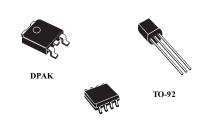


### Very low drop voltage regulators with inhibit function



SO-8

#### **Features**

- AEC-Q100 qualified (DPAK only)
- Very low dropout voltage (90 mV typ. at 10 mA load)
- Low quiescent current (typ. 2.5 mA, at 100 mA load)
- Output current up to 100 mA
- Adjustable (from V<sub>OUT</sub> = 2.5 V only SO-8) and fixed (3.3 V and 5 V) output voltage version
- · Internal current and thermal limit
- Load dump protection up to 60 V
- Reverse transient protection up to 50 V
- Temperature range: 40 to 125 °C
- Package available: TO-92, DPAK, SO-8 (with inhibit control)

#### **Description**

The LM2931 are very low drop regulators. The very low drop voltage and the low quiescent current make them particular suitable for low noise, low power applications and in battery-powered systems. In the 8-pin configuration (SO-8), fully compatible with the older L78L family, a shutdown logic control function is available. This means that when the device is used as a local regulator it is possible to put a part of the board in standby, decreasing total power consumption. Ideal for automotive applications, LM2931 is protected from reverse battery installations or 2 battery jumps. During the transient, such as a 60 V load dump, when the input voltage can exceed the specified maximum operating input voltage of 26 V, the regulator automatically shuts down to protect both internal circuitry and the load.

Maturity status link

LM2931



# 1 Diagram

V<sub>1</sub>
V<sub>0</sub>
ADJ

| INTERNAL | REFERENCE | ROTECTION | RO

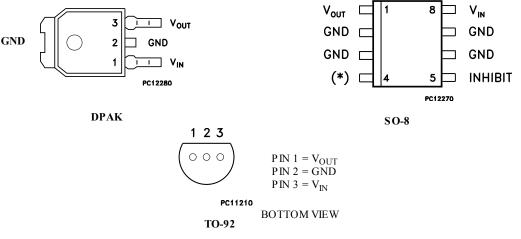
Figure 2. Schematic diagram

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# 2 Pin configuration

Figure 3. Pin connections (top view)



AMG110720161101MT

Note: (\*) ADJ pin on the adjustable version, not connected in the fixed output version.

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# 3 Maximum ratings

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
VI	DC positive input voltage	40	V
VI	DC reverse input voltage	-15	V
VI	Transient input voltage (T < 100 ms)	60	V
VI	Transient reverse input voltage (T < 100 ms)	-50	V
V <sub>INH</sub>	Inhibit input voltage	40	V
I <sub>O</sub>	Output current	Internally limited	
T <sub>STG</sub>	Storage temperature range	-65 to 150	°C
T <sub>OP</sub>	Operating junction temperature range	-40 to 125	°C

Note:

Absolute maximum ratings are those values beyond which damage to the device may occur. Functional operation under these condition is not implied.

Table 2. Thermal data

Symbol	Parameter		DPAK	TO-92	Unit
R <sub>thJC</sub>	Thermal resistance junction-case		8	57	°C/W
R <sub>thJA</sub>	Thermal resistance junction-ambient	55 <sup>(1)</sup>	100	200	°C/W

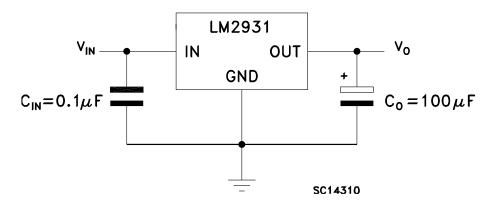
<sup>1.</sup> Considering 6 cm<sup>2</sup> of copper board heat-sink.

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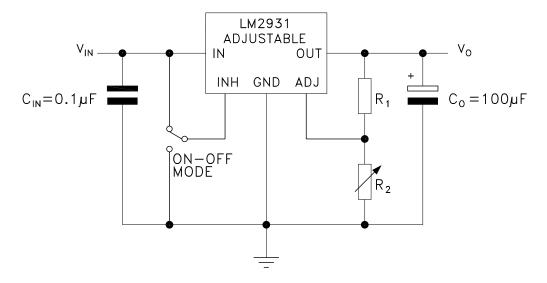
# 4 Application circuits

Figure 4. Application circuit for fixed output



AMG110720161102MT

Figure 5. Application circuit for adjustable output



Note:  $R_1$  suggested value = 27  $k\Omega$ 

 $V_0 = V_{REF} (R_1 + R_2)/R_1$ 

Inhibit pin: regulator is enabled when  $V_{INH} < 1.2 \text{ V}$ , disabled when  $V_{INH} > 3.25 \text{ V}$ 

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#### 5 Electrical characteristics

Refer to the application circuit Figure 4. Application circuit for fixed output,  $T_J$  = 25 °C,  $C_I$  = 0.1  $\mu$ F,  $C_O$  = 100  $\mu$ F,  $V_I$  = 14 V,  $I_O$  = 10 mA,  $V_{INH}$  = 0 V, unless otherwise specified.

Table 3. Electrical characteristics of LM2931A33/LM2931A33Y

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
VI	Maximum operating input voltage	I <sub>O</sub> = 10 mA, T <sub>J</sub> = -40 to 125 °C	26			V
Vo	Output voltage		3.175	3.3	3.425	V
Vo	Output voltage	$I_{O}$ = 100 mA, $V_{I}$ = 6 to 26 V $T_{J}$ = -40 to 125°C	3.135	3.3	3.465	V
$DV_O$	Line regulation	V <sub>I</sub> = 9 to 16 V		2	10	mV
		V <sub>I</sub> = 6 to 26 V		4	33	
$DV_O$	Load regulation	I <sub>O</sub> = 5 to 100 mA		10	33	mV
$V_d$	Dropout voltage <sup>(1)</sup>	I <sub>O</sub> = 10 mA		90	250	mV
		I <sub>O</sub> = 100 mA		250	600	
I <sub>d</sub>	Quiescent current	I <sub>O</sub> = 100 mA		2.5	30	mA
	ON MODE					
	OFF MODE	$V_{INH}$ = 2.5 V, $R_{LOAD}$ = 330 $\Omega$		0.3	1	mA
I <sub>SC</sub>	Short circuit current		100	300		mA
SVR	Supply voltage rejection	I <sub>O</sub> = 100 mA, V <sub>I</sub> = 14 ± 2 V f = 120 Hz	55	78		dB
V <sub>IL</sub>	Control input voltage low	T <sub>J</sub> = -40 to 125 °C		2	1.2	V
V <sub>IH</sub>	Control input voltage high	T <sub>J</sub> = -40 to 125 °C	3.25	2		V
I <sub>INH</sub>	Inhibit input current	V <sub>INH</sub> = 2.5 V		22	50	μA
VI	Transient input voltage	R <sub>LOAD</sub> = 330 Ω, T < 100 ms	60	70		V
VI	Reverse polarity input voltage	$V_O$ = ± 0.3 V, $R_{LOAD}$ = 330 $\Omega$	-15	-50		V
VI	Reverse polarity input voltage transient	R <sub>LOAD</sub> = 330 Ω, T < 100 ms	-50			V
eN	Output noise voltage	B = 10 Hz to 100 kHz		330		μV <sub>RMS</sub>

<sup>1.</sup>  $V_d$  measured when the output voltage has dropped 100 mV from the nominal value obtained at 14 V.

Refer to the application circuit Figure 4. Application circuit for fixed output,  $T_J$  = 25 °C,  $C_I$  = 0.1  $\mu$ F,  $C_O$  = 100  $\mu$ F,  $V_I$  = 14 V,  $I_O$  = 10 mA,  $V_{INH}$  = 0 V, unless otherwise specified.

Table 4. Electrical characteristics of LM2931A50/ LM2931A50Y

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
VI	Maximum operating input voltage	$I_{O}$ = 10 mA, $T_{J}$ = -40 to 125 °C	26			V
Vo	Output voltage		4.81	5	5.19	V
Vo	Output voltage	$I_{O}$ = 100 mA, $V_{I}$ = 6 to 26 V $T_{J}$ = -40 to 125 °C	4.75	5	5.25	V
DVO	Line regulation	V <sub>I</sub> = 9 to 16 V		2	10	mV
		V <sub>I</sub> = 6 to 26 V		4	30	
DV <sub>O</sub>	Load regulation	I <sub>O</sub> = 5 to 100 mA		15	50	mV
V <sub>d</sub>	Dropout voltage <sup>(1)</sup>	I <sub>O</sub> = 10 mA		90	200	mV
		I <sub>O</sub> = 100 mA		250	600	

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Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
I <sub>d</sub>	Quiescent current ON MODE	I <sub>O</sub> = 100 mA		2.5	30	mA
	OFF MODE	$V_{INH}$ = 2.5 V, $R_{LOAD}$ = 500 $\Omega$		0.3	1	mA
I <sub>SC</sub>	Short circuit current		100	300		mA
SVR	Supply voltage rejection	I <sub>O</sub> = 100 mA, V <sub>I</sub> = 14 ± 2 V f = 120 Hz	55	75		dB
V <sub>IL</sub>	Control input voltage low	T <sub>J</sub> = -40 to 125 °C		2	1.2	V
V <sub>IH</sub>	Control input voltage high	T <sub>J</sub> = -40 to 125 °C	3.25	2		V
I <sub>INH</sub>	Inhibit input current	V <sub>INH</sub> = 2.5 V		22	50	μA
VI	Transient input voltage	R <sub>LOAD</sub> = 500 Ω, T < 100 ms	60	70		V
VI	Reverse polarity input voltage	$V_{O} = \pm 0.3 \text{ V}, R_{LOAD} = 500 \Omega$	-15	-50		V
VI	Reverse polarity input voltage transient	R <sub>LOAD</sub> = 500 Ω, T < 100 ms	-50			V
eN	Output noise voltage	B = 10 Hz to 100 kHz		500		μV <sub>RMS</sub>

<sup>1.</sup>  $V_d$  measured when the output voltage has dropped 100 mV from the nominal value obtained at 14 V.

Refer to the application circuit Figure 5. Application circuit for adjustable output with  $R_1$  = 27 K $\Omega$ and  $R_2$  = 40.5 k $\Omega$ ,  $T_J$  = 25 °C,  $C_I$  = 0.1  $\mu$ F,  $C_O$  = 100  $\mu$ F,  $V_I$  = 14 V,  $I_O$  = 10 mA,  $V_{INH}$  = 0 V, unless otherwise specified.

Table 5. Electrical characteristics of LM2931 (adjustable version)

Symbol	Parameter	Test conditions	Min.	Тур.	Max.	Unit
VI	Maximum operating input voltage	$I_{O}$ = 10 mA, $T_{J}$ = -40 to 125 °C	26			V
V <sub>REF</sub>	Reference voltage (1)		1.14	1.2	1.26	V
$V_{REF}$	Reference voltage (1)	$I_{O}$ = 100 mA, $T_{J}$ = -40 to 125 °C	1.08	1.2	1.32	V
DV <sub>O</sub>	Line regulation	V <sub>I</sub> = 3.6 to 26 V		0.6	4.5	mV
DV <sub>O</sub>	Load regulation	I <sub>O</sub> = 5 to 100 mA		9	30	mV
V <sub>d</sub>	Dropout voltage <sup>(2)</sup>	I <sub>O</sub> = 10 mA		90	200	mV
		I <sub>O</sub> = 100 mA		250	600	
I <sub>d</sub>	Quiescent current ON MODE	I <sub>O</sub> = 100 mA		2.5	30	mA
	OFF MODE	$V_{INH}$ = 2.5 V, $R_{LOAD}$ = 300 $\Omega$		0.3	1	mA
I <sub>SC</sub>	Short circuit current		100	300		mA
SVR	Supply voltage rejection	I <sub>O</sub> = 100 mA, V <sub>I</sub> = 14 ± 2 V f = 120 Hz	55	80		dB
V <sub>IL</sub>	Control input voltage low	T <sub>J</sub> = -40 to 125 °C		2	1.2	V
V <sub>IH</sub>	Control input voltage high	T <sub>J</sub> = -40 to 125 °C	3.25	2		V
I <sub>INH</sub>	Inhibit input current	V <sub>INH</sub> = 2.5 V		22	50	μA
VI	Transient input voltage	R <sub>LOAD</sub> = 300 Ω, T < 100 ms	60	70		V
VI	Reverse polarity input voltage	$V_O$ = ± 0.3 V, $R_{LOAD}$ = 300 $\Omega$	-15	-50		V
VI	Reverse polarity input voltage transient	R <sub>LOAD</sub> = 300 Ω, T < 100 ms	-50			V
eN	Output noise voltage	B = 10 Hz to 100 kHz		330		μV <sub>RMS</sub>

<sup>1.</sup> Reference voltage is measured from  $V_{\mbox{\scriptsize OUT}}$  to ADJ pin.

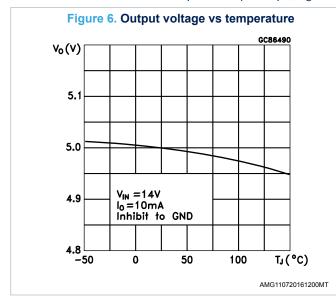
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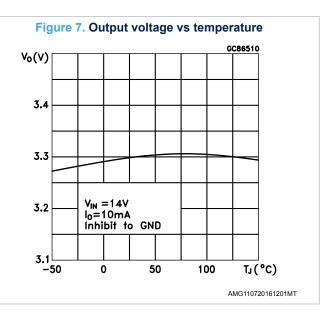
<sup>2.</sup>  $V_d$  measured when the output voltage has dropped 100 mV from the nominal value obtained at 14 V.

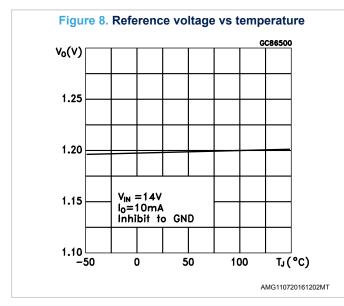


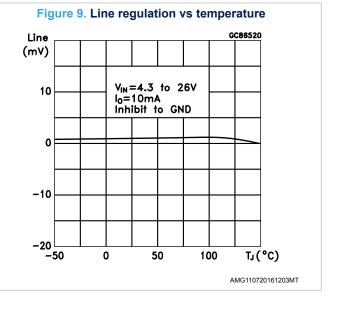
# 6 Typical characteristics

Unless otherwise specified  $C_I$  = 0.1  $\mu F$ ,  $C_O$  = 100  $\mu F$ .



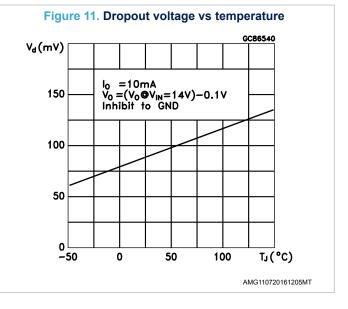


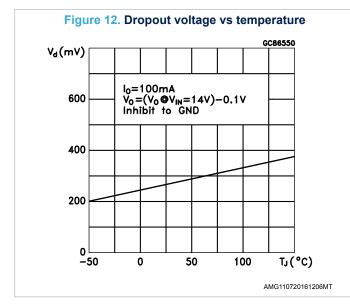


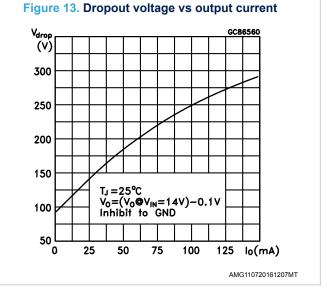


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Figure 14. Output voltage vs input voltage

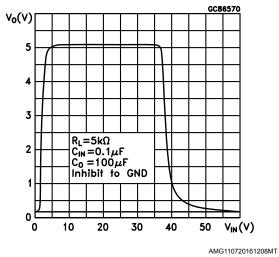


Figure 15. Short circuit current vs drop voltage

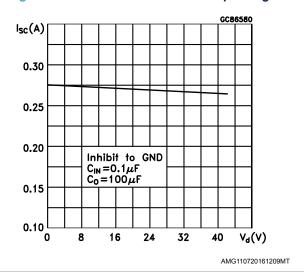


Figure 16. Quiescent current vs temperature

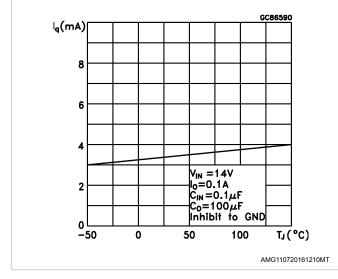
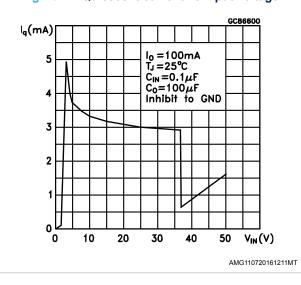


Figure 17. Quiescent current vs input voltage

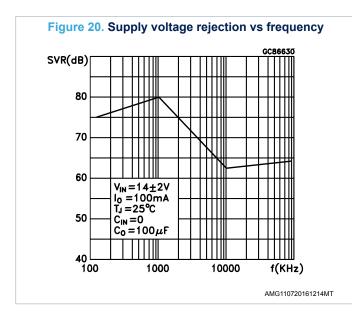


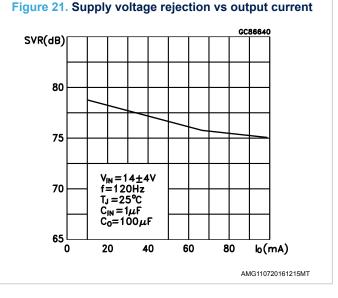
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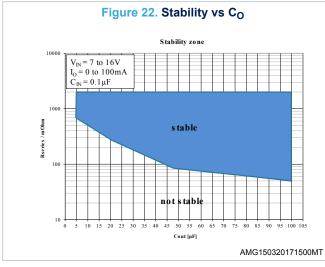


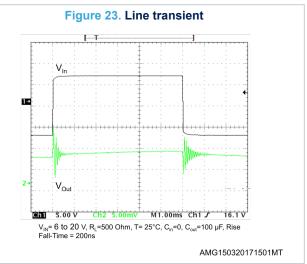
Figure 18. Quiescent current vs output current GC86611  $I_q(mA)$ 12 9 6 V<sub>IN</sub> =14V T<sub>J</sub> =25℃  $C_{IN} = 0.1 \mu F$  $C_0 = 100 \mu$ F Inhibit to GND 3 0 160 0 80 240 lo (mA) AMG110720161212MT

Figure 19. Supply voltage rejection vs temperature GC86620 SVR(dB) 75 70  $V_{IN} - V_{O} = 14 \pm 2V$ I<sub>0</sub>=100mA 65 f=120Hz  $C_{IN} = 1 \mu F$   $C_{0} = 100 \mu F$ Inhibit to GND 60 0 -50 50 100 T<sub>J</sub>(°C) AMG110720161213MT





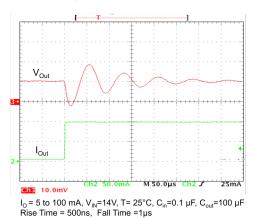




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Figure 24. Load transient



AMG150320171502MT

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# 7 Package information

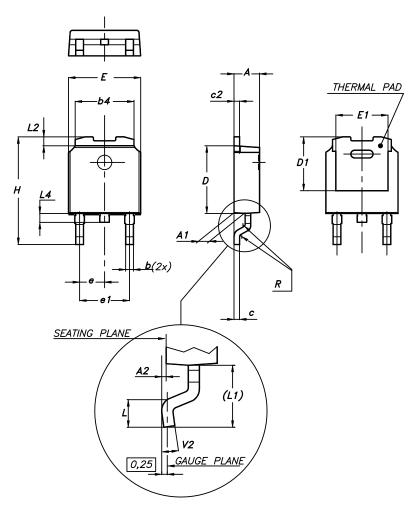
In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK® packages, depending on their level of environmental compliance. ECOPACK® specifications, grade definitions and product status are available at: www.st.com. ECOPACK® is an ST trademark.

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# 7.1 DPAK package information

Figure 25. DPAK package outline



0068772\_A\_21

Table 6. DPAK mechanical data

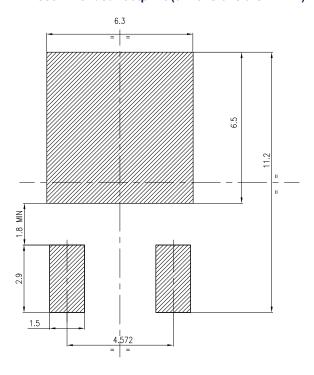
Dim.	mm				
	Min.	Тур.	Max.		
Α	2.20		2.40		
A1	0.90		1.10		
A2	0.03		0.23		
b	0.64		0.90		
b4	5.20		5.40		
С	0.45		0.60		
c2	0.48		0.60		
D	6.00		6.20		

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Dim.	mm			
	Min.	Тур.	Max.	
D1		5.10		
E	6.40		6.60	
E1		4.70		
е		2.28		
e1	4.40		4.60	
Н	9.35		10.10	
L	1.00		1.50	
(L1)		2.80		
L2		0.80		
L4	0.60		1.00	
R		0.20		
V2	0°		8°	

Figure 26. DPAK recommended footprint (dimensions are in mm)



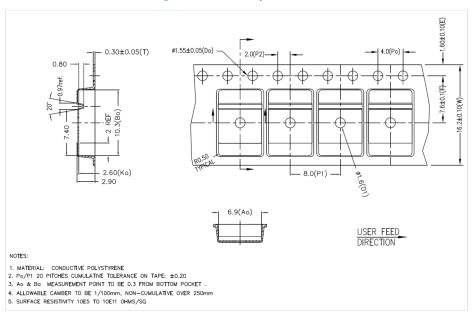
FP\_0068772\_24

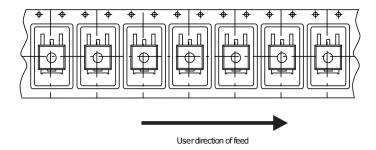
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### 7.2 DPAK packing information

Figure 27. DPAK tape outline





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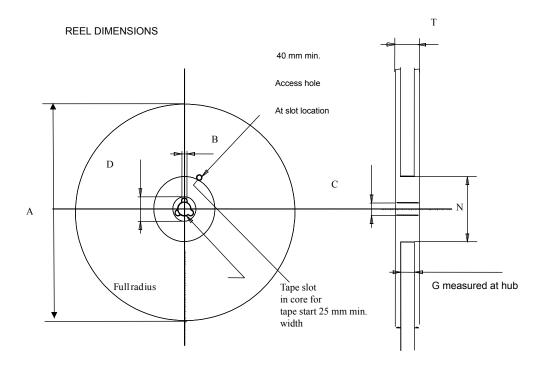
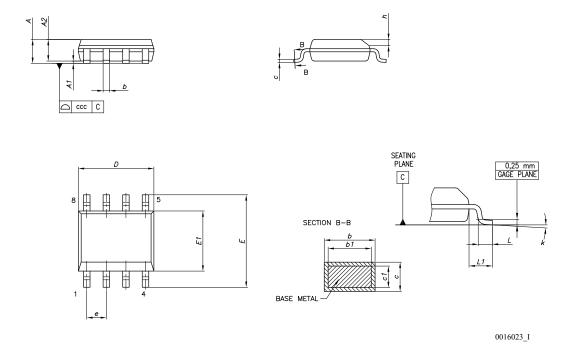


Figure 28. DPAK reel outline

# 7.3 SO8 package information

Figure 29. SO-8 package outline



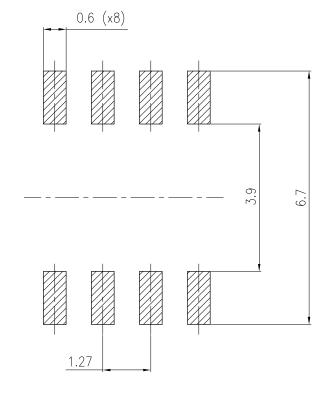
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Table 7. SO-8 mechanical data

Dim.		mm	
	Min.	Тур.	Max.
Α			1.75
A1	0.10		0.25
A2	1.25		
b	0.28		0.48
С	0.17		0.23
D	4.80	4.90	5.00
Е	5.80	6.00	6.20
E1	3.80	3.90	4.00
е		1.27	
h	0.25		0.50
L	0.40		1.27
L1		1.04	
k	0°		8°
ccc			0.10

Figure 30. SO-8 recommended footprint



0016023\_I

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# 7.4 SO-8 packing information

Figure 31. SO-8 tape and reel outline

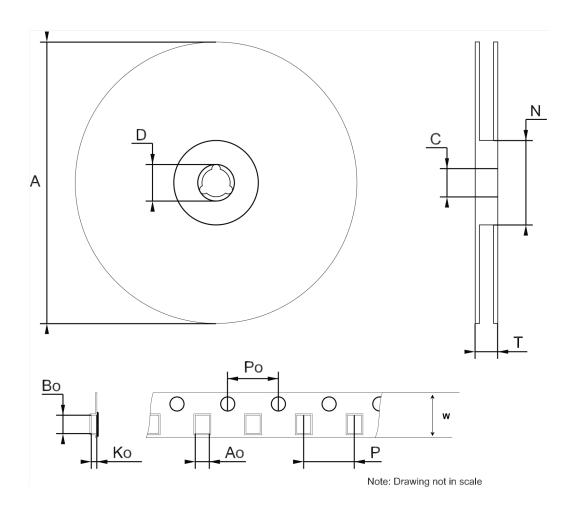


Table 8. SO-8 mechanical data

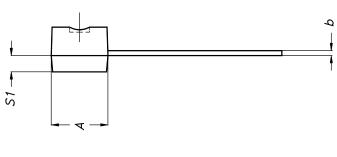
Dim.	mm				
	Min.	Тур.	Max.		
Α			330		
С	12.8		13.2		
D	20.2				
N	50				
Т			22.4		
Ao	6.4	6.5	6.6		
Во	5.2		5.4		
Ко	2.1		2.3		
Po	3.9		4.1		
Р	7.9		8.1		
W	11.7	12.0	12.3		

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# 7.5 TO-92 package information

Figure 32. TO-92 package outline



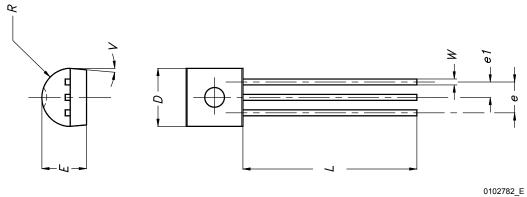


Table 9. TO-92 mechanical data

Dim.	mm					
	Min.	Тур.	Max.			
А	4.32		4.95			
b	0.36		0.51			
D	4.45		4.95			
Е	3.30		3.94			
е	2.41		2.67			
e1	1.14		1.40			
L	12.70		15.49			
R	2.16		2.41			
S1	0.92		1.52			
W	0.41		0.56			
V		5°				

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# 8 Ordering informations

Table 10. Order code

DPAK		TO-92 (bag)	SO-8	Output voltages
AG	Standard			
LM2931ADT33RY (1)			LM2931AD33R	3.3 V
LM2931ADT50RY <sup>(1)</sup>	LM2931ADT50R	LM2931AZ50R	LM2931AD50R	5.0 V
			LM2931D-R	2.5 to 26 V

Qualified and characterized according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 and Q002 or equivalent.

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# **Revision history**

**Table 11. Document revision history** 

Date	Revision	Changes
21-Jun-2004	12	Document updated.
16-Jun-2006	13	Order codes updated.
27-Jul-2007	14 15	Added Table 1 in cover page.
21-Aug-2007		Added root part number - (see Table 1).
22-Nov-2007	16	Modified: Table 1.
11-Feb-2008	17	Modified: Table 1 on page 1.
10-Jul-2008	18	Removed package TO-220, modified Table 1 on page 1.
26-May-2010	19	Modified: $V_{\rm I}$ values Table 4 on page 6, Table 5 on page 7 and Table 6 on page 8.
02-Nov-2011	20	Modified: Figure 4 on page 6. Added: (*) ADJ pin on the Adjustable version, Not Connected in the fixed output version. on page 4 and Inhibit pin: regulator is enabled when VINH < 1.2 V , disabled when VINH > 3.25 V on page 6.
09-Apr-2014	21	Part numbers LM2931XX, LM2931AXX33 and LM2931AXX50 changed to LM2931. Updated the description in cover page Section 2: Pin configuration and Section 7: Package information. Added Section 8: Revision history. Minor text changes.
16-Mar-2017	22	Updated features in cover page, removed Table 1. Device summary from cover page, Table 3: "Electrical characteristics of LM2931A33/LM2931A33Y", Table 4: "Electrical characteristics of LM2931A50/ LM2931A50Y" and Table 5: "Electrical characteristics of LM2931 (adjustable version)".
		Updated Section 7: "Package information".
		Added Section 8: "Ordering information".
		Minor text changes.
23-Feb-2018	23	Updated Figure 5. Application circuit for adjustable output.

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