enable Current vs Temperature
 $V_{EN} = 16V$

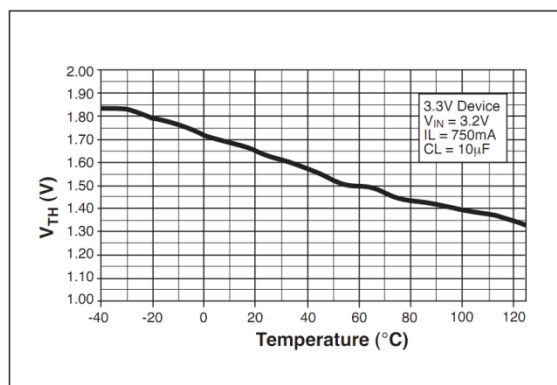


Fig. 19: Enable Threshold vs Temperature

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

θ_{HA} = heatsink to ambient thermal resistance

θ_{CH} = case to heatsink thermal resistance

θ_{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.

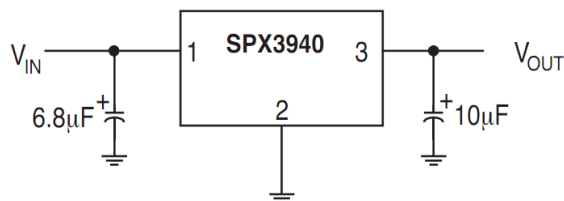
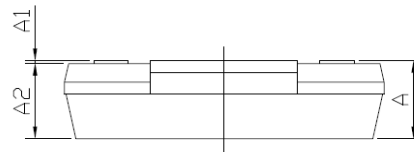
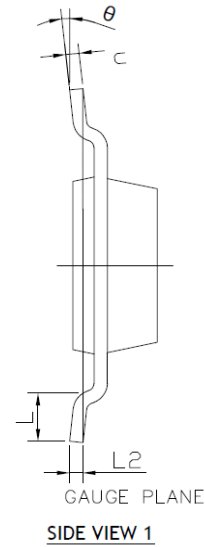
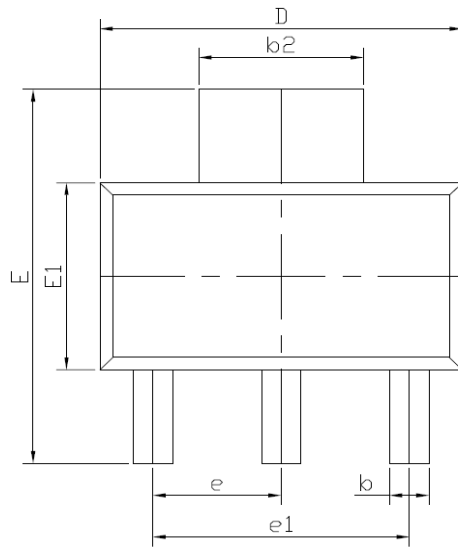


Fig. 20: Fixed Output Linear Regulator

PACKAGE SPECIFICATION
3-PIN SOT-223


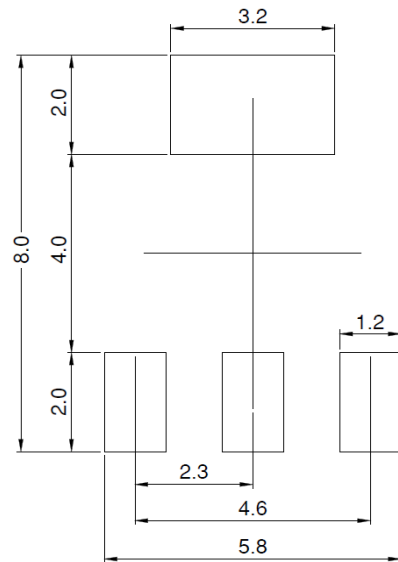
DIM SYMBOL	MIN.	NOM.	MAX.
A	-	-	1.80
A1	0.02	-	0.10
A2	1.50	1.60	1.70
b	0.66	0.76	0.84
b2	2.90	3.00	3.10
c	0.23	0.30	0.35
D	6.30	6.50	6.70
E	6.70	7.00	7.30
E1	3.30	3.50	3.70
e	2.30 BSC		
e1	4.60 BSC		
L	0.75	-	-
L2	0.25 BSC		
θ	0°	-	10°
N	3		

TERMINAL DETAILS

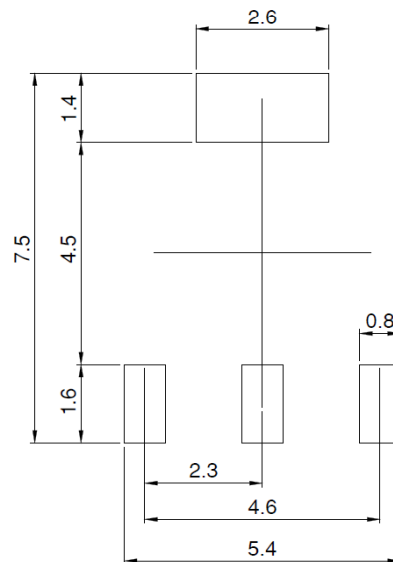
NOTE : ALL DIMENSIONS ARE IN MILLIMETERS, ANGLES ARE IN DEGREES.

Drawing No. : POD-00000098

Revision: D

RECOMMENDED LAND PATTERN AND STENCIL
3-PIN SOT-223


TYPICAL RECOMMENDED LAND PATTERN

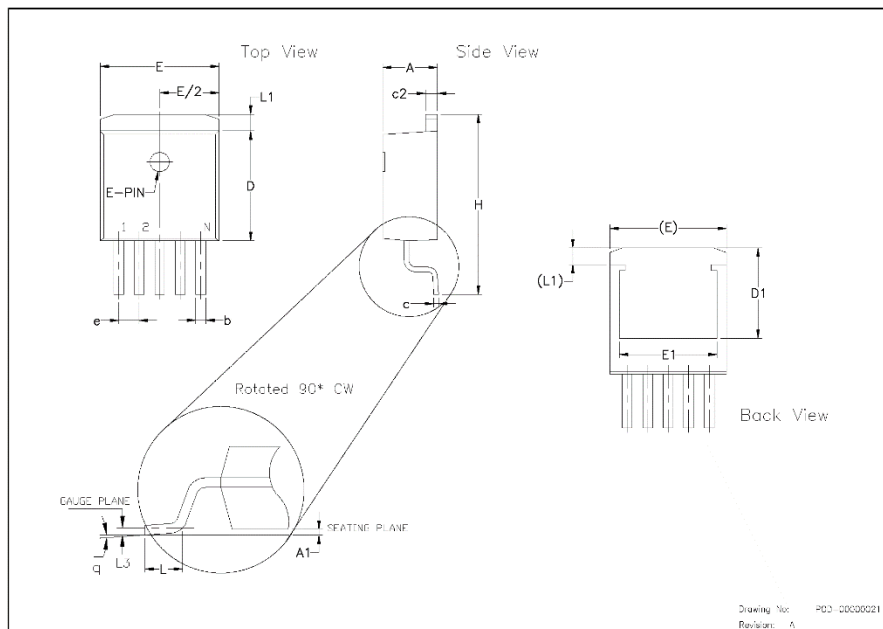


TYPICAL RECOMMENDED STENCIL

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

Drawing No. : POD-00000098

Revision: D

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	Updated: <ul style="list-style-type: none"> 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. "Package Specification 3-Pin SOT-223" figure. "Recommended Land Pattern and Stencil 3-Pin SOT-223" figure. "Package Specification 3-Pin TO-263" figures.
1.0.2	June 23, 2025	Updated: <ul style="list-style-type: none"> "Package Specification 3-Pin SOT-223" figure from Revision C to Revision D. No change to content; MxL document registration only. "Recommended land pattern and stencil 3-Pin SOT-223" figure: dimensions corrected.

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