National Semiconductor

LM2931
Series Low Dropout Regulators

General Description

The LM2931 positive voltage regulator features a very low quiescent current of 1mA or less when supplying 10mA loads. This unique characteristic and the extremely low input-output differential required for proper regulation (0.2V for output currents of 10mA) make the LM2931 the ideal regulator for standby power systems. Applications include memory standby circuits, CMOS and other low power processor power supplies as well as systems demanding as much as 100mA of output current.

Designed originally for automotive applications, the LM2931 and all regulated circuitry are protected from reverse battery installations or 2 battery jumps. During line transients, such as a load dump (60V) when the input voltage to the regulator can momentarily exceed the specified maximum operating voltage, the regulator will automatically shut down to protect both internal circuits and the load. The LM2931 cannot be harmed by temporary mirror-image insertion. Familiar regulator features such as short circuit and thermal overload protection are also provided.

The LM2931 family includes a fixed 5V output (±3.8% tolerance for A grade) or an adjustable output with ON/OFF pin. Both versions are available in a TO-220 power package, TO-263 surface mount package, and an 8-lead surface mount package. The fixed output version is also available in the TO-92 plastic and 6-Bump micro SMD packages.

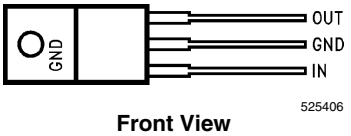
Features

- Very low quiescent current
- Output current in excess of 100 mA
- Input-output differential less than 0.6V
- Reverse battery protection
- 60V load dump protection
- –50V reverse transient protection
- Short circuit protection
- Internal thermal overload protection
- Mirror-image insertion protection
- Available in TO-220, TO-92, TO-263, SO-8 or 6-Bump micro SMD packages
- Available as adjustable with TTL compatible switch
- See AN-1112 for micro SMD considerations

Connection Diagrams

FIXED VOLTAGE OUTPUT

TO-220 3-Lead Power Package



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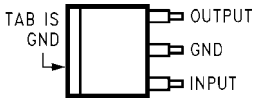
Front View

TO-263 Surface-Mount Package



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Top View

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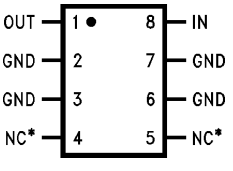
Side View

8-Pin Surface Mount



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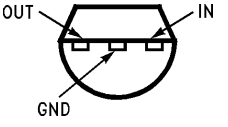
*NC = Not internally connected. Must be electrically isolated from the rest of the circuit for the micro SMD package.

Top View

TO-92 Plastic Package



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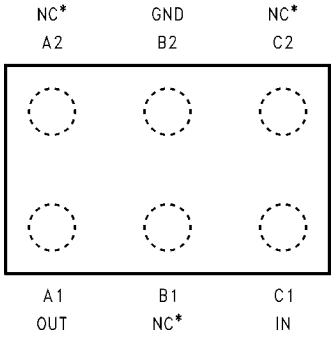
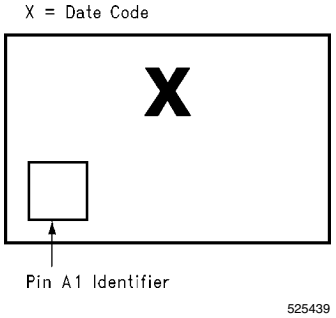
Bottom View

6-Bump micro SMD



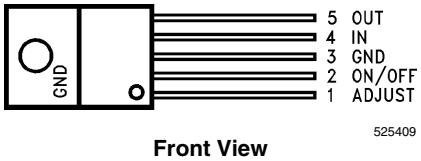
Top View
(Bump Side Down)

micro SMD Laser Mark



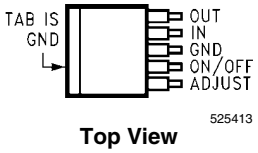
ADJUSTABLE OUTPUT VOLTAGE

TO-220 5-Lead Power Package



Front View

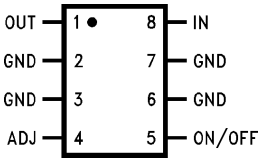
TO-263
5-Lead Surface-Mount Package



Top View

Side View

8-Pin Surface Mount



Top View

Ordering Information

Output Number	Package	Part Number	Package Marking	Transport Media	NSC Drawing
5V	3-Pin TO-220	LM2931T-5.0	LM2931T-5.0	Rails	T03B
		LM2931AT-5.0	LM2931AT-5.0	Rails	
	3-Pin TO-263	LM2931S-5.0	LM2931S-5.0	Rails	TS3B
		LM2931AS-5.0	LM2931AS-5.0	Rails	
	TO-92	LM2931Z-5.0	LM2931Z-5	1.8k Units per Box	Z03A
		LM2931AZ-5.0	LM2931AZ	1.8k Units per Box	
	8-Pin SOIC	LM2931M-5.0	2931M-5.0	Rails	M08A
		LM2931AM-5.0	2931AM-5.0	Rails	
	* 6-Bump micro SMD	LM2931IBPX-5.0	-	Tape and Reel	BPA06HTA
Adjustable, 3V to 24V	5-Pin TO-220	LM2931CT	LM2931CT	Rails	T05A
	5-Pin TO-263	LM2931CS	LM2931CS	Rails	TS5B
	8-Pin SOIC	LM2931CM	LM2931CM	Rails	M08A
3.3V	* 6-Bump micro SMD	LM2931IBPX-3.3	-	Tape and Reel	BPA06HTB

Note: The micro SMD package marking is a single digit manufacturing Date Code Only.

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/ Distributors for availability and specifications.

Input Voltage
- Operating Range: 26V
- Overvoltage Protection
  - LM2931A, LM2931C (Adjustable): 60V
  - LM2931: 50V

Internal Power Dissipation (Notes 2, 4): Internally Limited

Operating Ambient Temperature Range: −40°C to +85°C

Maximum Junction Temperature: 125°C

Storage Temperature Range: −65°C to +150°C

Lead Temp. (Soldering, 10 seconds): 230°C

ESD Tolerance (Note 5): 2000V

Electrical Characteristics for Fixed 3.3V Version

V_{IN} = 14V, I_O = 10mA, T_J = 25°C, C_2 = 100µF (unless otherwise specified) (Note 2)

Parameter	Conditions	LM2931-3.3		Units
		Typ	Limit (Note 3)	
Output Voltage		3.3	3.465 3.135	V_{MAX} V_{MIN}
	4V ≤ V_{IN} ≤ 26V, I_O = 100 mA −40°C ≤ T_J ≤ 125°C		**3.630** **2.970**	V_{MAX} V_{MIN}
Line Regulation	4V ≤ V_{IN} ≤ 26V	4	33	mV_{MAX}
Load Regulation	5mA ≤ I_O ≤ 100mA	10	50	mV_{MAX}
Output Impedance	100mA_{DC} and 10mA_{rms}, 100Hz - 10kHz	200		mΩ
Quiescent Current	I_O ≤ 10mA, 4V ≤ V_{IN} ≤ 26V −40°C ≤ T_J ≤ 125°C I_O = 100mA, V_{IN} = 14V, T_J = 25°C	0.4 15	**1.0**	mA_{MAX} mA
Output Noise Voltage	10Hz -100kHz, C_{OUT} = 100µF	330		μV_{rms}
Long Term Stability		13		mV/1000 hr
Ripple Rejection	f_O = 120Hz	80		dB
Dropout Voltage	I_O = 10mA I_O = 100mA	0.05 0.30	0.2 0.6	V_{MAX}
Maximum Operational Input Voltage		33	26	V_{MIN}
Maximum Line Transient	R_L = 500Ω, V_O ≤ 5.5V, T = 1ms, τ ≤ 100ms	70	50	V_{MIN}
Reverse Polarity Input Voltage, DC	V_O ≥ −0.3V, R_L = 500Ω	−30	−15	V_{MIN}
Reverse Polarity Input Voltage, Transient	T = 1ms, τ ≤ 100ms, R_L = 500Ω	−80	−50	V_{MIN}

Electrical Characteristics for Fixed 5V Version

V_{IN} = 14V, I_O = 10mA, T_J = 25°C, C2 = 100 µF (unless otherwise specified) (Note 2)

Parameter	Conditions	LM2931A-5.0		LM2931-5.0		Units
		Typ	Limit (Note 3)	Typ	Limit (Note 3)	
Output Voltage		5	5.19 4.81	5	5.25 4.75	V_{MAX} V_{MIN}
	6.0V ≤ V_{IN} ≤ 26V, I_O = 100mA −40°C ≤ T_J ≤ 125°C		**5.25** **4.75**		**5.5** **4.5**	V_{MAX} V_{MIN}
Line Regulation	9V ≤ V_{IN} ≤ 16V 6V ≤ V_{IN} ≤ 26V	2 4	10 30	2 4	10 30	mV_{MAX}
Load Regulation	5 mA ≤ I_O ≤ 100mA	14	50	14	50	mV_{MAX}
Output Impedance	100mA_{DC} and 10mA_{rms}, 100Hz -10kHz	200		200		mΩ
Quiescent Current	I_O ≤ 10mA, 6V ≤ V_{IN} ≤ 26V −40°C ≤ T_J ≤ 125°C	0.4	**1.0**	0.4	**1.0**	mA_{MAX}
	I_O = 100mA, V_{IN} = 14V, T_J = 25°C	15	30 5	15		mA_{MAX} mA_{MIN}
Output Noise Voltage	10Hz -100kHz, C_{OUT} = 100µF	500		500		$µV_{rms}$
Long Term Stability		20		20		mV/1000 hr
Ripple Rejection	f_O = 120 Hz	80	**55**	80		dB_{MIN}
Dropout Voltage	I_O = 10mA I_O = 100mA	0.05 0.3	0.2 0.6	0.05 0.3	0.2 0.6	V_{MAX}
Maximum Operational Input Voltage		33	26	33	26	V_{MIN}
Maximum Line Transient	R_L = 500Ω, V_O ≤ 5.5V, T = 1ms, τ ≤ 100ms	70	60	70	50	V_{MIN}
Reverse Polarity Input Voltage, DC	V_O ≥ −0.3V, R_L = 500Ω	−30	−15	−30	−15	V_{MIN}
Reverse Polarity Input Voltage, Transient	T = 1ms, τ ≤ 100ms, R_L = 500Ω	−80	−50	−80	−50	V_{MIN}

Note 1: Absolute Maximum Ratings indicate limits beyond which damage to the device may occur. Electrical specifications do not apply when operating the device beyond its rated operating conditions.

Note 2: See circuit in Typical Applications. To ensure constant junction temperature, low duty cycle pulse testing is used.

Note 3: All limits are guaranteed for T_J = 25°C (standard type face) or over the full operating junction temperature range of −40°C to +125°C (bold type face).

Note 4: The maximum power dissipation is a function of maximum junction temperature T_{Jmax}, total thermal resistance θ_{JA}, and ambient temperature T_A. The maximum allowable power dissipation at any ambient temperature is $P_D = (T_{Jmax} - T_A)/\theta_{JA}$. If this dissipation is exceeded, the die temperature will rise above 150°C and the LM2931 will go into thermal shutdown. For the LM2931 in the TO-92 package, θ_{JA} is 195°C/W; in the SO-8 package, θ_{JA} is 160°C/W, and in the TO-220 package, θ_{JA} is 50°C/W; in the TO-263 package, θ_{JA} is 73°C/W; and in the 6-Bump micro SMD package θ_{JA} is 290°C/W. If the TO-220 package is used with a heat sink, θ_{JA} is the sum of the package thermal resistance junction-to-case of 3°C/W and the thermal resistance added by the heat sink and thermal interface.

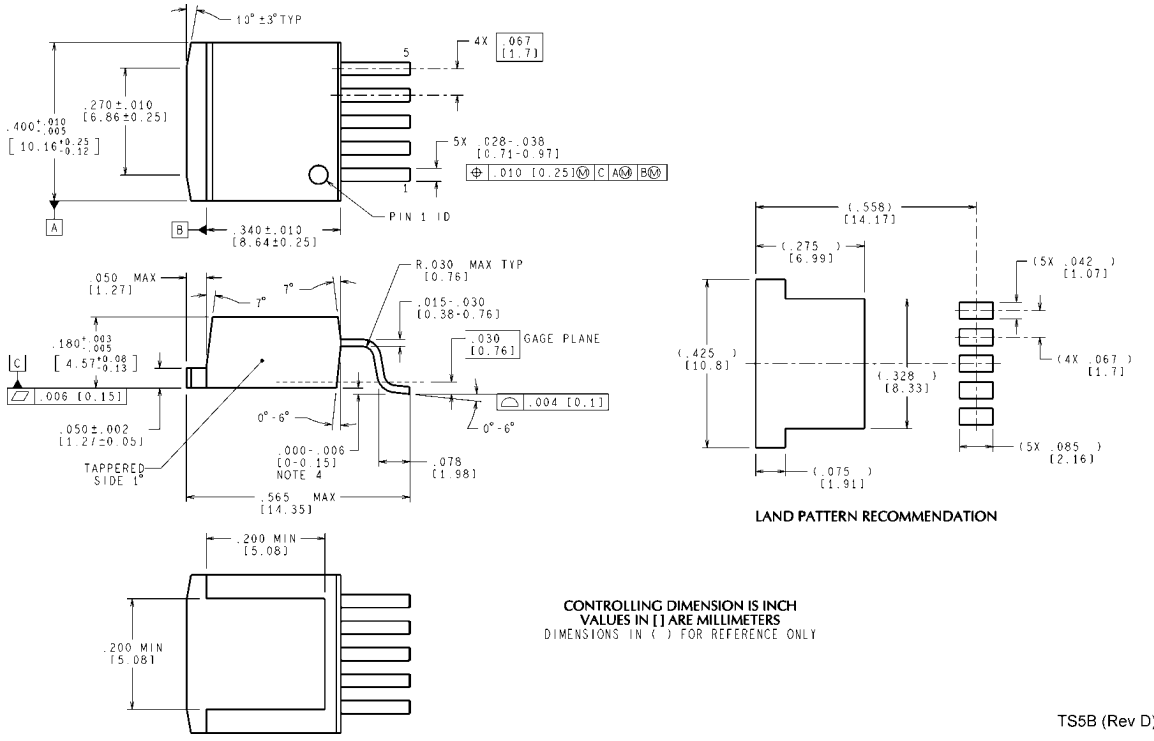
If the TO-263 package is used, the thermal resistance can be reduced by increasing the P.C. board copper area thermally connected to the package: Using 0.5 square inches of copper area, θ_{JA} is 50°C/W; with 1 square inch of copper area, θ_{JA} is 37°C/W; and with 1.6 or more square inches of copper area, θ_{JA} is 32°C/W.

Note 5: Human body model, 100 pF discharged through 1.5 kΩ.

Electrical Characteristics for Adjustable Version

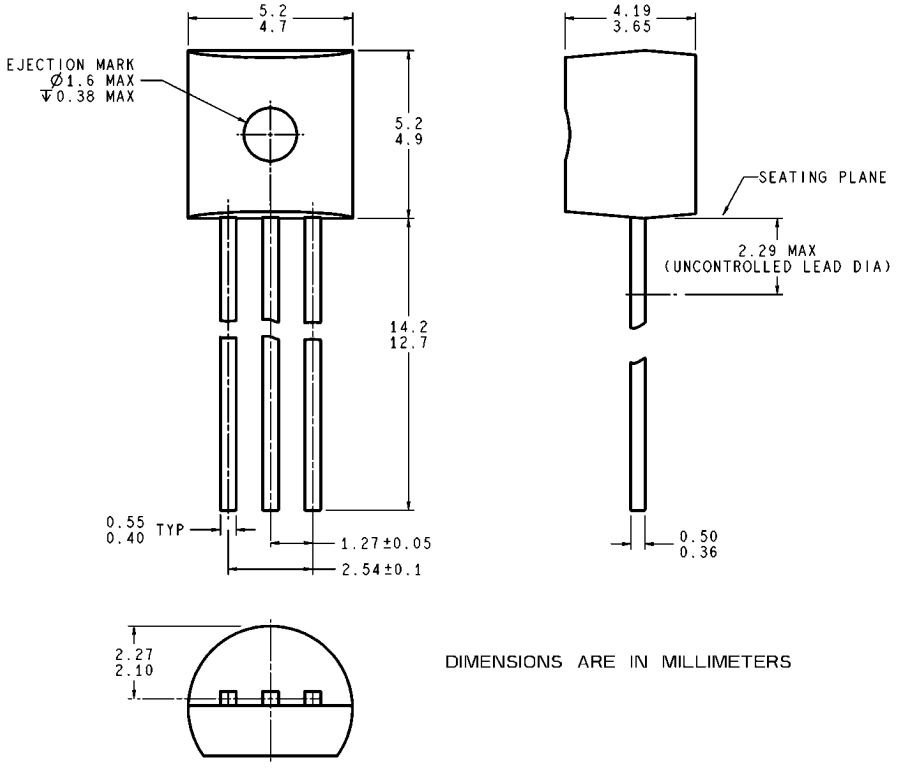
V_{IN} = 14V, V_{OUT} = 3V, I_O = 10 mA, T_J = 25°C, R1 = 27k, C2 = 100 µF (unless otherwise specified) (Note 2)

Parameter	Conditions	Typ	Limit	Units Limit
Reference Voltage		1.20	1.26	V_{MAX}
			1.14	V_{MIN}
	$I_O \le 100$ mA, $-40°C \le T_j \le 125°C$, R1 = 27k		**1.32**	V_{MAX}
	Measured from V_{OUT} to Adjust Pin		**1.08**	V_{MIN}
Output Voltage Range			24	V_{MAX}
			3	V_{MIN}
Line Regulation	$V_{OUT} + 0.6V \le V_{IN} \le 26V$	0.2	1.5	mV/V_{MAX}
Load Regulation	5 mA $\le I_O \le$ 100 mA	0.3	1	$\%_{MAX}$
Output Impedance	100 mA_{DC} and 10 mA_{rms}, 100 Hz–10 kHz	40		mΩ/V
Quiescent Current	I_O = 10 mA	0.4	1	mA_{MAX}
	I_O = 100 mA	15		mA
	During Shutdown R_L = 500Ω	0.8	1	mA_{MAX}
Output Noise Voltage	10 Hz–100 kHz	100		$\mu V_{rms}/V$
Long Term Stability		0.4		%/1000 hr
Ripple Rejection	f_O = 120 Hz	0.02		%/V
Dropout Voltage	$I_O \le$ 10 mA	0.05	0.2	V_{MAX}
	I_O = 100 mA	0.3	0.6	V_{MAX}
Maximum Operational Input Voltage		33	26	V_{MIN}
Maximum Line Transient	I_O = 10 mA, Reference Voltage ≤ 1.5V	70	60	V_{MIN}
	T = 1 ms, τ ≤ 100 ms			
Reverse Polarity Input Voltage, DC	$V_O \ge -0.3V$, R_L = 500Ω	–30	–15	V_{MIN}
Reverse Polarity Input Voltage, Transient	T = 1 ms, τ ≤ 100 ms, R_L = 500Ω	–80	–50	V_{MIN}
On/Off Threshold Voltage	V_O=3V			
On		2.0	1.2	V_{MAX}
Off		2.2	3.25	V_{MIN}
On/Off Threshold Current		20	50	μA_{MAX}



TS5B (Rev D)

5-Lead TO-263 Surface Mount Package
NS Package Number TS5B



Z03A (Rev G)

3-Lead TO-92 Plastic Package (Z)
NS Package Number Z03A