Revision History

Revision	Release Date	Change Description
1.0.0	12/17/2009	Initial Release of Datasheet.
2.0.0	3/31/2010	Reformat of datasheet Inserted ESD data Modified Dropout Voltage and Ground Current values in electrical characteristics table Corrected typographical error in result of calculus in note 8 Removed “Gound Current vs Load Current”, “Enable Threshold vs Temperature” and “Power Supply Rejection Ratio curves” Updated “Dropout Voltage vs Load Current”, “Line Regulation” and “Load Regulation” curves Added “start Up” curve
2.1.0	10/19/2010	Corrected Adjustable Regulator Design paragraph equation
2.2.0	12/21/2016	Updated package specification and ordering information.
2.2.1	8/30/2019	Updated to MaxLinear format. Updated ordering information and moved to end. Obsolete 1.8V version (SPX29300T-L-1-8/TR) removed.
2.2.2	12/15/2020	Clarified that package tabs are GND on pinout.

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Specifications

Absolute Maximum Ratings

Important: These are stress rating 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 ratings conditions for extended periods of time may affect reliability.

Table 1: Absolute Maximum Ratings

Parameter	Minimum	Maximum	Units
Input voltage V_{IN} (1)		20.0	V
Storage temperature	-65	150	°C
Lead temperature (soldering, 5 sec)		260	°C

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

ESD Ratings

Table 2: ESD Ratings

Parameter	Value	Units
HBM (Human Body Model) all pins except EN	2	kV
HBM (Human Body Model) EN pin	1	kV

Operating Ratings

Table 3: Operating Ratings

Parameter	Value	Units
Input voltage range V_{IN}	16	V
Junction temperature range	-40 to 125	°C
Thermal Resistance		
TO-263-3 junction to ambient	31.4	°C/W
TO-263-5 junction to ambient	31.2	°C/W
TO-263-3, TO-263-5 junction to case	3	°C/W

Electrical Characteristics

Specifications with standard type are for an Operating Junction Temperature of $T_J = T_A = 25°C$ 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 $T_J = 25°C$, and are provided for reference purposes only. Unless otherwise noted, $V_{IN} = V_{OUT} + 1V$ and $I_{OUT} = 10mA$. $C_{IN} = 6.8\mu F$, $C_{OUT} = 10\mu F$, $T_A = 25°C$.

Table 4: Electrical Characteristics

Parameter	Test Condition		Minimum	Typical	Maximum	Units
Fixed Voltage Versions						
Output voltage, 2.5V version	I_{OUT}= 10mA		2.475	2.500	2.525	V
	10mA ≤ I_{OUT} ≤ 3A, 3.5V ≤ V_{IN} ≤ 16V	•	2.450	2.500	2.550	
Output voltage, 3.3V version	I_{OUT}= 10mA		3.267	3.300	3.333	V
	10mA ≤ I_{OUT} ≤ 3A, 4.3V ≤ V_{IN} ≤ 16V	•	3.234	3.300	3.366	
Output voltage, 5.0V version	I_{OUT}= 10mA		4.950	5.000	5.050	V
	10mA ≤ I_{OUT} ≤ 3A, 6.0V ≤ V_{IN} ≤ 16V	•	4.900	5.000	5.100	
All Voltage Versions						
Line regulation	I_{OUT}= 10mA, (V_{OUT} + 1V) ≤ V_{IN} ≤ 16V			0.06	0.5	%
Load regulation	$V_{IN} = V_{OUT}$ + 1V, 10mA ≤ I_{OUT} ≤ I_{FL}[2]			0.2	1	%
ΔV / ΔT	V_{OUT} temp coefficient[6]	•		20	100	ppm/°C
Dropout voltage[3]	I_{OUT}= 100mA	•		120	300	mV
	I_{OUT}= 1.5A			380		
	I_{OUT}= 3A	•		600	800	
Ground current[5]	I_{OUT}= 1.5A	•		30	60	mA
	I_{OUT}= 3A			40		
Ground pin current at dropout	V_{IN} = 0.5V less than specified V_{OUT}, I_{OUT} = 10mA			0.9		mA
Current limit	V_{OUT} = 0V[4]		3.0	4.5		A
Output noise voltage	10Hz - 100kHz, I_{OUT} = 100mA, C_{OUT} = 10μF			400		μV_{RMS}
	10Hz - 100kHz, I_{OUT} = 100mA, C_{OUT} = 33μF			260		
Reference voltage temperature coefficient[7]				20		ppm/°C
Reference Voltage and Adjustable Pin - SPX29302						
Reference voltage			1.228	1.24	1.252	V
		•	1.215		1.265	
	$V_{REF} ≤ V_{OUT} ≤ (V_{IN} - 1)$, 2.3 ≤ V_{IN} ≤ 16V, 10mA ≤ I_L ≤ I_{FL}, $T_J < T_{JMAX}$		1.203		1.277	
Adjust pin bias current				40	80	nA
		•			120	
Adjust pin bias current temperature coefficient				0.1		nA/°C

Table 4: Electrical Characteristics

Parameter	Test Condition		Minimum	Typical	Maximum	Units
Power Good Flag Output - SPX29301						
Output leakage current	V_{OH} = 16V			0.01	1	µA
		•			2	
Output low voltage	Device set for 5V, V_{IN} = 4.5V, I_{OL} = 250µA			220	300	mV
		•			400	
Upper threshold voltage	Device set for 5V(8)		40	60		mV
		•	25			
Lower threshold voltage	Device set for 5V(8)			75	95	mV
		•			140	
Hysteresis	Device set for 5V(8)			15		mV
Enable Input - SPX29301 / 02						
Input logic voltage low (OFF)	V_{IN} < 10V	•			0.8	V
Input logic voltage high (ON)		•	2.4			
Enable input pin	V_{EN} = 16V			100	600	µA
		•			750	
	V_{EN} = 0.8V	•			1	
		•			2	
Regulator output current in shutdown(9)		•		10	500	µA

2. Full load current (I_{FL}) is defined as 3.0A.

3. Dropout voltage is defined (V_{IN} - V_{OUT}) when the output voltage drops to 99% of its nominal value.

4. V_{IN} = V_{OUT}(nom) + 1V. Use pulse-testing procedures to minimize temperature rise.

5. 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.

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

7. Thermal regulation is defined as the change in output voltage at time T after a change in power dissipation is applied, excluding load / line regulation effects. Specifications for a 200mA load pulse as V_{IN} = 20V (a 4W pulse) for t = 10ms.

8. Comparator threshold is expressed in terms of a voltage differential at the Adjust terminal below the nominal reference voltage measured 6V input. To express these thresholds in terms of output voltage change, multiply the error amplifier gain = V_{OUT} / V_{REF} = (R1 + R2) / R2. For example, at a programmable output voltage of 5V, the Error output is guaranteed to go low when the output drops by 95mV x 5V / 1.240V = 383mV. Threshold remains constant as a percent of V_{OUT} as V_{OUT} is varied, with the dropout warning occurring at typically 5% below nominal, 7.7% guaranteed.

9. V_{EN} ≤ 0.8V and V_{IN} ≤ 16V, V_{OUT} = 0V.

Block Diagram

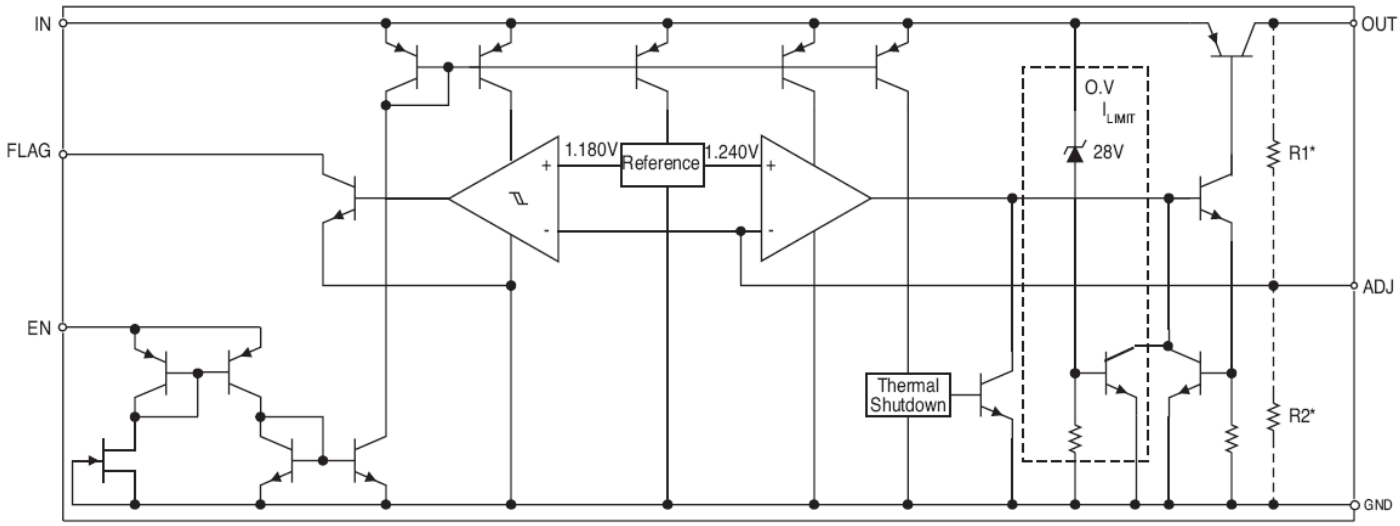
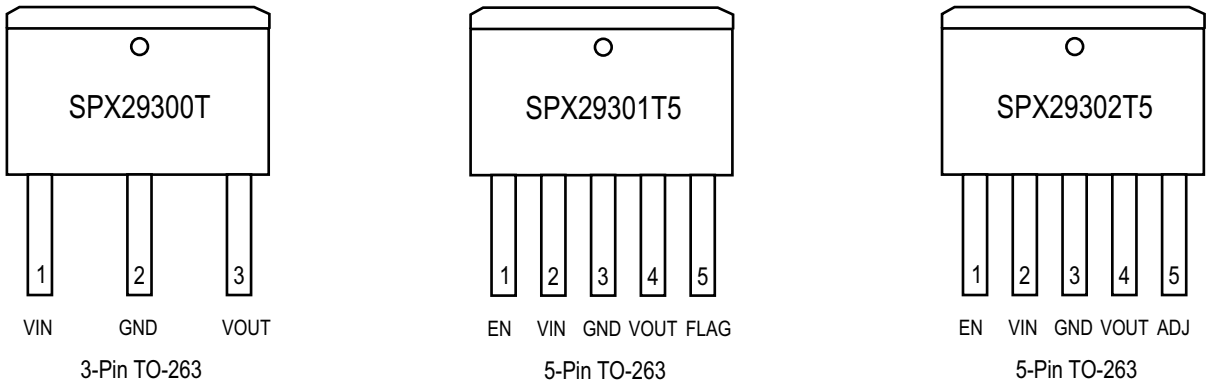


Figure 2: SPX29300, SPX29301, SPX29302 Block Diagram

Pin Information(1)



1. On all devices, the Tab is GND.

Figure 3: SPX29300, SPX29301, SPX29302 Pin Assignments

Typical Performance Characteristics

All data taken at $V_{IN} = V_{OUT} + 1V$, $T_J = T_A = 25°C$, unless otherwise specified.

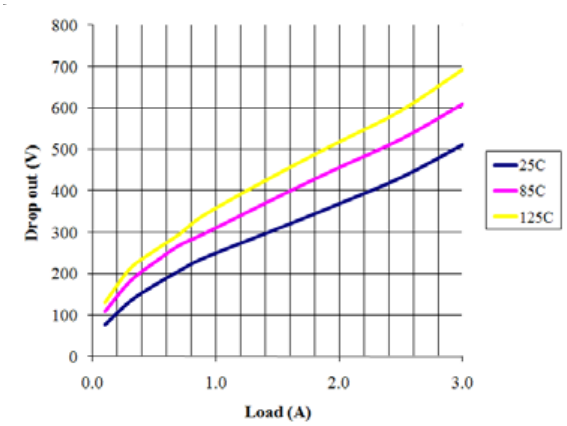


Figure 4: Dropout Voltage vs. Load Current

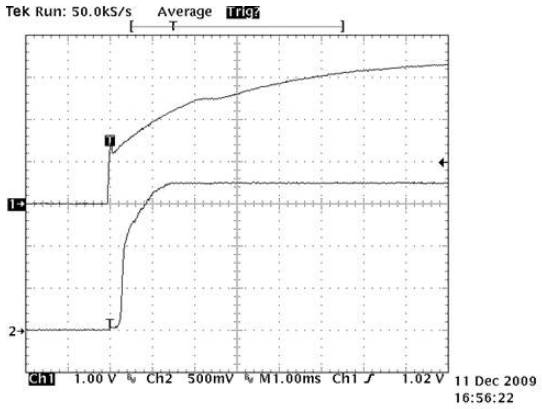


Figure 5: Startup

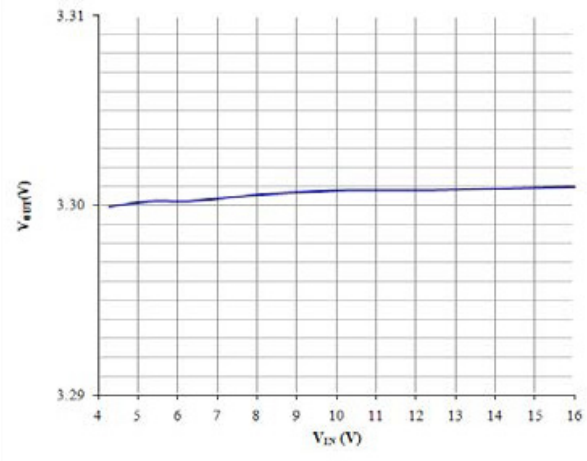


Figure 6: Line Regulation: I_{OUT} = 10mA, V_{OUT} = 3.3V

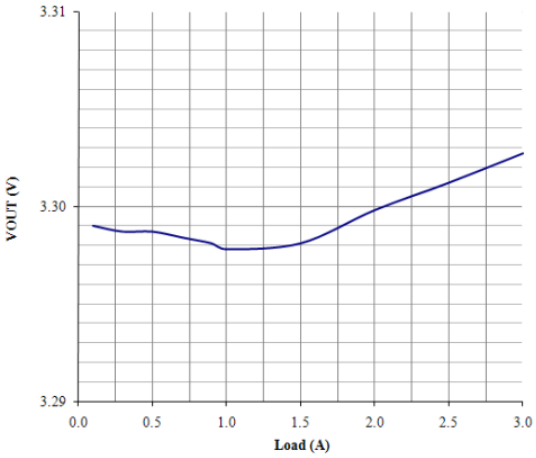


Figure 7: Load Regulation: V_{OUT} = 3.3V

Theory of Operation

The SPX29300/01/02 incorporates protection against over-current faults, reversed load insertion, over temperature operation, and positive and negative transient voltage.

Thermal Considerations

Although the SPX29300/01/02 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.

TO-263 Design Example

Assume that V_{IN} = 5V, V_{OUT} = 3.3V, I_{OUT} = 1.0A, T_A = 50°C and θ_{JA} = 31.4°C/W, where:

T_A = ambient temperature,

θ_{JA} = junction to ambient thermal resistance

The power calculated under these conditions is:

$$P_D = (V_{IN} - V_{OUT}) \times I_{OUT} = 1.7W$$

And the junction temperature is calculated as

$$T_J = T_A + P_D \times \theta_{JA}$$

or

$$T_J = 50 + 1.7 \times 31.4 = 103.4°C$$

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 10µF 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 high AC impedance, a 0.1µF ceramic capacitor between input and ground is recommended.

Minimum Load Current

To ensure a proper behavior of the regulator under light load, a minimum load of 5mA for SPX29300/01/02 is required.

Adjustable Regulator Design

The SPX29300/01/02 is an adjustable regulator that can be programmed to any value between 1.25V and 16V using 2 external resistors, R1 and R2. The relationship between the resistors and the output voltage is:

$$R_1 = R_2 \times \left(\frac{V_{OUT}}{1.240} - 1\right)$$

Error Flag

The SPX29301 features an error flag that indicates either an over current or under current voltage condition. The flag output goes low, sinking 10mA when either condition occurs.

Enable Input

The SPX29301/02 has an Enable function that switches the regulator on and off. Its thresholds are TTL compatible. When the regulator is active, approximately 20µA flows through the Enable pin.

Typical Application Circuits

Figure 1 represents the typical implementation for an adjustable output regulator. The values of R1 and R2 set the output voltage value as follows:

$$V_{OUT} = V_{REF} \times \left(1 + \frac{R_1}{R_2}\right)$$

A minimum value of 10kΩ is recommended for R2 with a range between 10kΩ and 47kΩ.

Mechanical Dimensions

3-pin and 5-pin TO-263

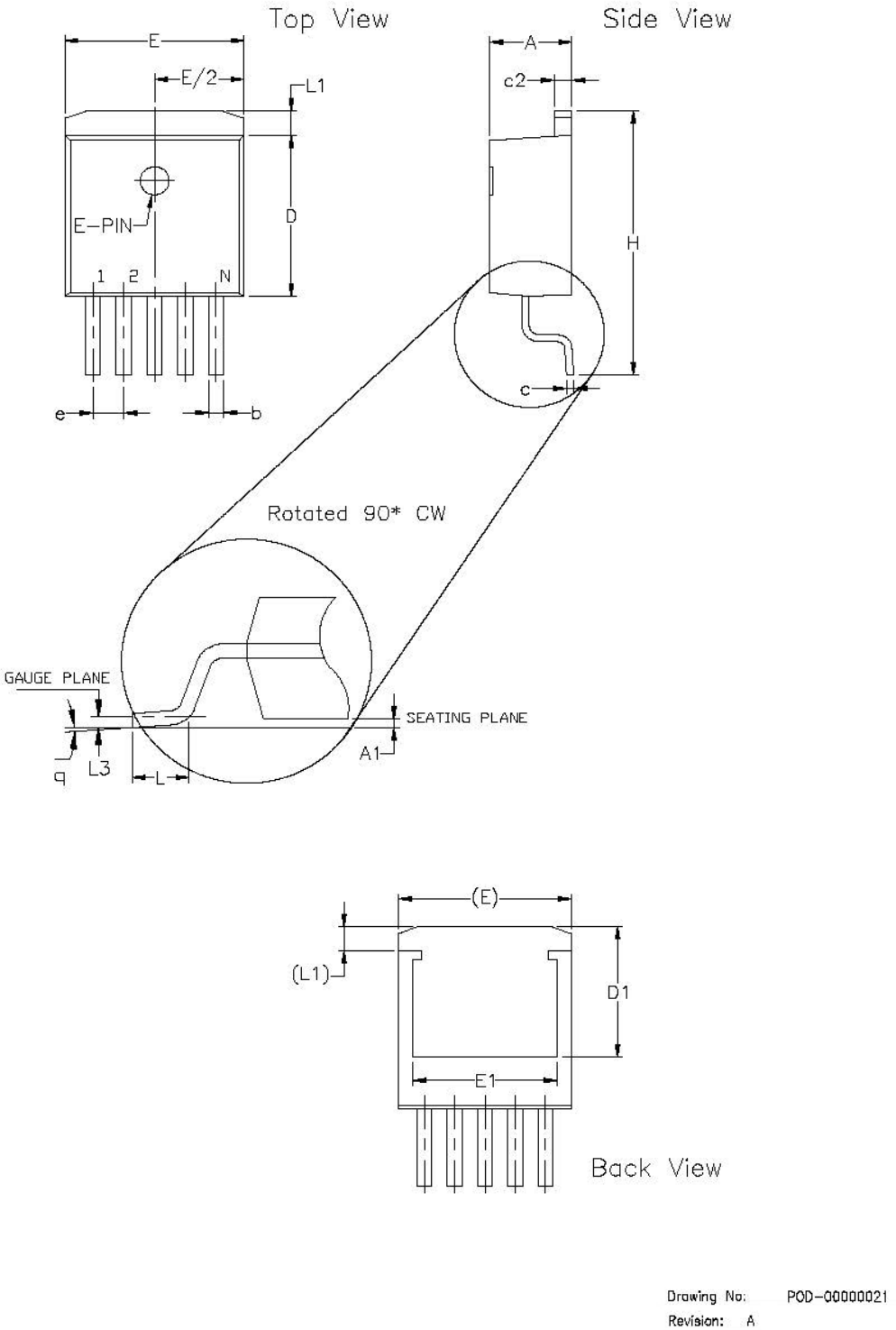


Figure 8: Mechanical Dimensions, 3-pin and 5-pin TO-263

Mechanical Dimensions, continued

3-pin and 5-pin TO-263, continued

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

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

Drawing No: POD-00000021
Revision: A

Figure 9: Mechanical Dimensions, 3-pin and 5-pin TO-263, continued

Ordering Information

Table 5: Ordering Information

Ordering Part Number	Operating Temperature Range	Package	Packaging Method	Lead-Free(2)
SPX29300T-L-2-5/TR	-40°C ≤ T_J ≤ 125°C	3-pin TO-263	Tape and Reel	Yes
SPX29300T-L-3-3/TR	-40°C ≤ T_J ≤ 125°C	3-pin TO-263	Tape and Reel	Yes
SPX29300T-L-5-0/TR	-40°C ≤ T_J ≤ 125°C	3-pin TO-263	Tape and Reel	Yes
SPX29301T5-L-5-0/TR	-40°C ≤ T_J ≤ 125°C	5-pin TO-263	Tape and Reel	Yes
SPX29302T5-L/TR	-40°C ≤ T_J ≤ 125°C	5-pin TO-263	Tape and Reel	Yes

1. Refer to www.maxlinear.com/SPX29300, www.maxlinear.com/SPX29301, and www.maxlinear.com/SPX29302 for most up-to-date Ordering Information.

2. Visit www.maxlinear.com for additional information on Environmental Rating.

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