

## General Description

The SPX2941 is a 1A, accurate voltage regulator with a low drop out voltage of 280mV (Typ.) at 1A. These regulators are 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 SPX2941 is offered in a 5-pin TO-263 package. For more information about a 3A version, refer to the SPX29300 data sheet.

**TO-263 version available, TO-220 version obsolete**

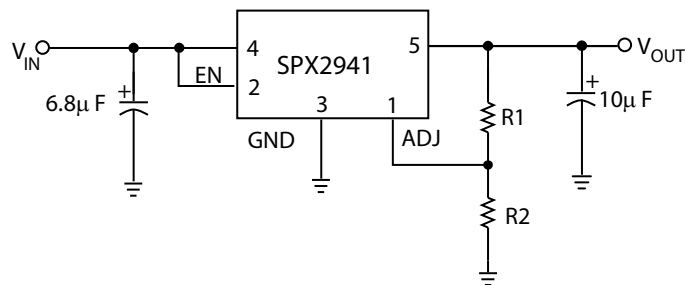
For more details about the ordering information, see ["Ordering Information"](#) on page 11.

## Features

- Adjustable output down To 1.25V
- Low quiescent current
- Guaranteed 1.5A peak output current
- Low dropout voltage of 280mV @ 1A
- Extremely tight load and line regulation
- Extremely fast transient response
- Reverse-battery protection
- Internal thermal and current limit protection
- Zero current shutdown

## Applications

- Industrial equipment
- Telecommunications equipment
- LCD Monitors
- USB Power supply
- SMPS Post-regulator
- Battery charger
- Constant current regulators



**Figure 1: SPX2941 Typical Application**

## Revision History

Document No.	Release Date	Change Description
244DSR00	May 17, 2023	<b>Updated:</b> <ul style="list-style-type: none"><li>■ New template applied, contents rewriting, and obsolete packages highlighted.</li><li>■ "General Description" section.</li><li>■ "Features" section.</li><li>■ "Applications" section.</li><li>■ "Specifications" section.</li><li>■ "Pin Information" section.</li><li>■ "Application Information" section.</li><li>■ "Ordering Information" section.</li></ul>
Rev E	Sept 28-06	Legacy Sipex data sheet.

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# Specifications

## Absolute Maximum Ratings

**Important:** The stresses above what is listed under the following table may cause permanent damage to the device. This is a stress rating only—functional operation of the device above what is listed under the following table or any other conditions beyond what MaxLinear recommends is not implied. Exposure to conditions above the recommended extended periods of time may affect device reliability. Solder reflow profile is specified in the IPC/JEDEC J-STD-020C standard.

**Table 1: Absolute Maximum Ratings**

	Min	Max	Units
Lead Temperature (soldering, 5 seconds)	-65	150	°C
Storage Temperature Range	-	260	°C
Operating Junction Temperature Range	-40	125	°C
Input Supply Voltage	-	16	V
Input Supply Voltage <100ms, < 1% duty cycles	-	20	V

## Thermal Specifications

*TO-263 version available, TO-220 version obsolete*

**Table 2: Thermal Performance**

Symbol	Parameter	Package	Typ	Units
$\Psi_{JB}$	Junction to Case, at Tab	TO-220	3	°C/W
$\Theta_{JA}$	Junction to Ambient	TO-220	29.3	°C/W
$\Psi_{JB}$	Junction to Case, at Tab	TO-263	3	°C/W
$\Theta_{JA}$	Junction to Ambient	TO-263	31.2	°C/W

## Electrical Characteristics

Electrical characteristics at  $V_{IN} = V_{OUT} + 1V$ ,  $T_A = 25^\circ\text{C}$ ,  $C_{IN} = 6.8\mu\text{F}$ ,  $C_{OUT} = 10\mu\text{F}$ ,  $I_{OUT} = 10\text{mA}$ , unless otherwise specified. Adjustable versions are set at 5.0V. The • denotes the specifications that apply over the full operating temperature range of  $-40^\circ\text{C} \leq T_J \leq 125^\circ\text{C}$ , unless otherwise specified.

**Table 3: Electrical Characteristics**

Parameter	Conditions		Min	Typ	Max	Units
Reference Voltage	Adjustable version only, $2.5 \leq V_{IN} \leq 16V$		1.228	1.240	1.252	V
		•	1.215	-	1.265	
Adjust Pin Bias Current	-		-	40	80	nA
		•	-	-	120	
Reference Voltage Temperature Coefficient <sup>(4)</sup>	-		-	20	-	ppm/ $^\circ\text{C}$
Adjust Pin Bias Current Temperature Coefficient	-		-	0.1	-	nA/ $^\circ\text{C}$
Line Regulation	$I_O = 10\text{mA}$ , $(V_{OUT} + 1V) \leq V_{IN} \leq 16V$		-	0.2	1.0	%
Load Regulation	$V_{IN} = V_{OUT} + 1V$ , $10\text{mA} \leq I_{OUT} \leq I_{FULLLOAD}$		-	0.3	1.5	%
Dropout Voltage <sup>(1)</sup> (except 1.8V version)	$I_O = 100\text{mA}$	•	-	70	200	mV
	$I_O = 1A$	•	-	280	550	
Ground Current <sup>(3)</sup>	$I_O = 750\text{mA}$ , $V_{IN} = V_{OUT} + 1V$	•	-	12	25	mA
	$I_O = 1A$		-	18	-	
$I_{GNDDO}$ Ground Pin Current at Dropout	$V_{IN} = 0.1V$ less than specified $V_{OUT} I_{OUT} = 10\text{mA}$		-	1.2	-	mA
Current Limit <sup>(2)</sup>	$V_{OUT} = 0V$		1.5	2.2	-	A
Output Noise Voltage	(10Hz to 100kHz), $I_L = 100\text{mA}$ , $C_L = 10\mu\text{F}$		-	400	-	$\mu\text{V}_{\text{RMS}}$
	(10Hz to 100kHz), $I_L = 100\text{mA}$ , $C_L = 33\mu\text{F}$		-	260	-	
Low (OFF)	Input Logic Voltage ( $V_{IN} < 10V$ )	•	-	-	0.8	V
High (ON)		•	2.4	-	-	
Enable Input Pin Input Current	$V_{EN} = 16V$		-	100	600	$\mu\text{A}$
		•	-	-	750	
	$V_{EN} = 0.8V$		-	-	1	$\mu\text{A}$
		•	-	-	2	
Regulator Output Current in Shutdown <sup>(5)</sup>	-		-	10	-	$\mu\text{A}$
		•	-	-	500	

1. Dropout voltage is defined as the input to output differential at which the output voltage drops to 99% of its nominal value.

2.  $V_{IN} = V_{OUT} (\text{NOMINAL}) + 1V$ ; for example,  $V_{IN} = 4.3V$  for a 3.3V regulator. Employ pulse-testing procedures to minimize temperature rise.

3. Ground pin current is the regulator quiescent current. The total current drawn from the source is the sum of the load and ground currents.

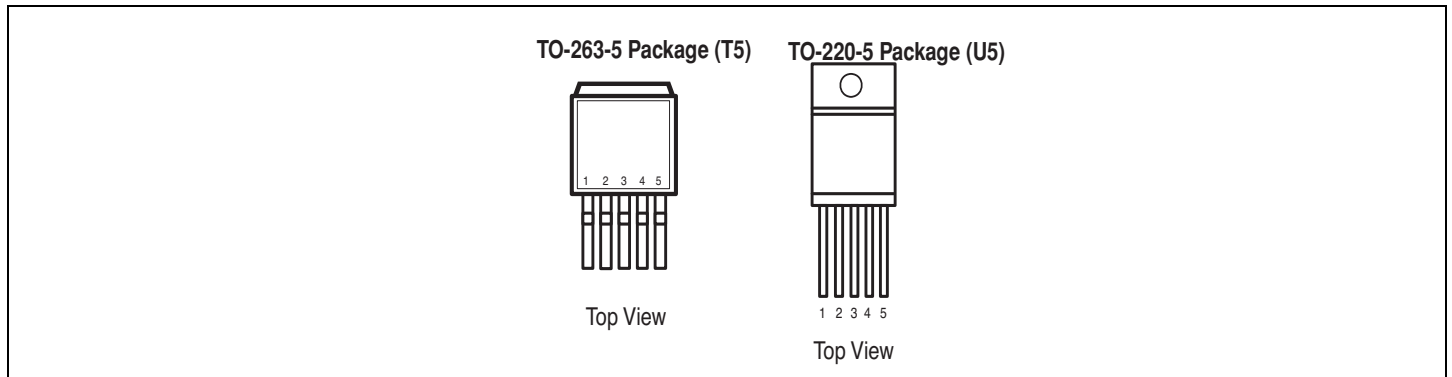
4. Thermal regulation is defined as the change in the output voltage at a time T after a change in power dissipation is applied, excluding load or line regulation effects.

5.  $V_{EN} \leq 0.8V$  and  $V_{IN} \leq 16V$ ,  $V_{OUT} = 0$ .

## Pin Information

*TO-263 version available, TO-220 version obsolete*

## Pin Configuration



**Figure 2: SPX2941 Pin Configuration**

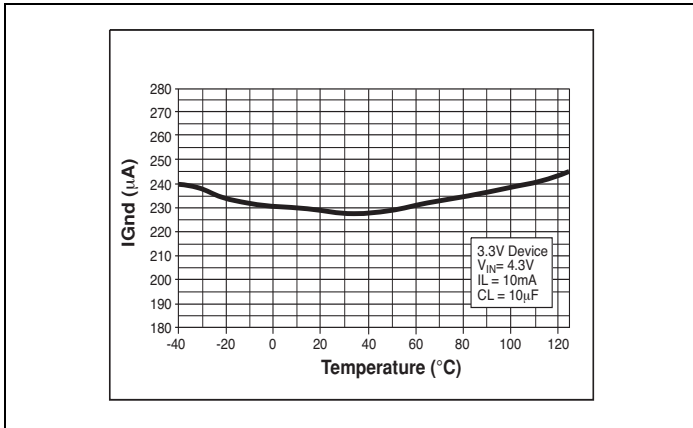
## Pin Description

**Table 4: Pin Description**

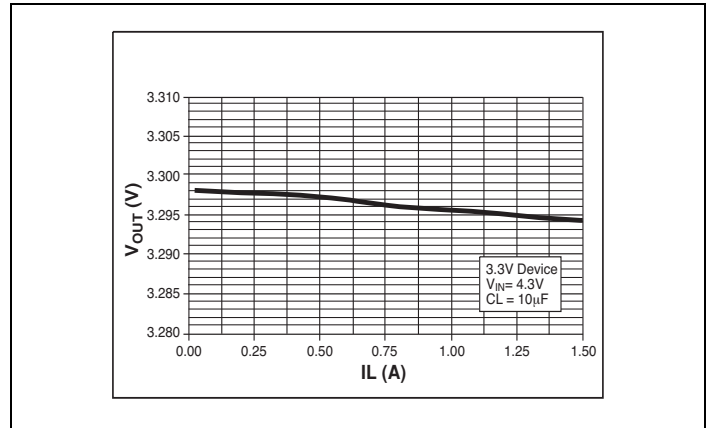
Pin Number	Pin Name	Description
1	ADJ	Output voltage adjust pin. For more information on how to set the output voltage, see <a href="#">“Application Information”</a> on page 8.
2	EN	Enable pin. < 0.8V the device is turned off and >2.4V the device is guaranteed to be turned on.
3	GND	Ground pin. Connect to tab.
4	VIN	Input voltage pin. Bypass to GND with $\geq 6.8\mu\text{F}$ capacitor.
5	VOUT	Output voltage pin. Bypass to GND with $\geq 10\mu\text{F}$ capacitor.
Tab	GND	Ground and die attach paddle. Best thermal performance requires heat sinking to internal ground planes using multiple vias.



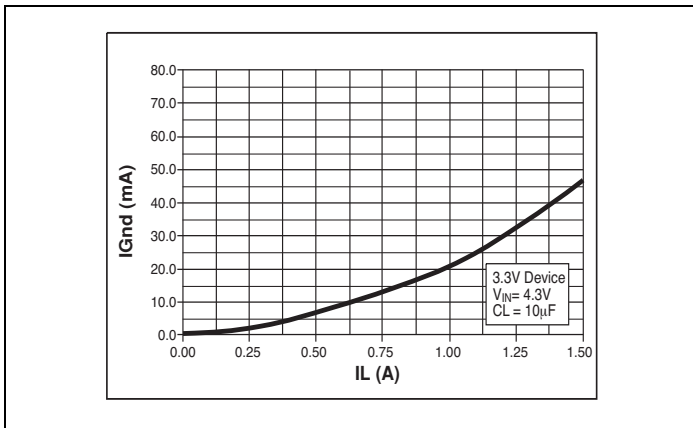
# Typical Performance Characteristics



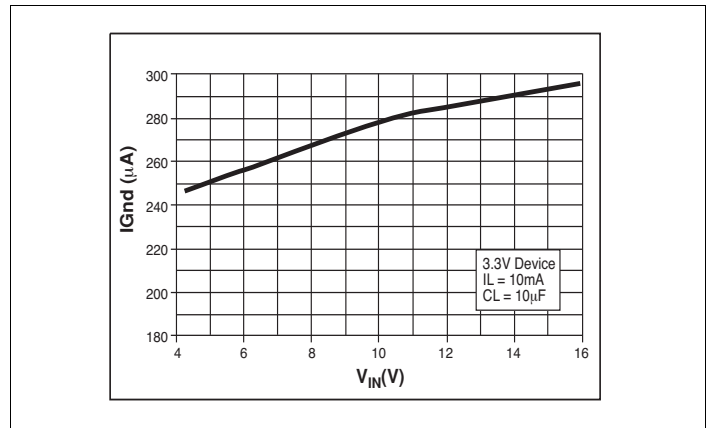
**Figure 3: Line Regulation for 3.3V Device**



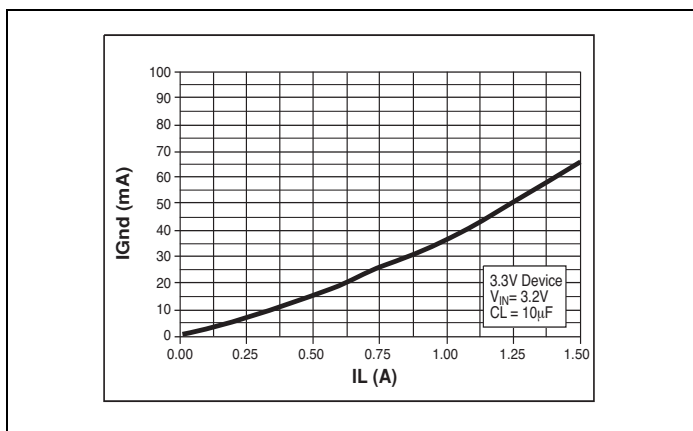
**Figure 4: Load Regulation for 3.3V Device**



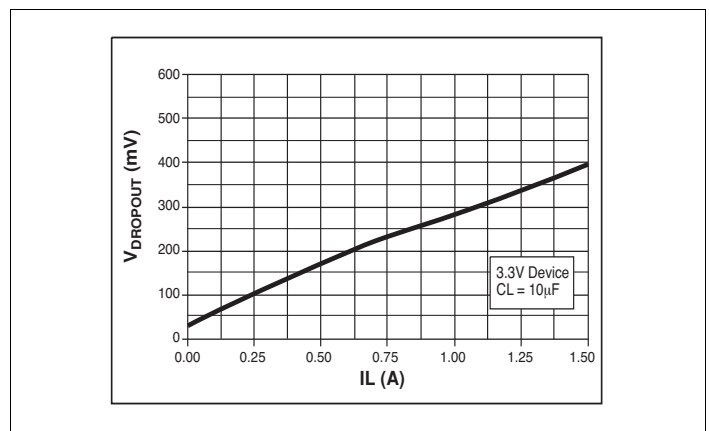
**Figure 5: Ground Current vs Load Current for 3.3V Device**



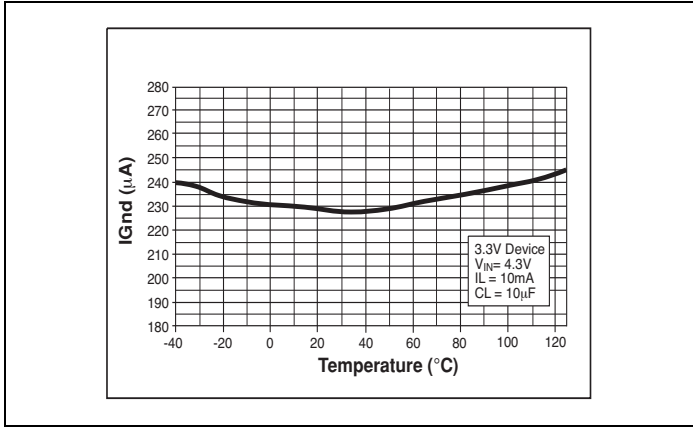
**Figure 6: Ground Current vs Input Current**



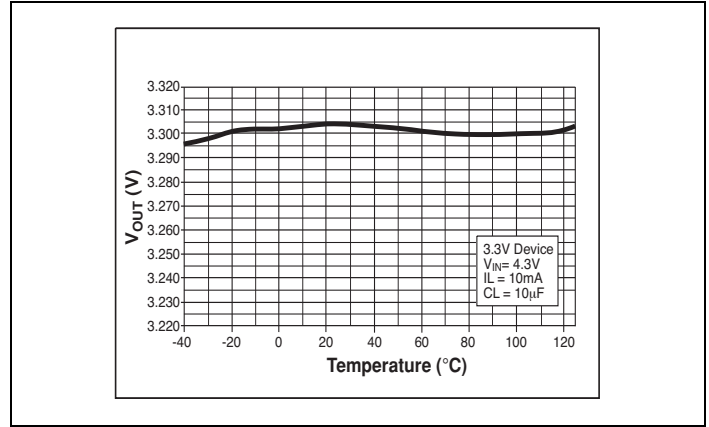
**Figure 7: Ground Current vs Load Current in Dropout**



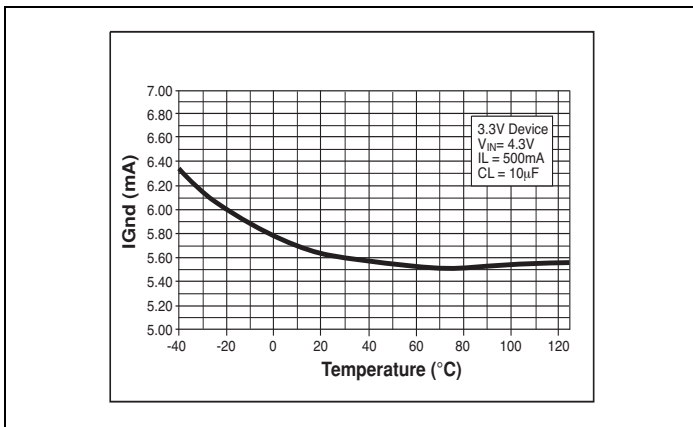
**Figure 8: Dropout Voltage vs Load Current for 3.3V**



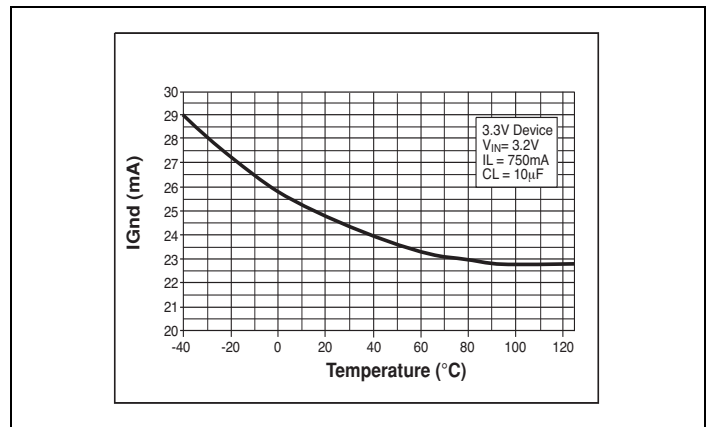
**Figure 9: Ground Current vs Temperature at  $I_{LOAD} = 10mA$**



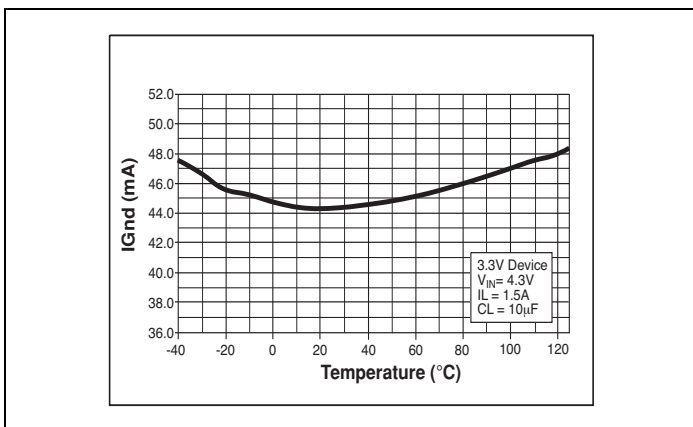
**Figure 10: Output Voltage vs Temperature at  $I_{LOAD} = 10mA$**



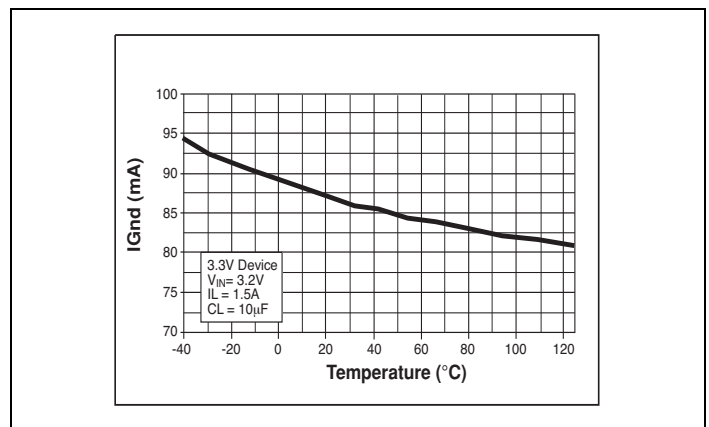
**Figure 11: Ground Current vs Temperature at  $I_{LOAD} = 500mA$**



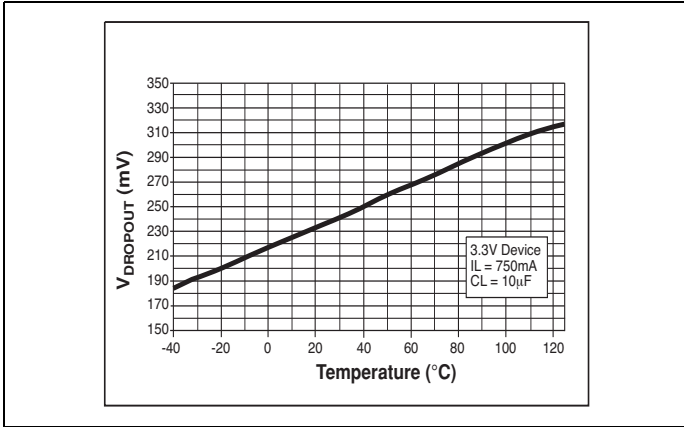
**Figure 11: Ground Current vs Temperature in Dropout at  $I_{LOAD} = 750mA$**



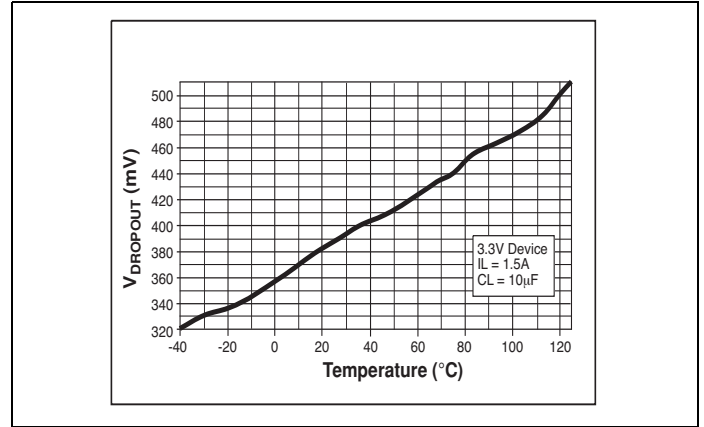
**Figure 12: Ground Current vs Temperature at  $I_{LOAD} = 10mA$**



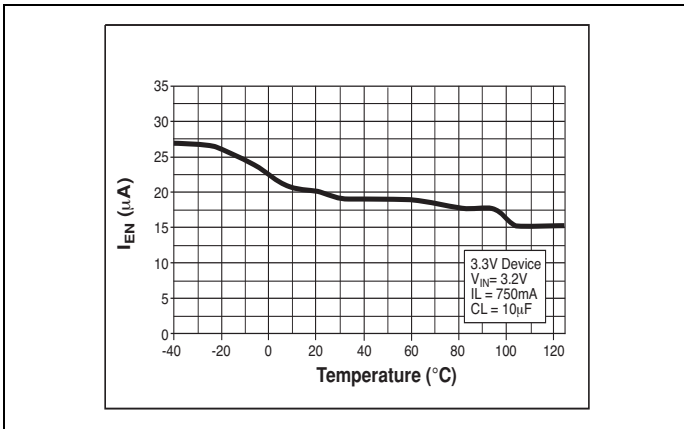
**Figure 13: Ground Current vs Temperature in Dropout at  $I_{LOAD} = 1.5mA$**



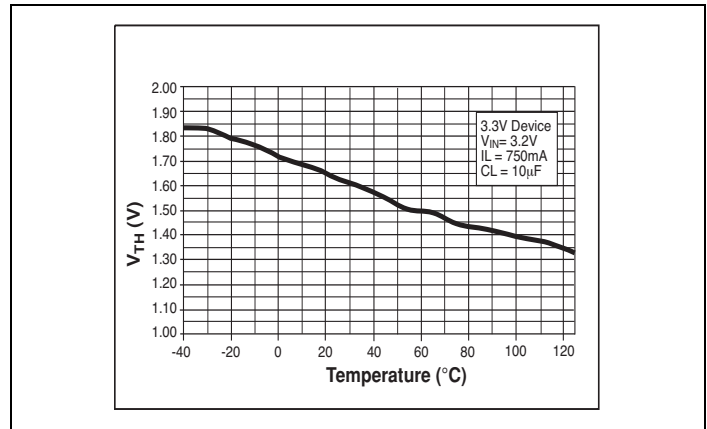
**Figure 14: Dropout Voltage vs Temperature at  $I_{LOAD} = 750mA$**



**Figure 15: Dropout Voltage vs Temperature at  $I_{LOAD} = 1.5mA$**

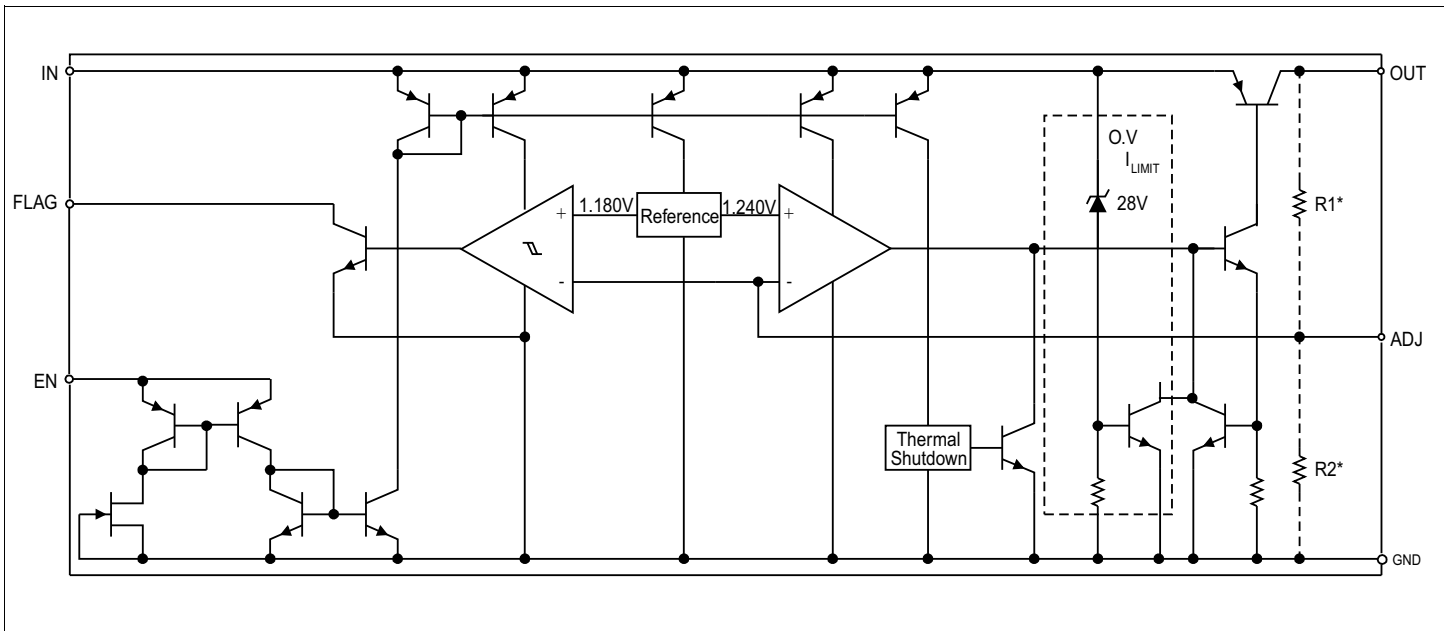


**Figure 16: Enable Current vs Temperature for 3.3V Devices**



**Figure 17: Enable Threshold vs Temperature for 3.3V Devices**

# Block Diagram



**Figure 18: SPX2941 Block Diagram**

## Application Information

The SPX2941 incorporates protection against over-current faults, reversed load insertion, over temperature operation, and positive and negative transient voltage.

## Thermal Considerations

Although the SPX2941 offers limiting circuitry for overload conditions, it is still necessary to ensure that the maximum junction temperature is not exceeded in the application. Heat flows through the lowest resistance path, the junction-to-case path. The tab of the device is electrically connected to GND. To ensure the best thermal flow of the component, proper mounting is required. The tab of the device should be electrically and thermally connected to the PCB's main ground plane with multiple vias to get the best thermal performance.

Power dissipation is calculated as follows:

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

Junction temperature range is calculate as follows:

$$T_J = T_A(\text{max}) + P_D \times \theta_{JA} \text{ (thermal resistance, junction-to-ambient)}$$

The maximum junction temperature must not exceed 125°C.

## Capacitor Requirements

The output capacitor s needed to ensure stability and minimize the output noise. The value of the capacitor varies with the load. However, a minimum value of 10µF aluminum capacitor guarantees stability over all load

conditions. MaxLinear recommends a tantalum capacitor if a faster load transient response is needed. If the power source has a high AC impedance, MaxLinear also recommends a 0.1µF ceramic capacitor between input and ground.

## Minimum Load Current

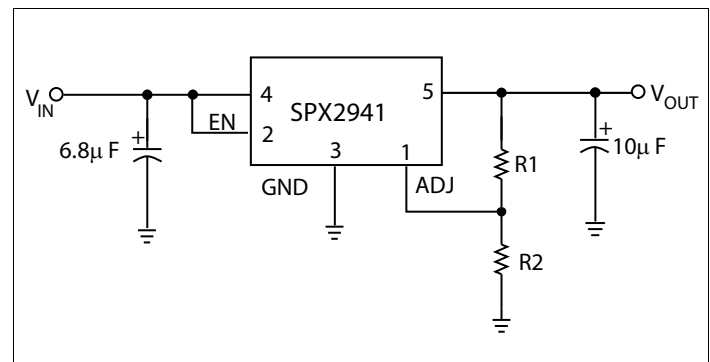
To ensure the expected regulator performance under the light load, a minimum load of 5mA for the SPX2941 device is required.

## Typical Application Circuits

Figure 19 shows a typical applications circuit for an adjustable output regulator. The values of R1 and R2 set the output voltage value as follows:

$$V_{OUT} = V_{REF} \times [1 + (R1/R2)]$$

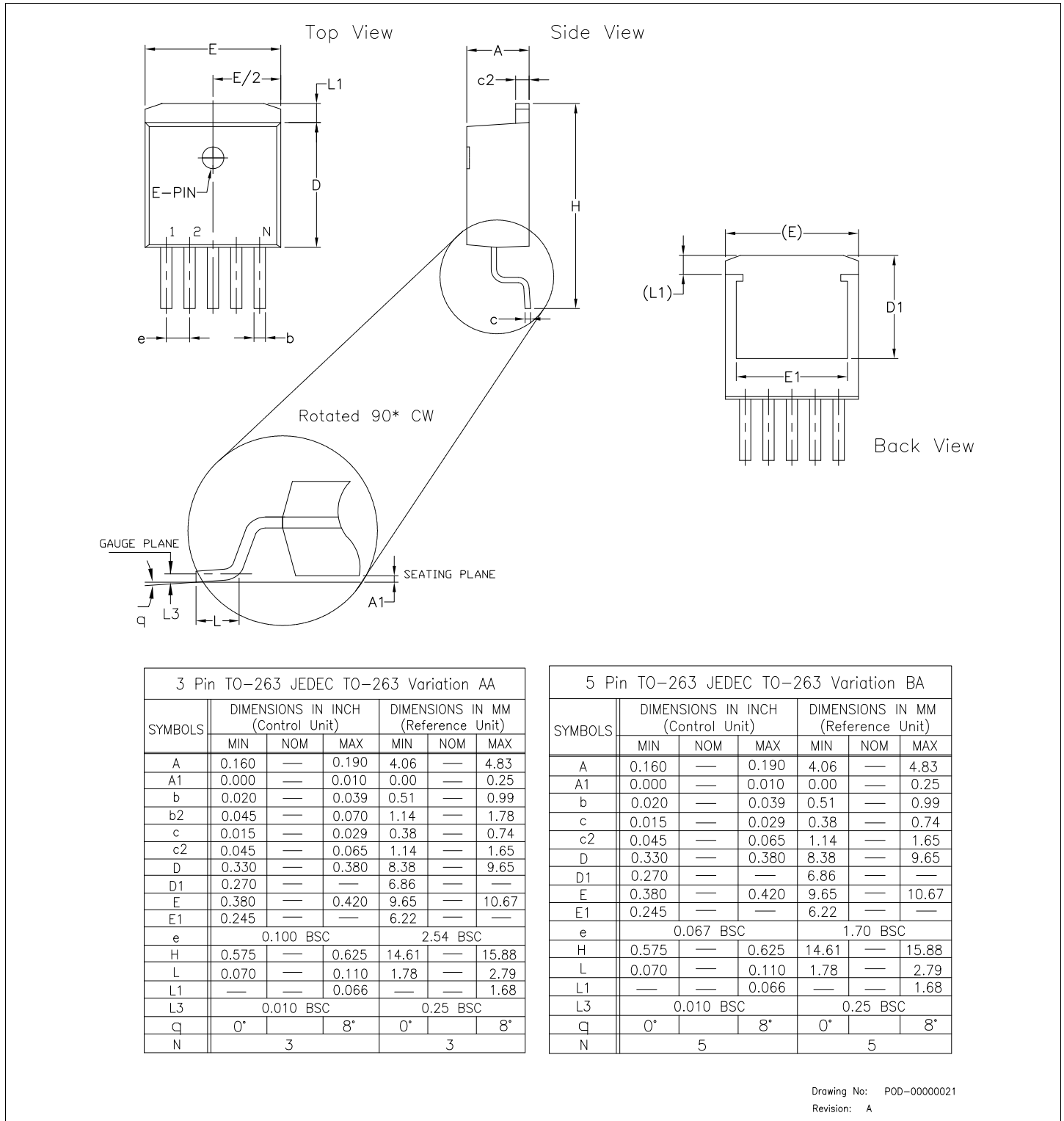
MaxLinear recommends a minimum value of 10kΩ is for R2 with a range from 10kΩ to 47kΩ.



**Figure 19: Adjustable Output Linear Regulator**

# Mechanical Dimensions

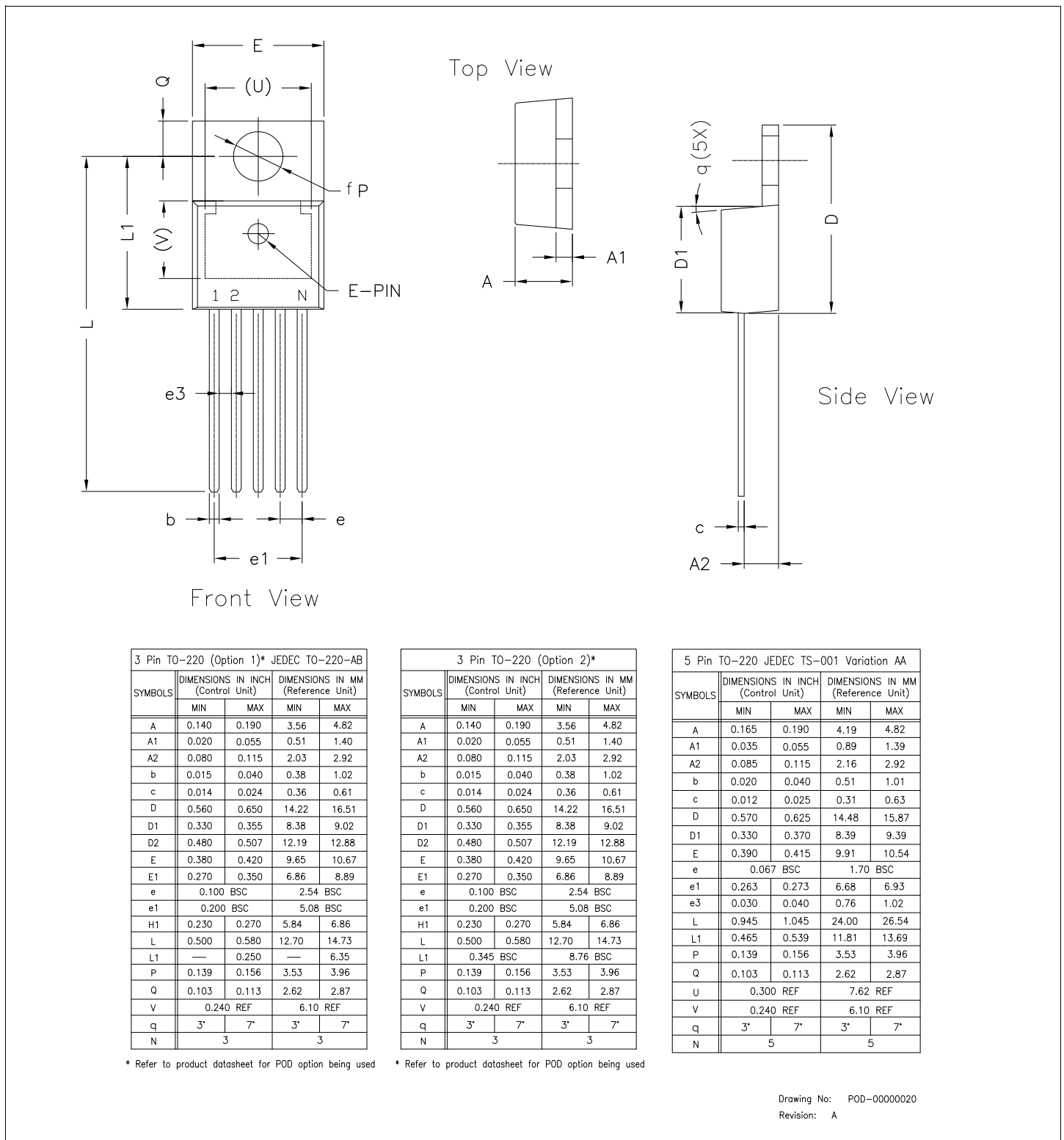
## 5-pin TO-263



**Figure 20: SPX2941 Mechanical Dimensions—5-Pin TO-263**

# 5-pin TO-220

**TO-220 version obsolete**



**Figure 21: SPX2941 Mechanical Dimensions—5-Pin TO-220**

## Ordering Information

**Table 5: Ordering Information**

Ordering Part Number	Operating Temperature Range	Accuracy	Output Voltage	Package	Packaging Method
SPX2941T5-L/TR	$-40^{\circ}\text{C} \leq T_J \leq 125^{\circ}\text{C}$	3%	Adj	5 lead TO-263	Tape and Reel

**Note:** For more information about part numbers, as well as the most up-to-date ordering information and additional information on environmental rating, go to [www.maxlinear.com/SPX2941](http://www.maxlinear.com/SPX2941).



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