General Description

The SPX29300/01/02 are 3A, highly accurate voltage regulators with a low dropout voltage of 600mV (typical) at 3A.

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. On-Chip trimming adjusts the reference voltage to 1% initial accuracy.

The SPX29300 is offered in a 3-pin TO-263 package, the SPX29301 and SPX29302 are offered in a 5-pin TO-263 package.

Features

- 3A guaranteed output current
- Low dropout voltage of 600mV @ 3A
- Adjustable output down to 1.25V
- 1% output accuracy
- Tight load and line regulation
- Fast transient response
- Reverse battery protection
- Zero current shutdown (SPX29301/02)
- Power Good flag (SPX29301)
- Lead free 3-pin TO-263 and 5-pin TO-263 packages

Applications

- Adjustable power supplies
- Constant current regulators
- Audio and video / graphic cards
- Battery chargers

Ordering Information - page 9

Typical Application Diagram
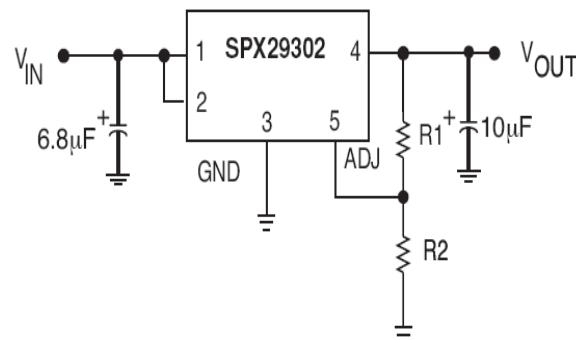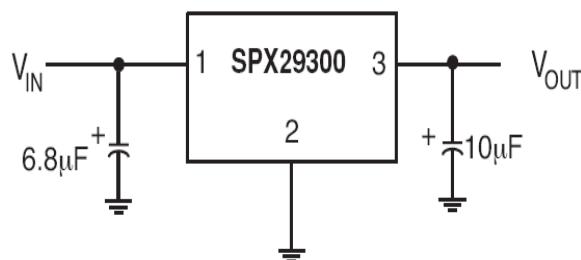
Figure 1: SPX29300 and SPX29302 Application Diagrams

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.
2.2.3	May 3, 2022	**Updated:** ■ In "Electrical Characteristics" table, typical value for ground pin current at dropout parameter.

Table of Contents

List of Figures

List of Tables

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} = 6.8µF, C_{OUT} = 10µF, 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}[1]			0.2	1	%
ΔV / ΔT	V_{OUT} temp coefficient[2]	•		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[4]	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			5.0		mA
Current limit	V_{OUT} = 0V[5]		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[6]				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[7]		40	60		mV
		●	25			
Lower threshold voltage	Device set for 5V[7]			75	95	mV
		●			140	
Hysteresis	Device set for 5V[7]			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[8]		●		10	500	µA

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

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

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

4. 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.

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

6. 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.

7. 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.

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

Block Diagram
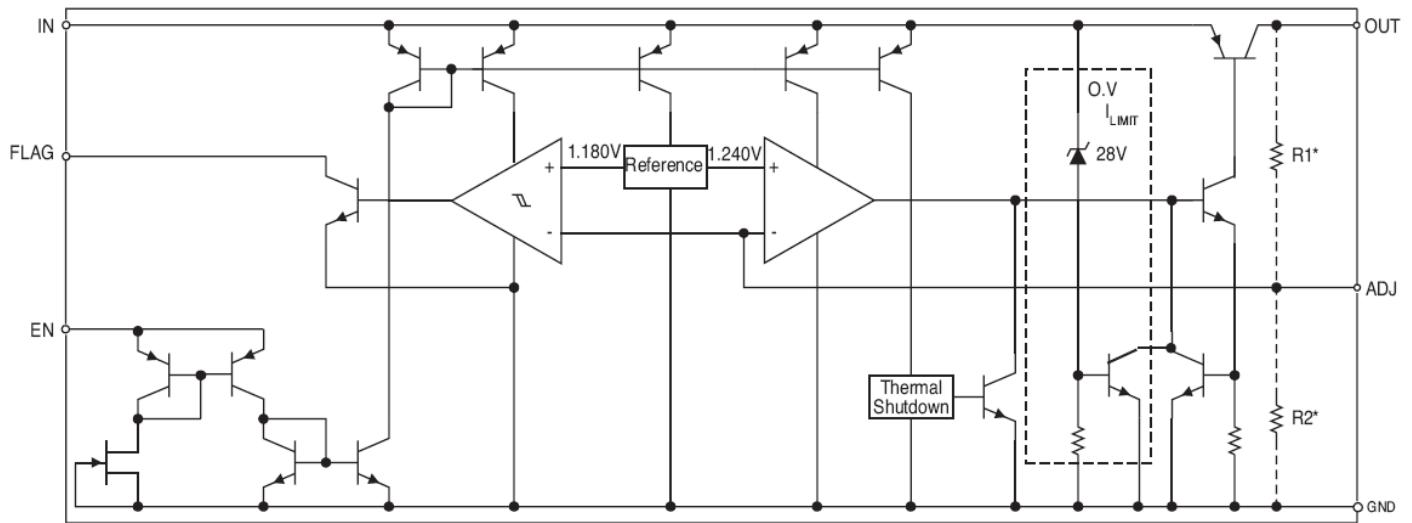
Figure 2: SPX29300, SPX29301, SPX29302 Block Diagram

Pin Information[(1)]

SPX29300T	SPX29301T5	SPX29302T5
1 2 3	1 2 3 4 5	1 2 3 4 5
VIN GND VOUT	EN VIN GND VOUT FLAG	EN VIN GND VOUT ADJ
3-Pin TO-263	5-Pin TO-263	5-Pin TO-263
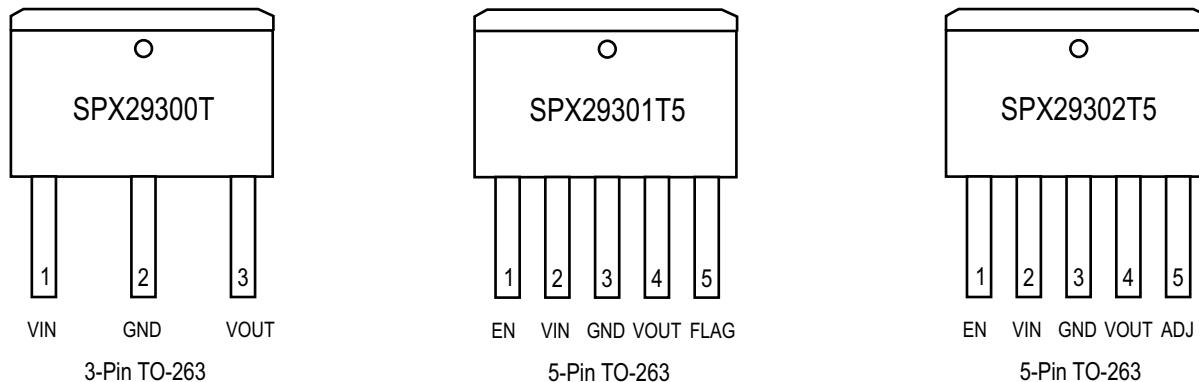
1. On all devices, the Tab is GND.

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.
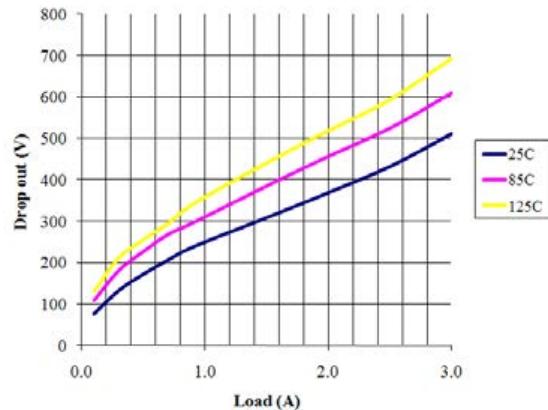
Figure 4: Dropout Voltage vs. Load Current
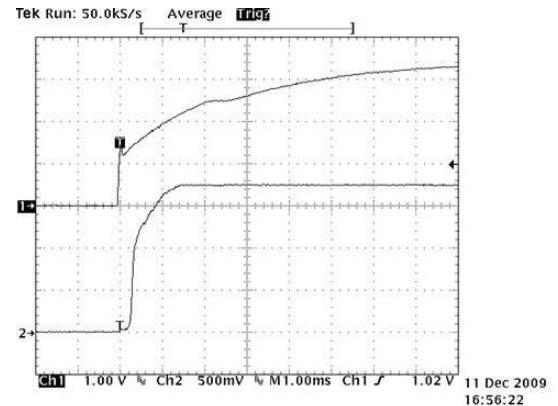
Figure 5: Startup
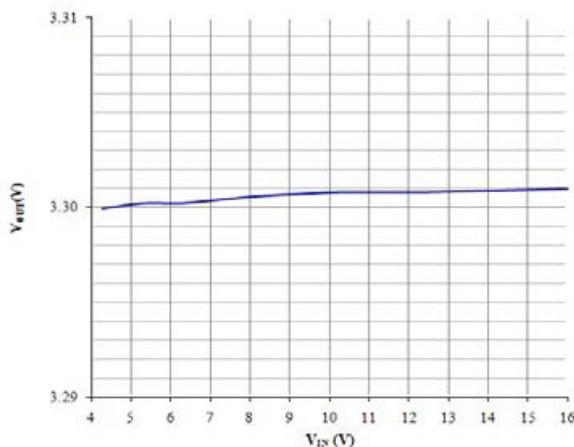
**Figure 6: Line Regulation: I_{OUT} = 10mA, V_{OUT} = 3.3V**
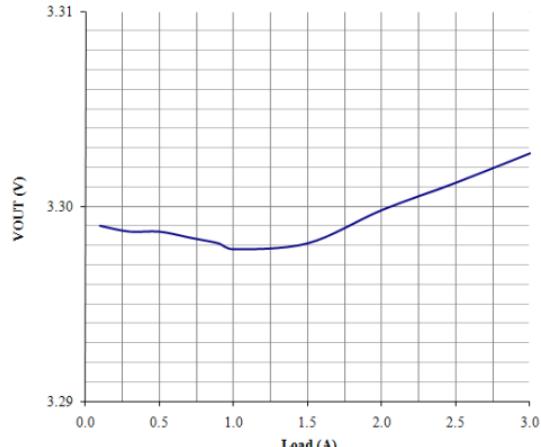
Figure 7: Load Regulation: V_{OUT} = 3.3V

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
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

Note: For more information about part numbers, as well as the most up-to-date information and additional information on environmental rating, go to www.maxlinear.com/SPX29300, www.maxlinear.com/SPX29301, and www.maxlinear.com/SPX29302.

Corporate Headquarters:
5966 La Place Court, Suite 100
Carlsbad, CA 92008
Tel.: +1 (760) 692-0711
Fax: +1 (760) 444-8598

www.maxlinear.com