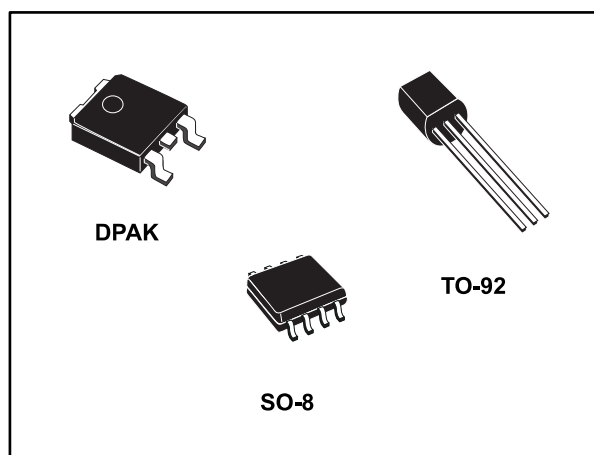


## Very low drop voltage regulators with inhibit function

Datasheet - production data



## Description

The LM2931 are very low drop regulators. The very low drop voltage and the low quiescent current make them particularly 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.

## 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  $V_{OUT} = 2.5$  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)

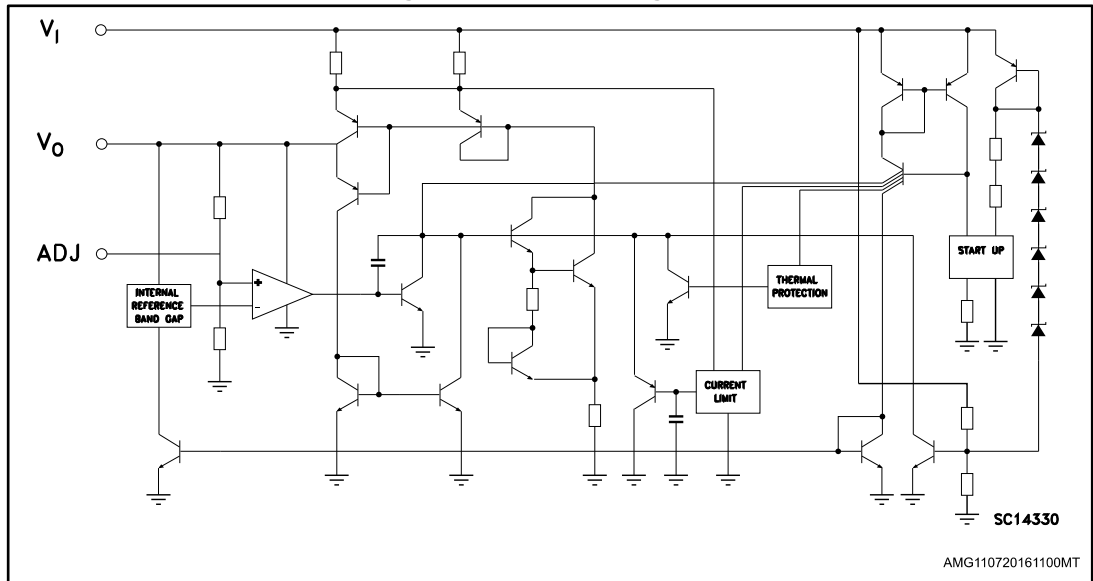
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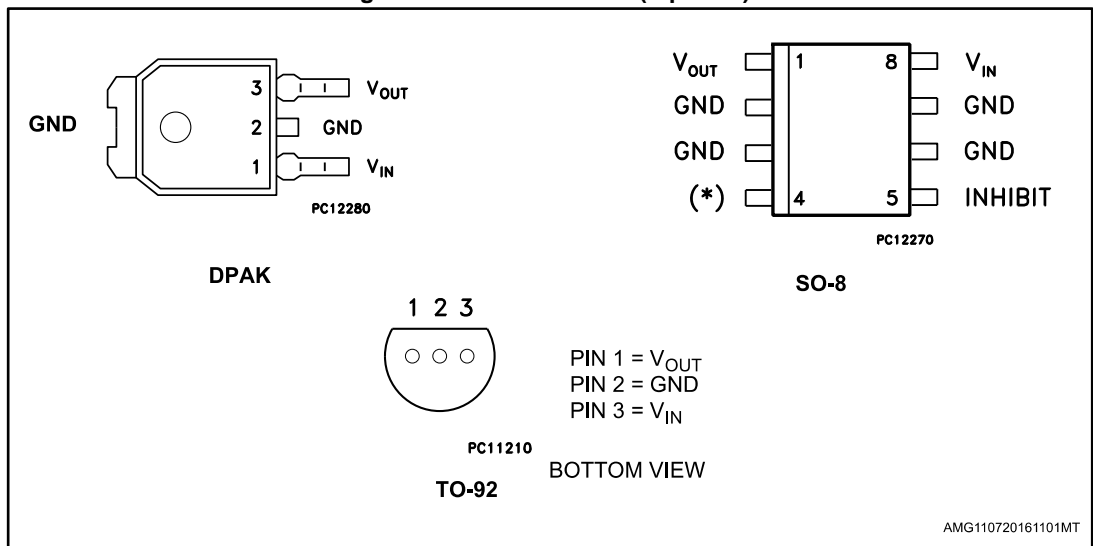
# 1 Diagram

Figure 1: Schematic diagram



# 2 Pin configuration

Figure 2: Pin connections (top view)



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

### 3 Maximum ratings

Table 1: Absolute maximum ratings

Symbol	Parameter	Value	Unit
V <sub>I</sub>	DC positive input voltage	40	V
V <sub>I</sub>	DC reverse input voltage	-15	V
V <sub>I</sub>	Transient input voltage (T < 100 ms)	60	V
V <sub>I</sub>	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



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	SO-8	DPAK	TO-92	Unit
R <sub>thJC</sub>	Thermal resistance junction-case	20	8	57	°C/W
R <sub>thJA</sub>	Thermal resistance junction-ambient	55 <sup>(1)</sup>	100	200	°C/W

**Notes:**

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

## 4 Application circuits

Figure 3: Application circuit for fixed output

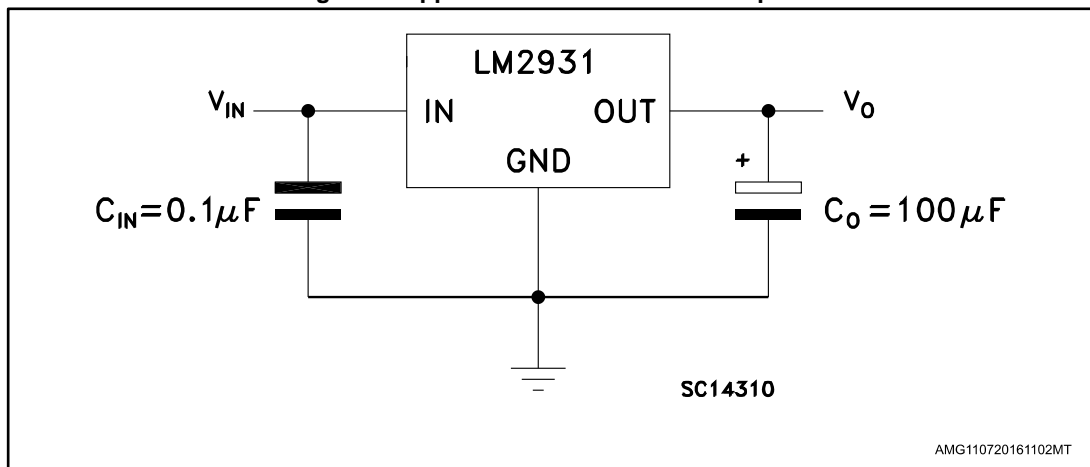
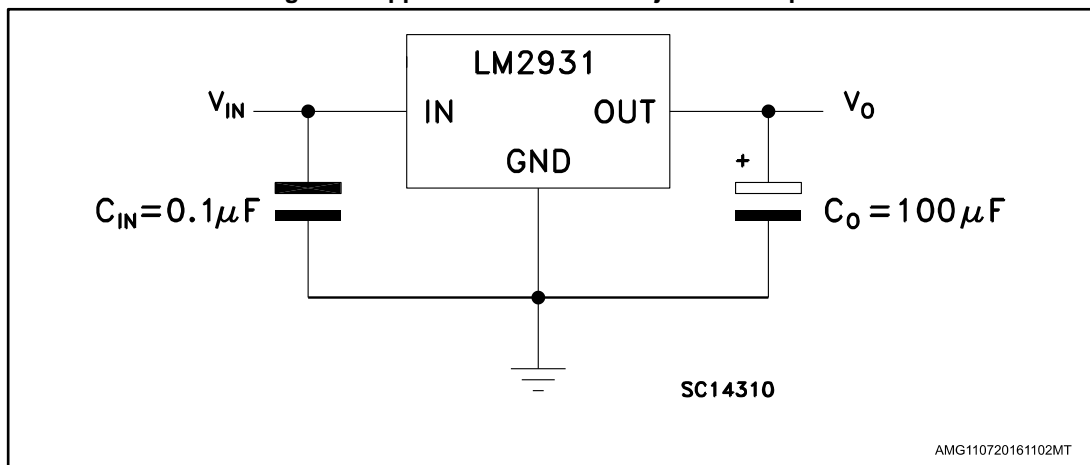


Figure 4: Application circuit for adjustable output



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

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

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

## 5 Electrical characteristics

Refer to the application circuit [Figure 3: "Application circuit for fixed output"](#),  $T_J = 25\text{ °C}$ ,  $C_I = 0.1\text{ }\mu\text{F}$ ,  $C_O = 100\text{ }\mu\text{F}$ ,  $V_I = 14\text{ V}$ ,  $I_O = 10\text{ mA}$ ,  $V_{INH} = 0\text{ V}$ , unless otherwise specified.

Table 3: Electrical characteristics of LM2931A33/LM2931A33Y

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

### Notes:

<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 3: "Application circuit for fixed output"*,  $T_J = 25\text{ }^\circ\text{C}$ ,  $C_I = 0.1\text{ }\mu\text{F}$ ,  $C_O = 100\text{ }\mu\text{F}$ ,  $V_I = 14\text{ V}$ ,  $I_O = 10\text{ mA}$ ,  $V_{INH} = 0\text{ V}$ , unless otherwise specified.

**Table 4: Electrical characteristics of LM2931A50/ LM2931A50Y**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_I$	Maximum operating input voltage	$I_O = 10\text{ mA}$ , $T_J = -40\text{ to }125\text{ }^\circ\text{C}$	26			V
$V_O$	Output voltage		4.81	5	5.19	V
$V_O$	Output voltage	$I_O = 100\text{ mA}$ , $V_I = 6\text{ to }26\text{ V}$ , $T_J = -40\text{ to }125\text{ }^\circ\text{C}$	4.75	5	5.25	V
$DV_O$	Line regulation	$V_I = 9\text{ to }16\text{ V}$		2	10	mV
		$V_I = 6\text{ to }26\text{ V}$		4	30	
$DV_O$	Load regulation	$I_O = 5\text{ to }100\text{ mA}$		15	50	mV
$V_d$	Dropout voltage <sup>(1)</sup>	$I_O = 10\text{ mA}$		90	200	mV
		$I_O = 100\text{ mA}$		250	600	
$I_d$	Quiescent current ON MODE	$I_O = 100\text{ mA}$		2.5	30	mA
	OFF MODE	$V_{INH} = 2.5\text{ V}$ , $R_{LOAD} = 500\text{ }\Omega$		0.3	1	mA
$I_{sc}$	Short circuit current		100	300		mA
SVR	Supply voltage rejection	$I_O = 100\text{ mA}$ , $V_I = 14 \pm 2\text{ V}$ , $f = 120\text{ Hz}$	55	75		dB
$V_{IL}$	Control input voltage low	$T_J = -40\text{ to }125\text{ }^\circ\text{C}$		2	1.2	V
$V_{IH}$	Control input voltage high	$T_J = -40\text{ to }125\text{ }^\circ\text{C}$	3.25	2		V
$I_{INH}$	Inhibit input current	$V_{INH} = 2.5\text{ V}$		22	50	$\mu\text{A}$
$V_I$	Transient input voltage	$R_{LOAD} = 500\text{ }\Omega$ , $T < 100\text{ ms}$	60	70		V
$V_I$	Reverse polarity input voltage	$V_O = \pm 0.3\text{ V}$ , $R_{LOAD} = 500\text{ }\Omega$	-15	-50		V
$V_I$	Reverse polarity input voltage transient	$R_{LOAD} = 500\text{ }\Omega$ , $T < 100\text{ ms}$	-50			V
eN	Output noise voltage	$B = 10\text{ Hz to }100\text{ kHz}$		500		$\mu\text{V}_{RMS}$

**Notes:**

<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 adjustable output"](#) with  $R_1 = 27\text{ k}\Omega$  and  $R_2 = 40.5\text{ k}\Omega$ ,  $T_J = 25\text{ }^\circ\text{C}$ ,  $C_I = 0.1\text{ }\mu\text{F}$ ,  $C_O = 100\text{ }\mu\text{F}$ ,  $V_I = 14\text{ V}$ ,  $I_O = 10\text{ mA}$ ,  $V_{INH} = 0\text{ V}$ , unless otherwise specified.

**Table 5: Electrical characteristics of LM2931 (adjustable version)**

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
$V_I$	Maximum operating input voltage	$I_O = 10\text{ mA}$ , $T_J = -40\text{ to }125\text{ }^\circ\text{C}$	26			V
$V_{REF}$	Reference voltage <sup>(1)</sup>		1.14	1.2	1.26	V
$V_{REF}$	Reference voltage <sup>(1)</sup>	$I_O = 100\text{ mA}$ , $T_J = -40\text{ to }125\text{ }^\circ\text{C}$	1.08	1.2	1.32	V
$DV_O$	Line regulation	$V_I = 3.6\text{ to }26\text{ V}$		0.6	4.5	mV
$DV_O$	Load regulation	$I_O = 5\text{ to }100\text{ mA}$		9	30	mV
$V_d$	Dropout voltage <sup>(2)</sup>	$I_O = 10\text{ mA}$		90	200	mV
		$I_O = 100\text{ mA}$		250	600	
$I_d$	Quiescent current ON MODE	$I_O = 100\text{ mA}$		2.5	30	mA
	OFF MODE	$V_{INH} = 2.5\text{ V}$ , $R_{LOAD} = 300\text{ }\Omega$		0.3	1	mA
$I_{SC}$	Short circuit current		100	300		mA
SVR	Supply voltage rejection	$I_O = 100\text{ mA}$ , $V_I = 14 \pm 2\text{ V}$ $f = 120\text{ Hz}$	55	80		dB
$V_{IL}$	Control input voltage low	$T_J = -40\text{ to }125\text{ }^\circ\text{C}$		2	1.2	V
$V_{IH}$	Control input voltage high	$T_J = -40\text{ to }125\text{ }^\circ\text{C}$	3.25	2		V
$I_{INH}$	Inhibit input current	$V_{INH} = 2.5\text{ V}$		22	50	$\mu\text{A}$
$V_I$	Transient input voltage	$R_{LOAD} = 300\text{ }\Omega$ , $T < 100\text{ ms}$	60	70		V
$V_I$	Reverse polarity input voltage	$V_O = \pm 0.3\text{ V}$ , $R_{LOAD} = 300\text{ }\Omega$	-15	-50		V
$V_I$	Reverse polarity input voltage transient	$R_{LOAD} = 300\text{ }\Omega$ , $T < 100\text{ ms}$	-50			V
eN	Output noise voltage	$B = 10\text{ Hz to }100\text{ kHz}$		330		$\mu\text{V}_{RMS}$

**Notes:**

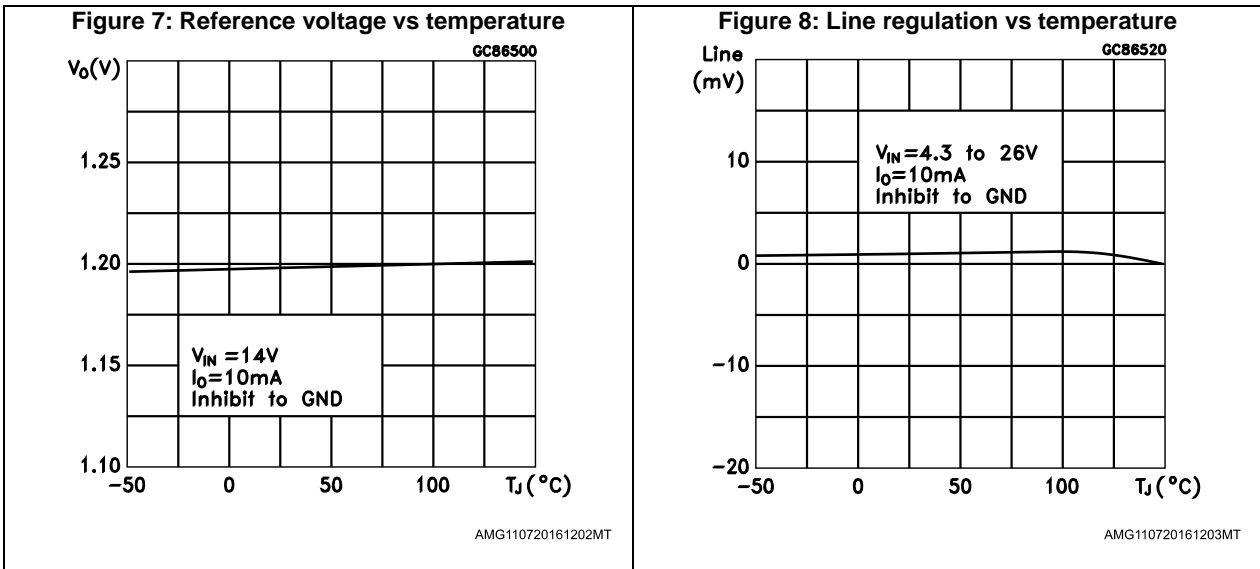
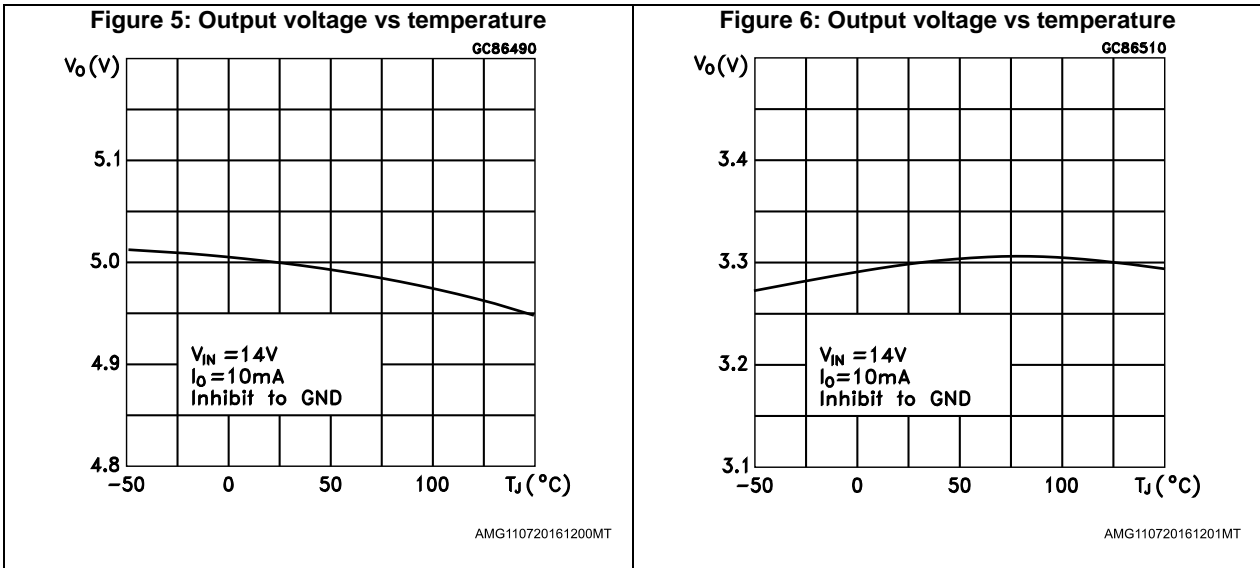
<sup>(1)</sup>Reference voltage is measured from  $V_{OUT}$  to ADJ pin.

<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  $C_I = 0.1 \mu\text{F}$ ,  $C_O = 100 \mu\text{F}$ .



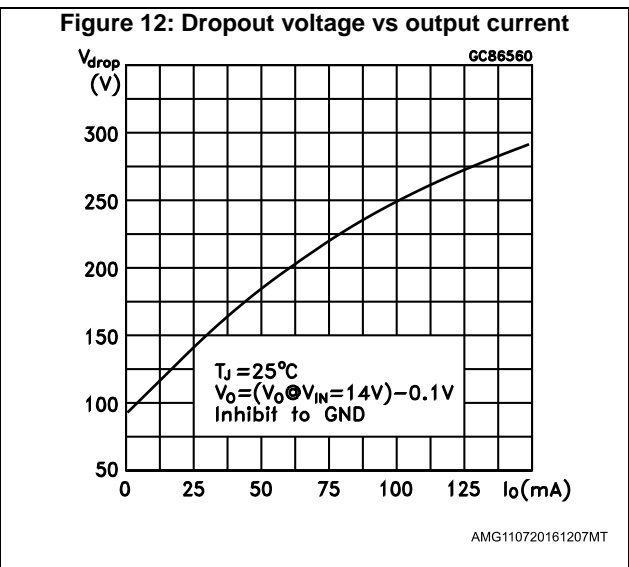
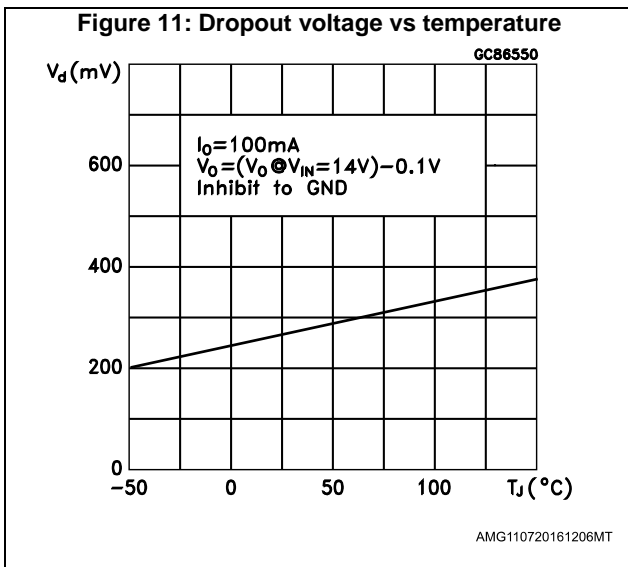
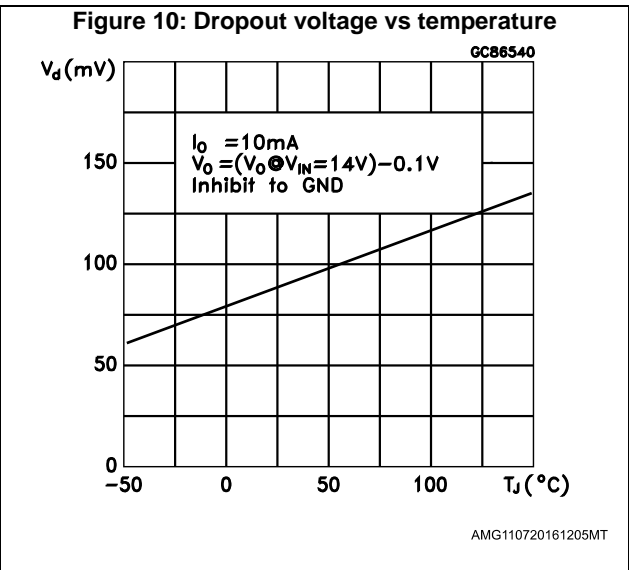
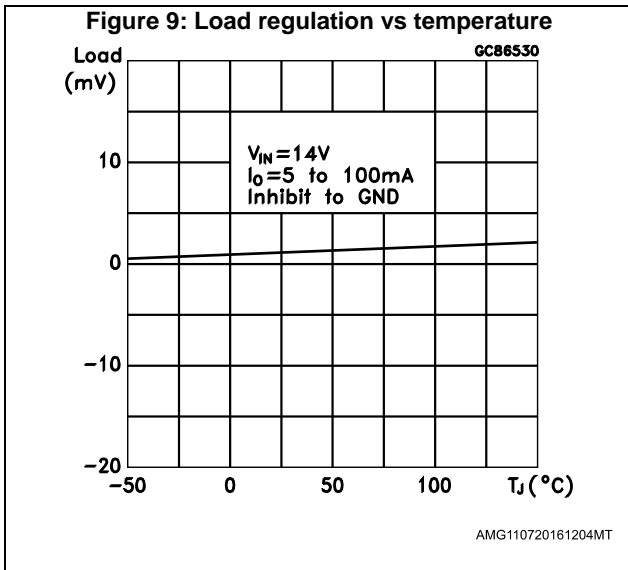
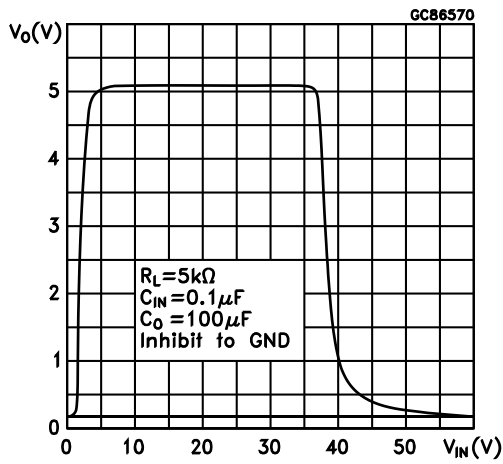
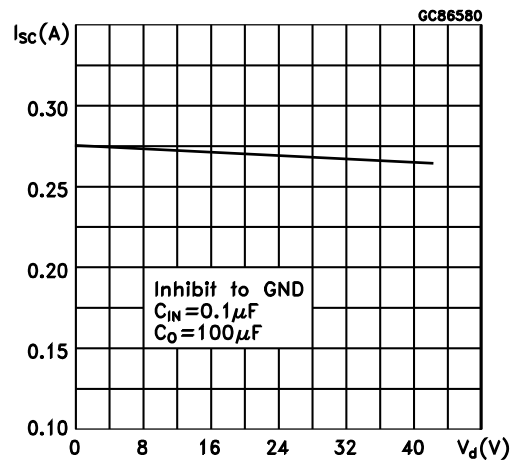


Figure 13: Output voltage vs input voltage



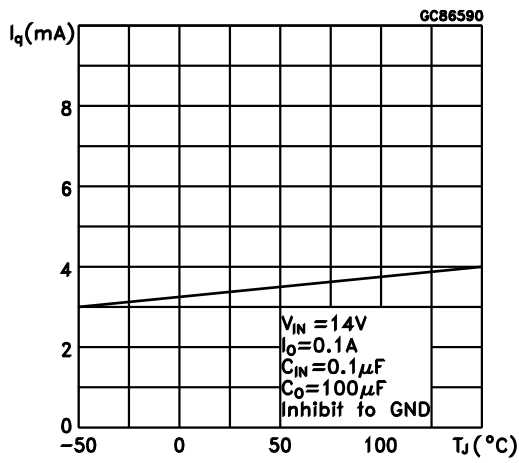
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Figure 14: Short circuit current vs drop voltage



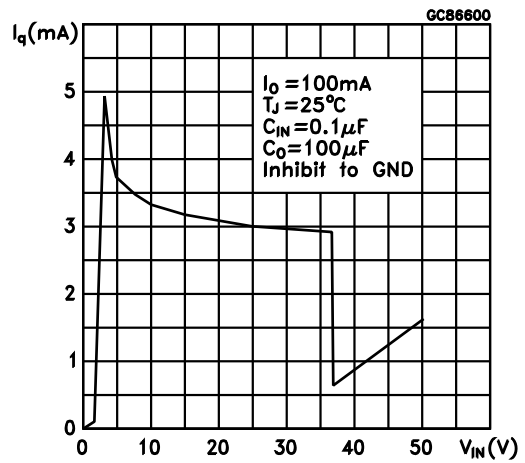
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Figure 15: Quiescent current vs temperature



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Figure 16: Quiescent current vs input voltage



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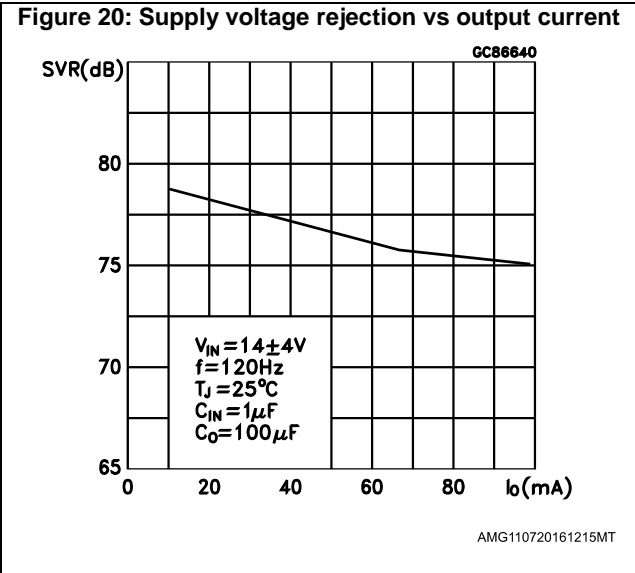
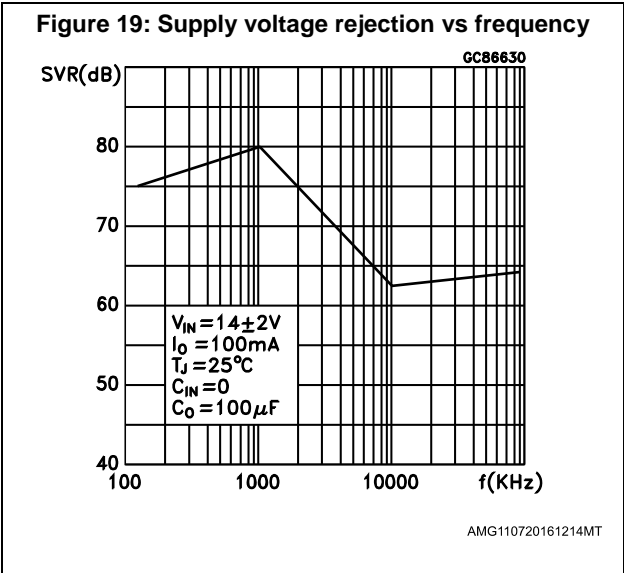
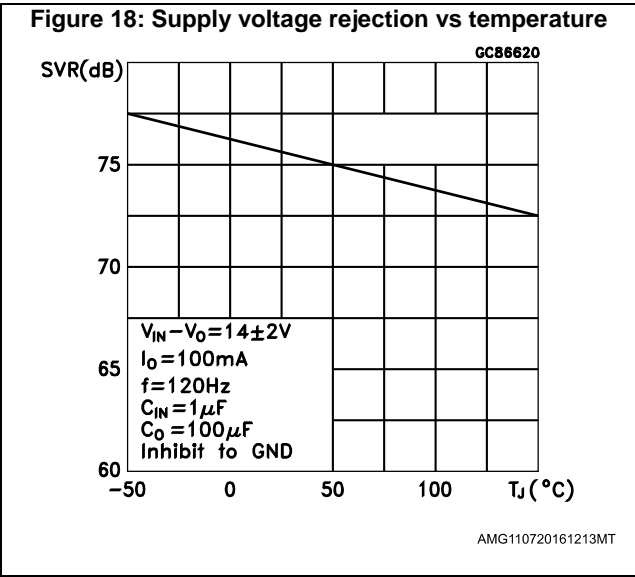
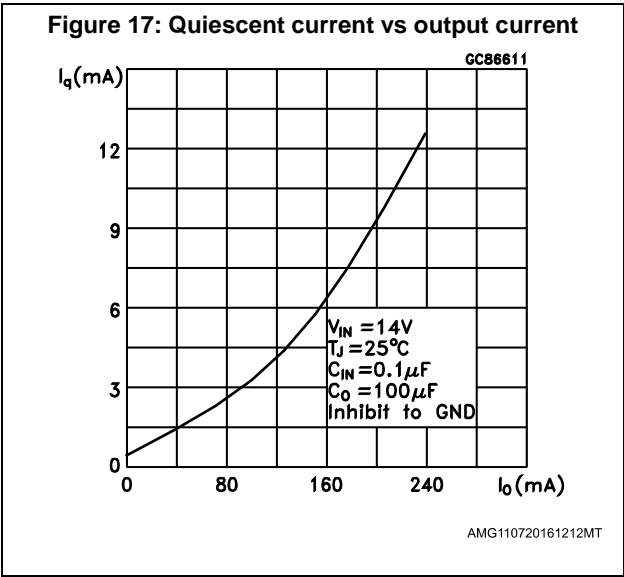


Figure 21: Stability vs Co

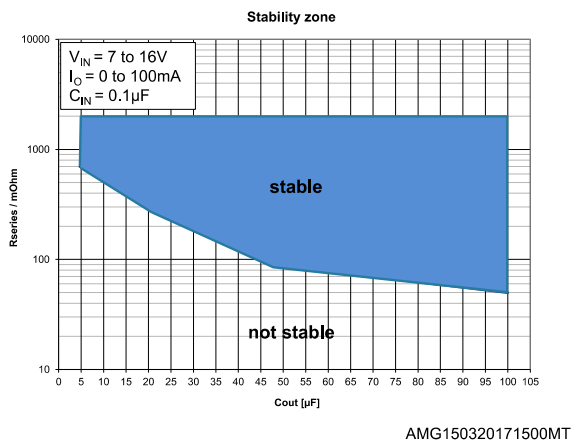
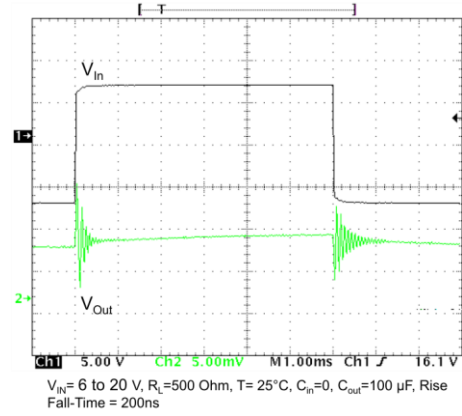
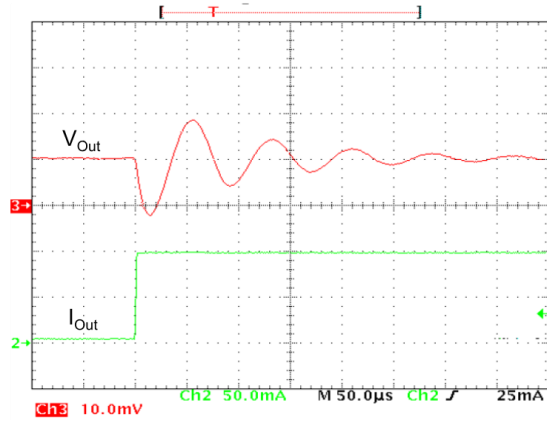


Figure 22: Line transient



AMG150320171501MT

Figure 23: Load transient



$I_O = 5 \text{ to } 100 \text{ mA}$ ,  $V_{IN} = 14\text{V}$ ,  $T = 25^\circ\text{C}$ ,  $C_{in} = 0.1 \mu\text{F}$ ,  $C_{out} = 100 \mu\text{F}$   
 Rise Time = 500ns, Fall Time = 1µs

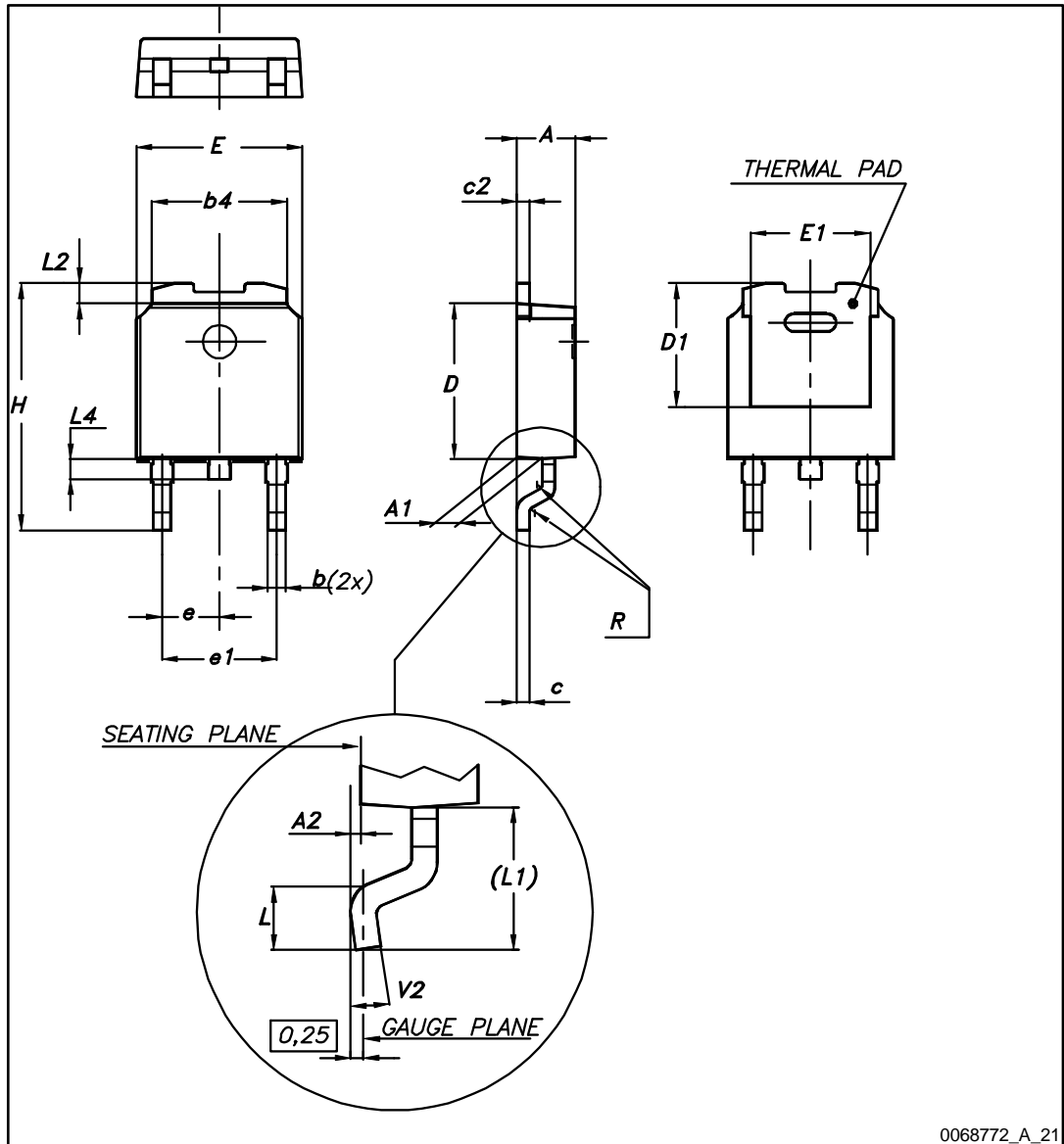
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## 7 Package information

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](http://www.st.com). ECOPACK® is an ST trademark.

### 7.1 DPAK package information

Figure 24: DPAK package outline

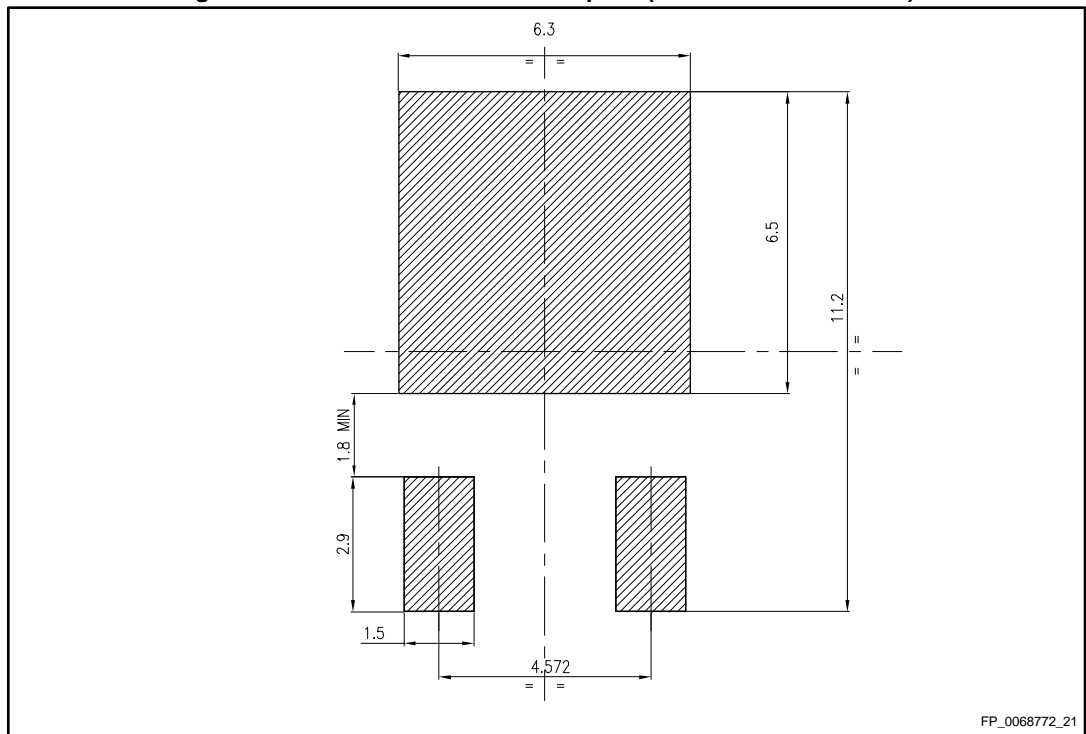


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Table 6: DPAK mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	2.20		2.40
A1	0.90		1.10
A2	0.03		0.23
b	0.64		0.90
b4	5.20		5.40
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
D1		5.10	
E	6.40		6.60
E1		4.70	
e		2.28	
e1	4.40		4.60
H	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 25: DPAK recommended footprint (dimensions are in mm)





## 7.2 DPAK packing information

Figure 26: DPAK tape outline

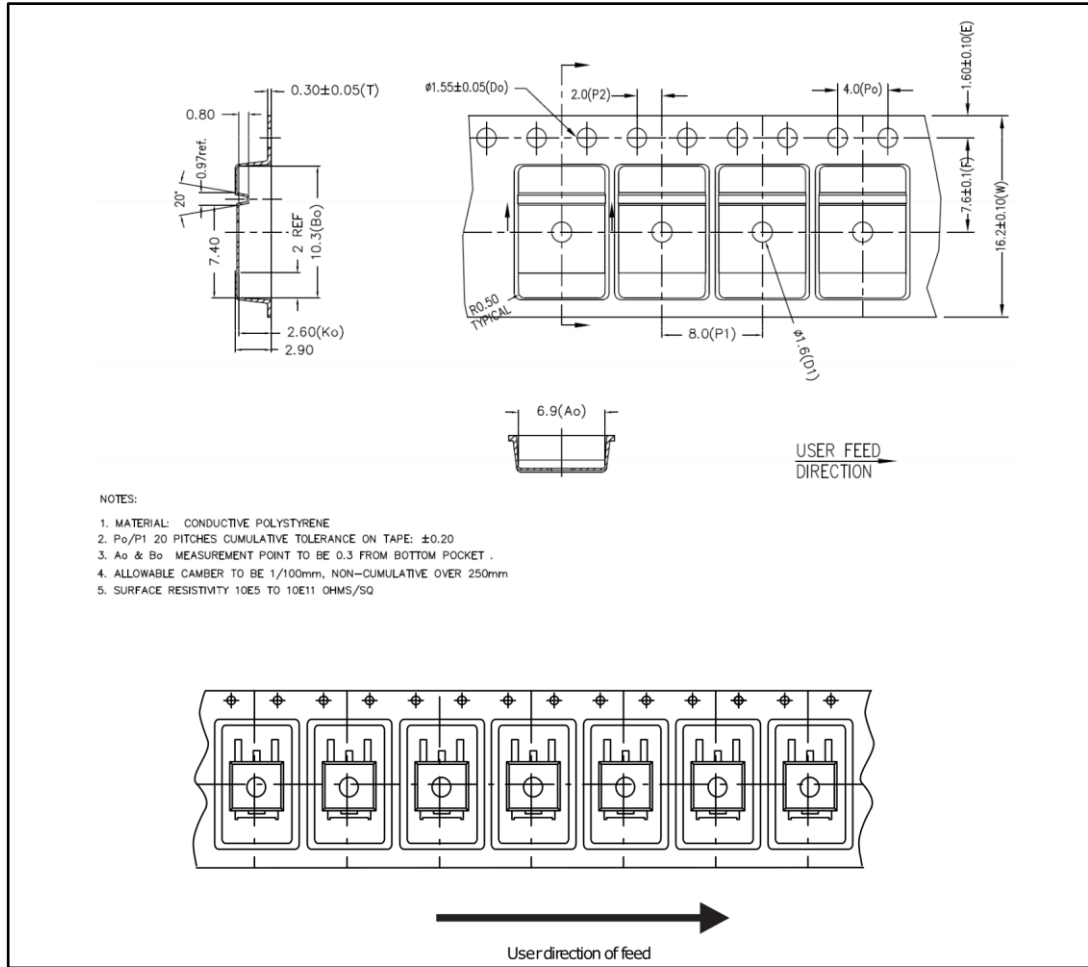
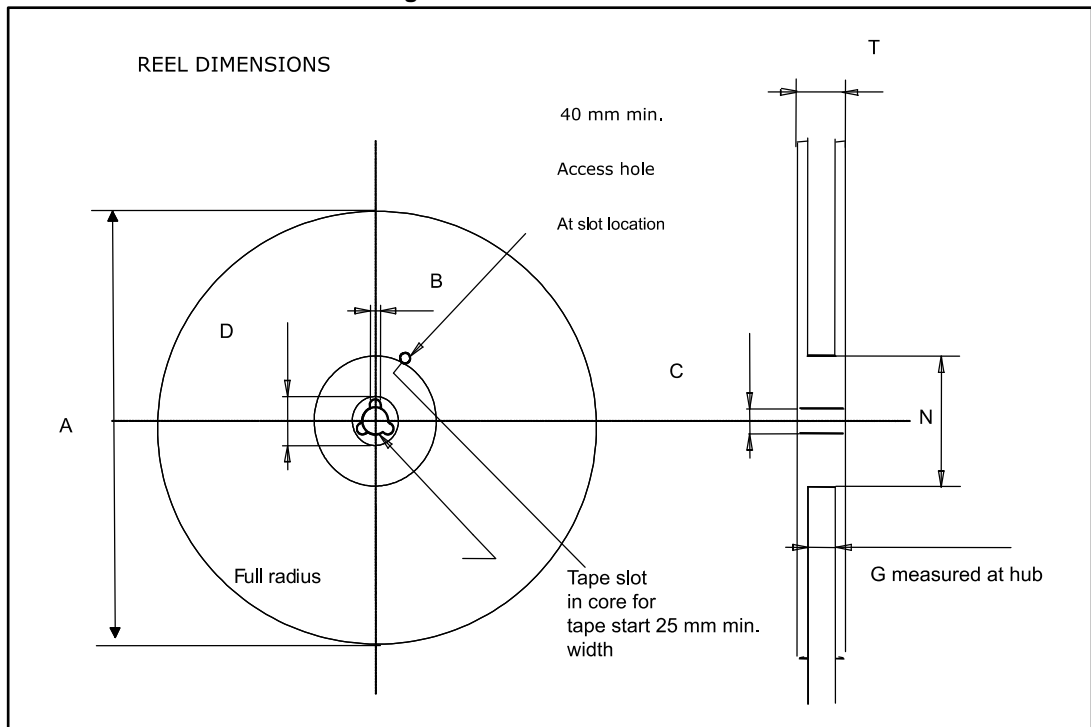


Figure 27: DPAK reel outline



### 7.3 SO-8 package information

Figure 28: SO-8 package outline

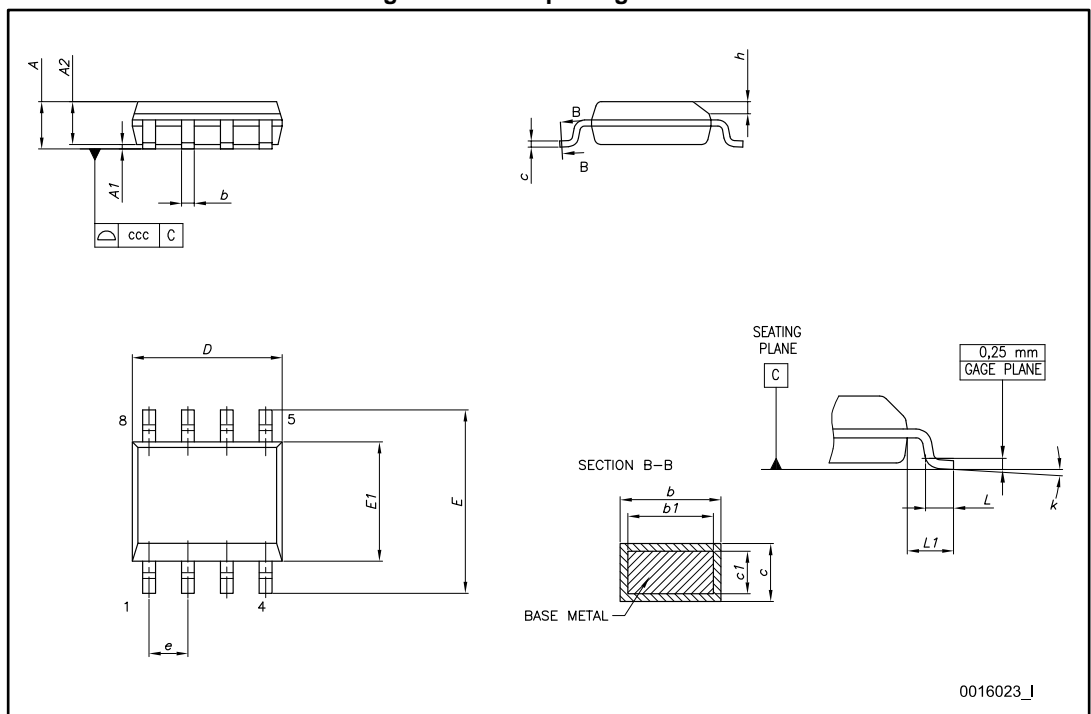
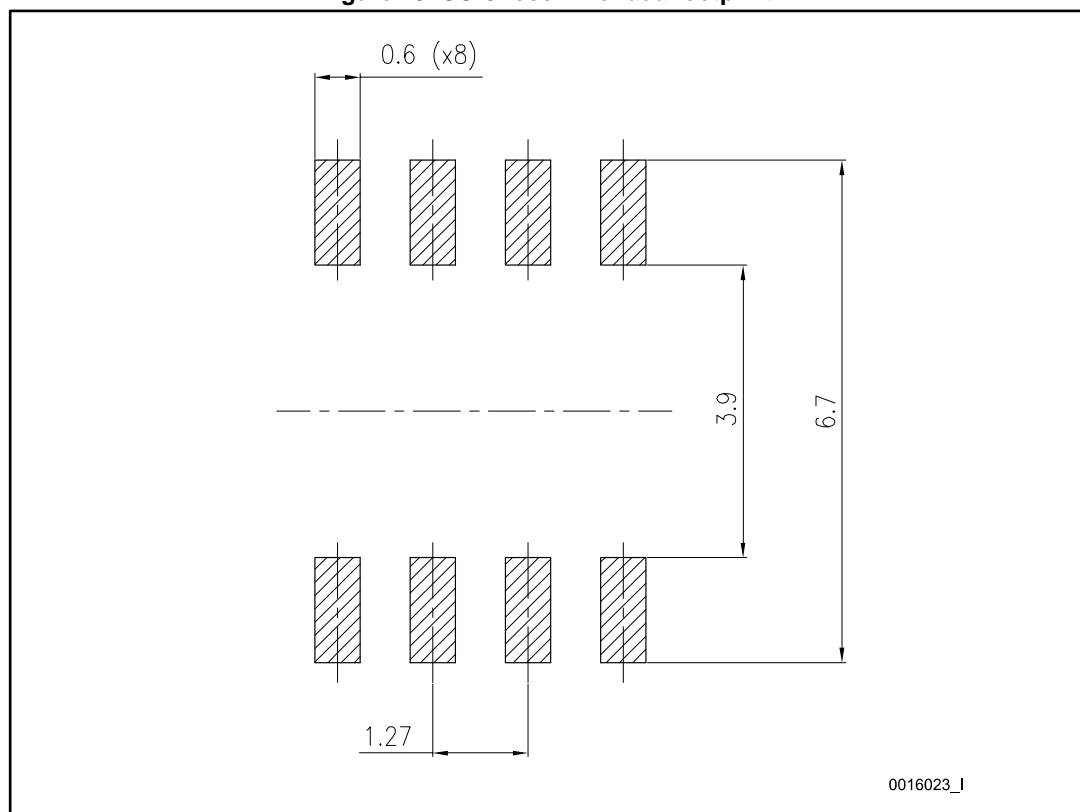


Table 7: SO-8 mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A			1.75
A1	0.10		0.25
A2	1.25		
b	0.28		0.48
c	0.17		0.23
D	4.80	4.90	5.00
E	5.80	6.00	6.20
E1	3.80	3.90	4.00
e		1.27	
h	0.25		0.50
L	0.40		1.27
L1		1.04	
k	0°		8°
ccc			0.10

Figure 29: SO-8 recommended footprint



### 7.4 SO-8 packing information

Figure 30: SO-8 tape and reel outline

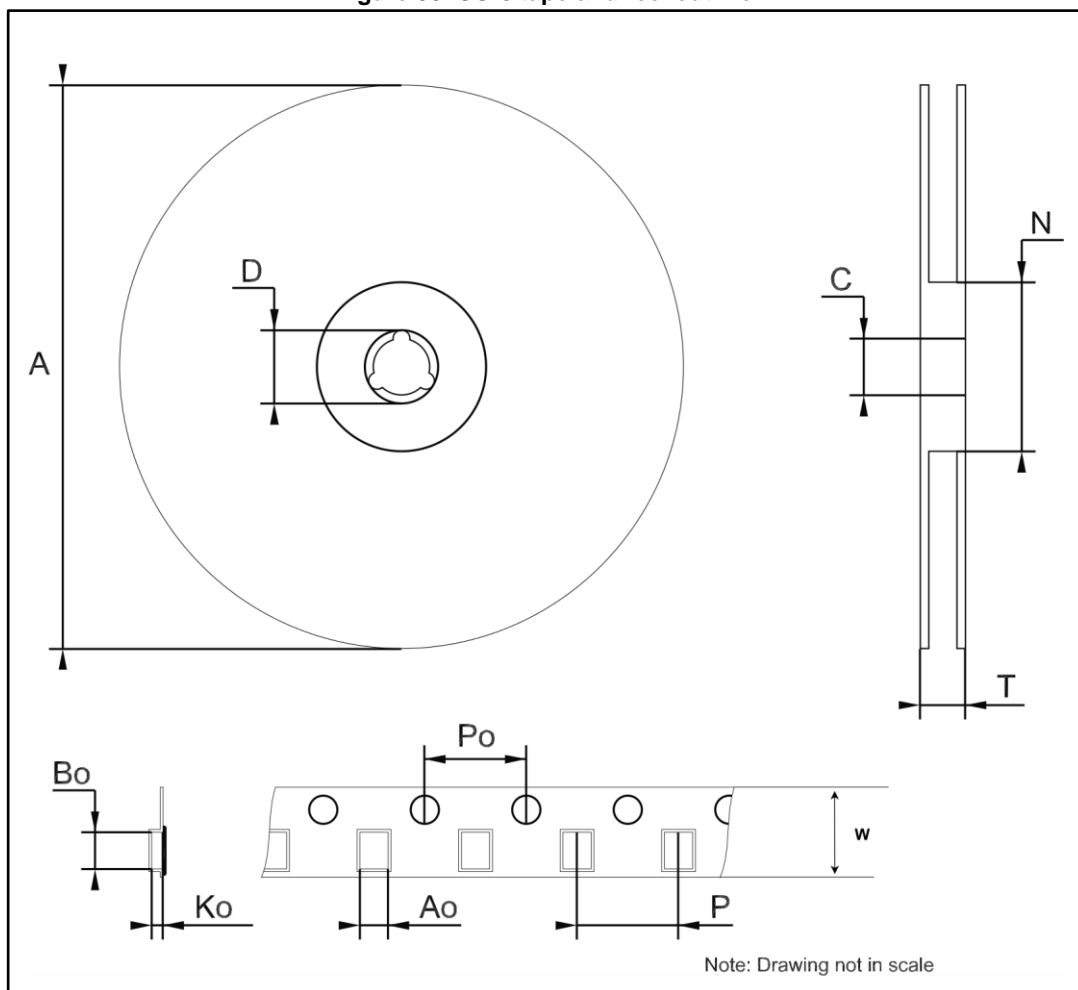
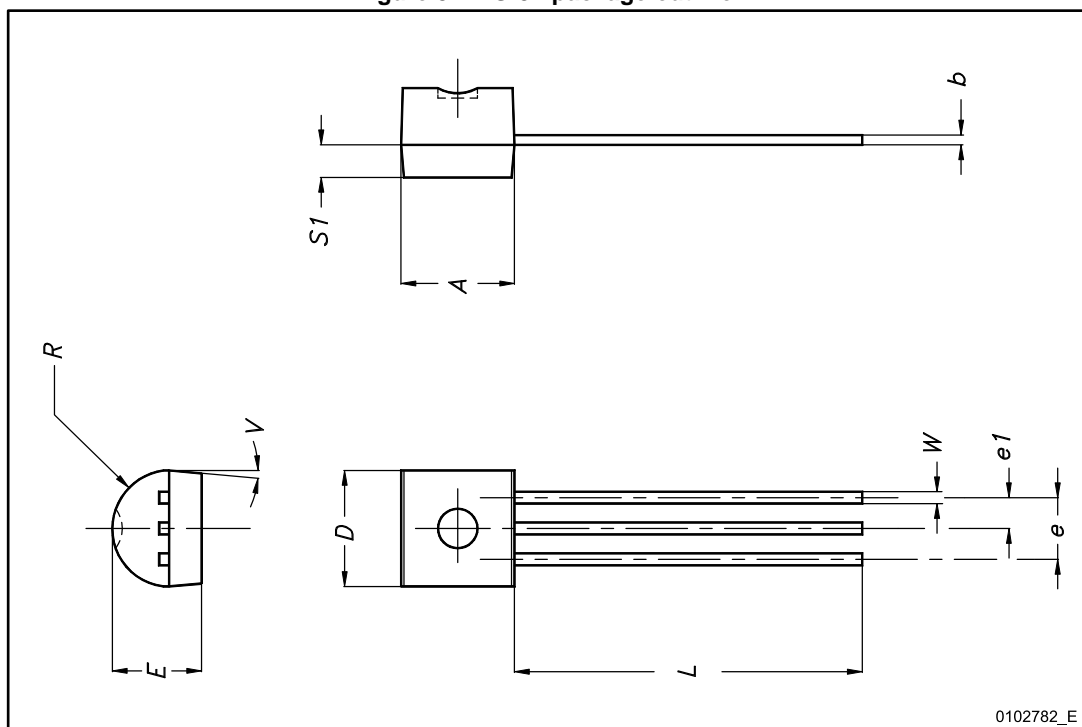


Table 8: SO-8 mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A			330
C	12.8		13.2
D	20.2		
N	50		
T			22.4
Ao	6.4	6.5	6.6
Bo	5.2		5.4
Ko	2.1		2.3
Po	3.9		4.1
P	7.9		8.1
W	11.7	12.0	12.3

## 7.5 TO-92 package information

Figure 31: TO-92 package outline



0102782\_E

Table 9: TO-92 mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	4.32		4.95
b	0.36		0.51
D	4.45		4.95
E	3.30		3.94
e	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°	

## 8 Ordering information

Table 10: Order code

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

**Notes:**

<sup>(1)</sup>Qualified and characterized according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 and Q002 or equivalent .

## 9 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	Added <i>Table 1</i> in cover page.
21-Aug-2007	15	Added root part number - (see <i>Table 1</i> ).
22-Nov-2007	16	Modified: <i>Table 1</i> .
11-Feb-2008	17	Modified: <i>Table 1 on page 1</i> .
10-Jul-2008	18	Removed package TO-220, modified <i>Table 1 on page 1</i> .
26-May-2010	19	Modified: $V_I$ values <i>Table 4 on page 6</i> , <i>Table 5 on page 7</i> and <i>Table 6 on page 8</i> .
02-Nov-2011	20	Modified: <i>Figure 4 on page 6</i> . Added: (*) <i>ADJ pin on the Adjustable version, Not Connected in the fixed output version. on page 4</i> and <i>Inhibit pin: regulator is enabled when <math>V_{INH} &lt; 1.2\text{ V}</math>, disabled when <math>V_{INH} &gt; 3.25\text{ V}</math> on page 6</i> .
09-Apr-2014	21	Part numbers LM2931XX, LM2931AXX33 and LM2931AXX50 changed to LM2931. Updated the description in cover page <i>Section 2: Pin configuration</i> and <i>Section 7: Package information</i> . Added <i>Section 8: Revision history</i> . Minor text changes.
16-Mar-2017	22	Updated features in cover page, removed <i>Table 1</i> . Device summary from cover page, <i>Table 3: "Electrical characteristics of LM2931A33/LM2931A33Y"</i> , <i>Table 4: "Electrical characteristics of LM2931A50/ LM2931A50Y"</i> and <i>Table 5: "Electrical characteristics of LM2931 (adjustable version)"</i> . Updated <i>Section 7: "Package information"</i> . Added <i>Section 8: "Ordering information"</i> . Minor text changes.

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