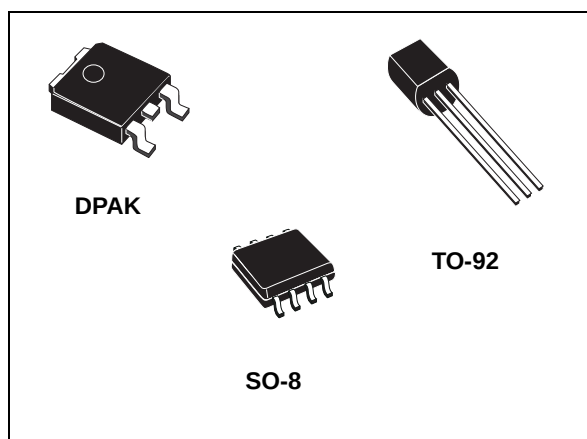


Very low drop voltage regulators with inhibit function

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

- 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)

Table 1. Device summary

Order codes			Output voltages
DPAK	TO-92 (bag)	SO-8	
		LM2931AD33R	3.3 V
LM2931ADT50R	LM2931AZ50R	LM2931AD50R	5.0 V
		LM2931D-R	2.5 to 26 V

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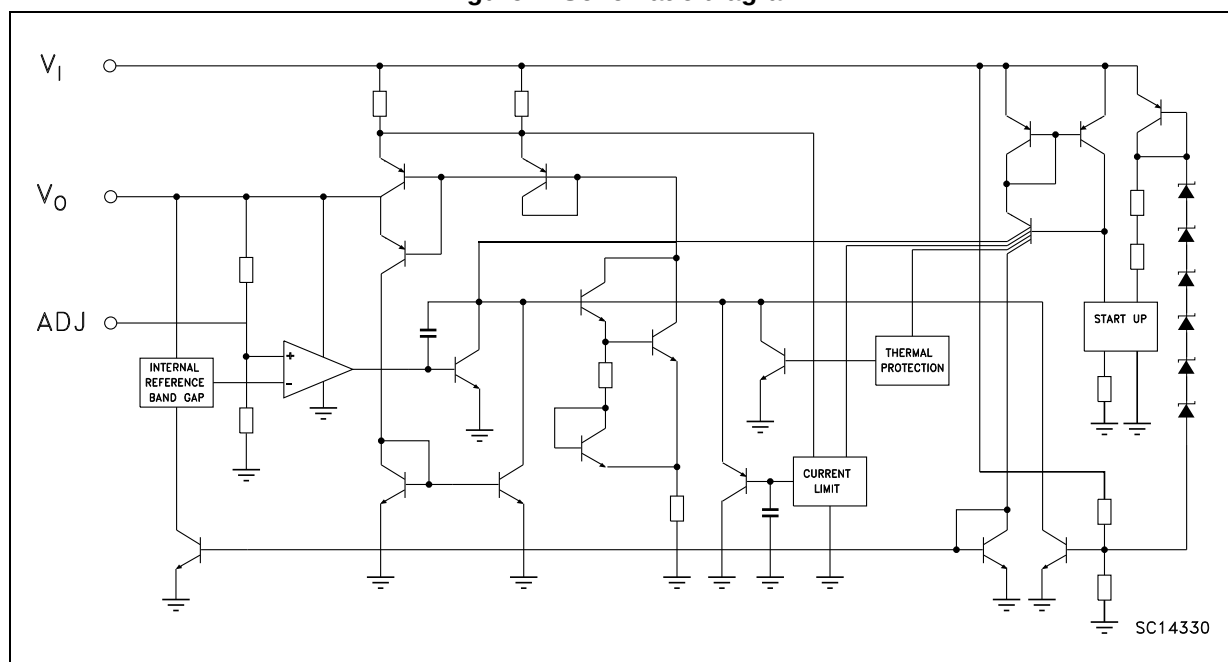
7 **Package mechanical data 14**

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9 **Revision history 23**

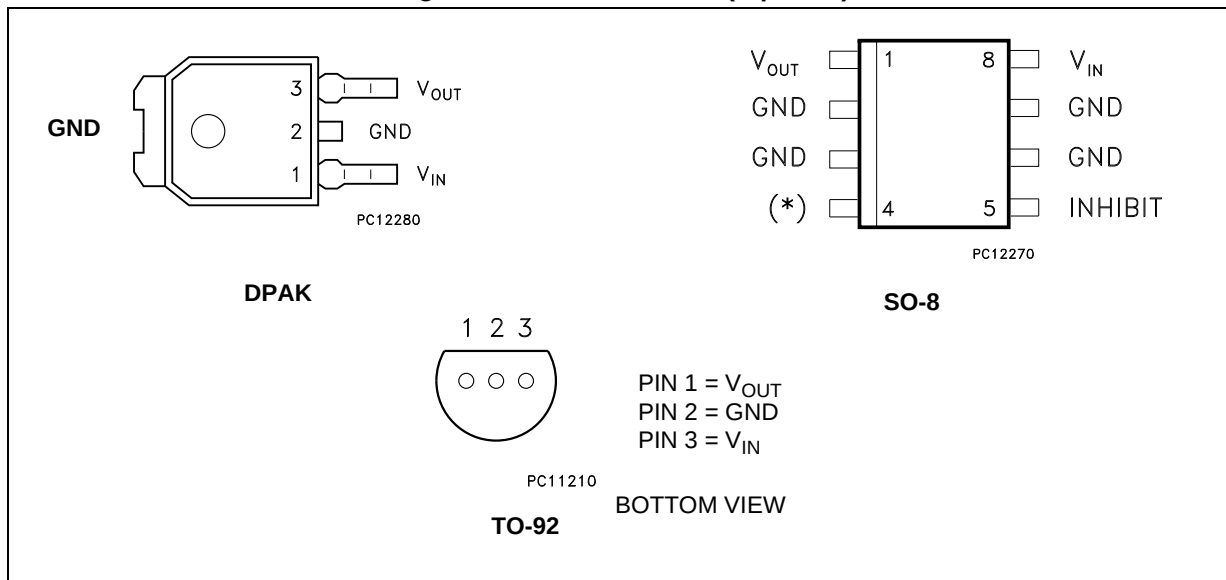


1 Diagram

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 2. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_I	DC positive input voltage	40	V
V_I	DC reverse input voltage	-15	V
V_I	Transient input voltage ($\tau < 100$ ms)	60	V
V_I	Transient reverse input voltage ($\tau < 100$ ms)	-50	V
V_{INH}	Inhibit input voltage	40	V
I_O	Output current	Internally limited	
T_{STG}	Storage temperature range	-65 to 150	°C
T_{OP}	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 3. Thermal data

Symbol	Parameter	SO-8	DPAK	TO-92	Unit
R_{thJC}	Thermal resistance junction-case	20	8		°C/W
R_{thJA}	Thermal resistance junction-ambient	55 ⁽¹⁾	100	200	°C/W

1. Considering 6 cm² of copper board heat-sink.

4 Application circuits

Figure 3. Application circuit for fixed output

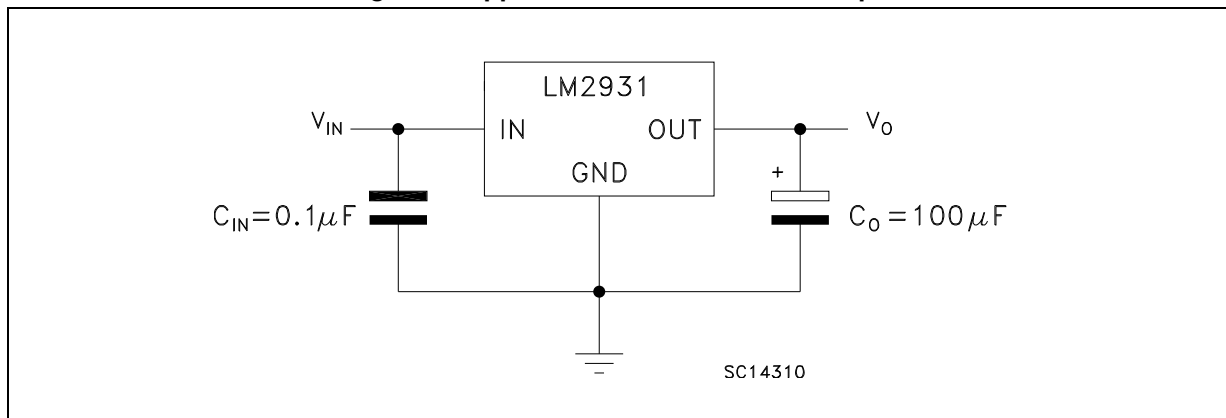
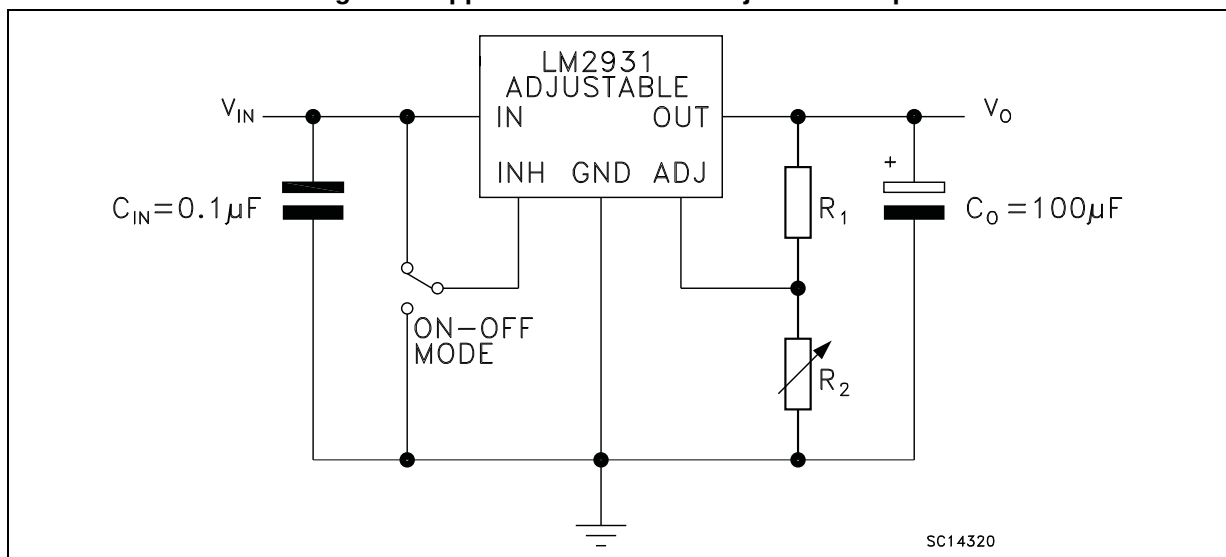


Figure 4. Application circuit for adjustable output



Note: R_1 suggested value = 27 k Ω

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

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](#), $T_J = 25^\circ\text{C}$, $C_I = 0.1\ \mu\text{F}$, $C_O = 100\ \mu\text{F}$, $V_I = 14\ \text{V}$, $I_O = 10\ \text{mA}$, $V_{INH} = 0\ \text{V}$, unless otherwise specified.

Table 4. Electrical characteristics of LM2931A33

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

1. Reference voltage is measured from V_{OUT} to ADJ pin.

2. 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](#), $T_J = 25^\circ\text{C}$, $C_I = 0.1\ \mu\text{F}$, $C_O = 100\ \mu\text{F}$, $V_I = 14\ \text{V}$, $I_O = 10\ \text{mA}$, $V_{INH} = 0\ \text{V}$, unless otherwise specified.

Table 5. Electrical characteristics of LM2931A50

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

1. Reference voltage is measured from V_{OUT} to ADJ pin.

2. 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](#) 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 6. Electrical characteristics of LM2931

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_I	Maximum operating input voltage	$I_O = 10\text{ mA}$, $T_J = -40\text{ to }125^\circ\text{C}$	26			V
V_{REF}	Reference voltage ⁽¹⁾		1.14	1.2	1.26	V
V_{REF}	Reference voltage ⁽¹⁾	$I_O = 100\text{ mA}$, $T_J = -40\text{ to }125^\circ\text{C}$	1.08	1.2	1.32	V
ΔV_O	Line regulation	$V_I = 3.6\text{ to }26\text{ V}$		0.6	4.5	mV
ΔV_O	Load regulation	$I_O = 5\text{ to }100\text{ mA}$		9	30	mV
V_d	Dropout voltage ^{(1) (2)}	$I_O = 10\text{ mA}$		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	$I_O = 100\text{ mA}$, $V_I = 14 \pm 2\text{ V}$ $f = 120\text{ Hz}$, $T_J = -40\text{ to }125^\circ\text{C}$	55	80		dB
V_{IL}	Control input voltage low	$T_J = -40\text{ to }125^\circ\text{C}$		2	1.2	V
V_{IH}	Control input voltage high	$T_J = -40\text{ to }125^\circ\text{C}$	3.25	2		V
I_{INH}	Inhibit input current	$V_{INH} = 2.5\text{ V}$		22	50	μA
V_I	Transient input voltage	$R_{LOAD} = 300\text{ }\Omega$, $\tau < 100\text{ ms}$	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	$R_{LOAD} = 300\text{ }\Omega$, $\tau < 100\text{ ms}$	-50			V
eN	Output noise voltage	$B = 10\text{ Hz to }100\text{ kHz}$		330		μV_{RMS}

1. Reference voltage is measured from V_{OUT} to ADJ pin.

2. 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 5. Output voltage vs. temperature

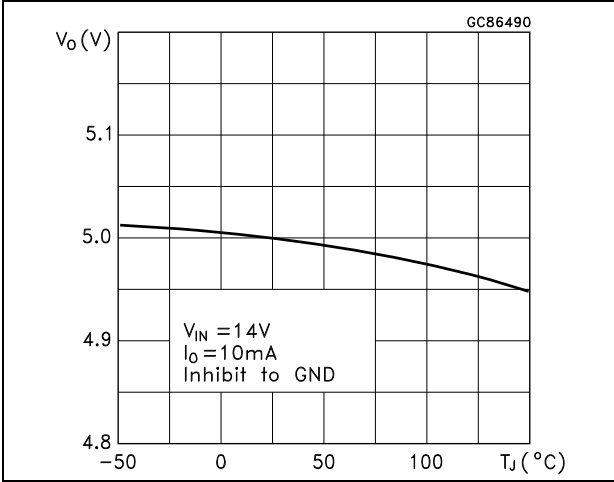


Figure 6. Output voltage vs. temperature

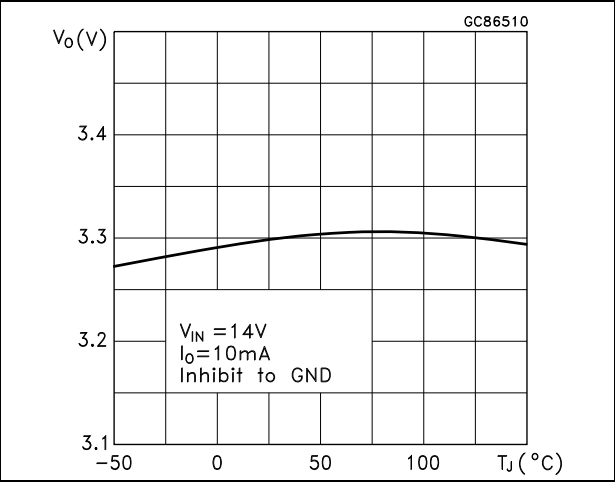


Figure 7. Reference voltage vs. temperature

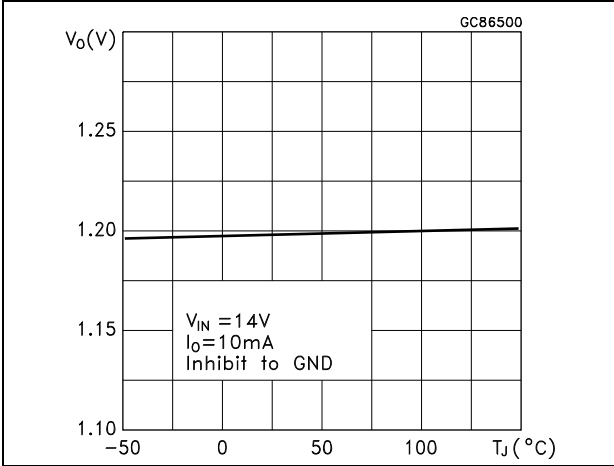


Figure 8. Line regulation vs. temperature

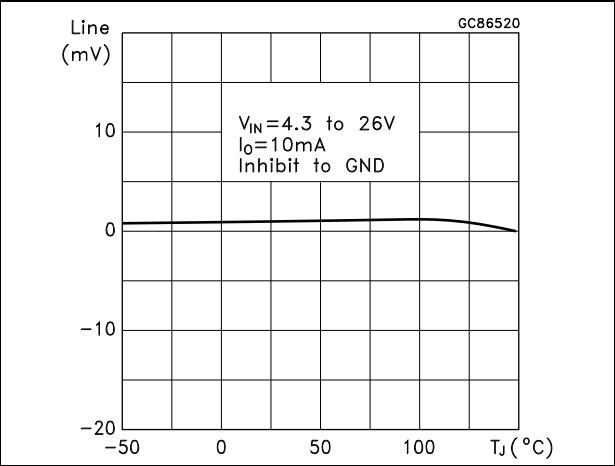


Figure 9. Load regulation vs. temperature

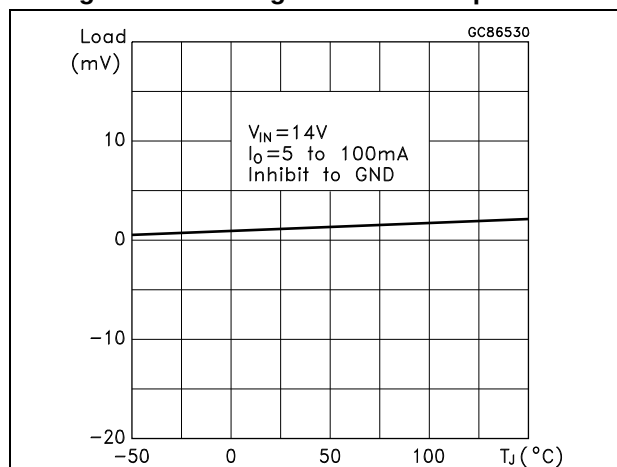


Figure 10. Dropout voltage vs. temperature

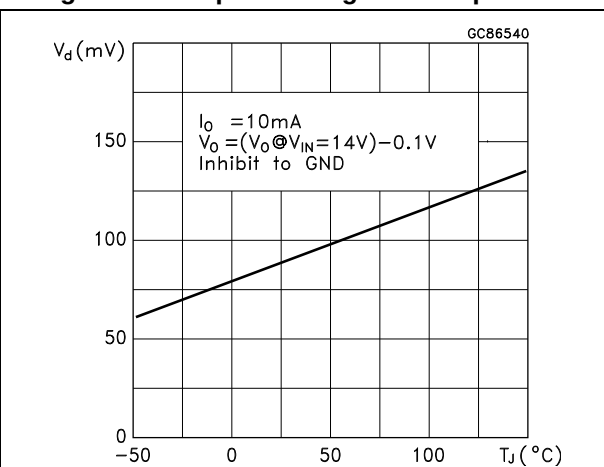


Figure 11. Dropout voltage vs. temperature

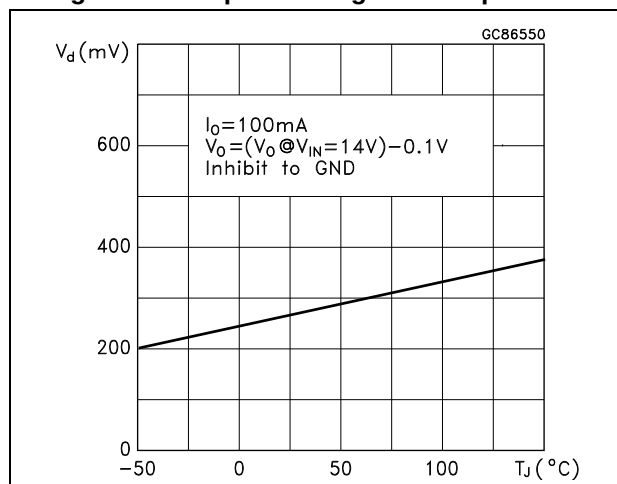


Figure 12. Dropout voltage vs. output current

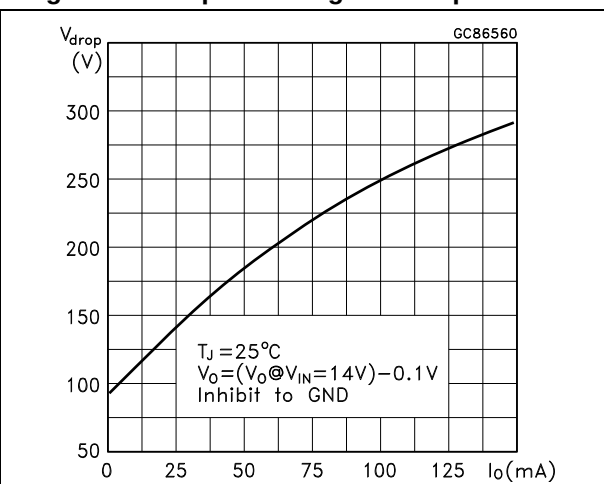


Figure 13. Output voltage vs. input voltage

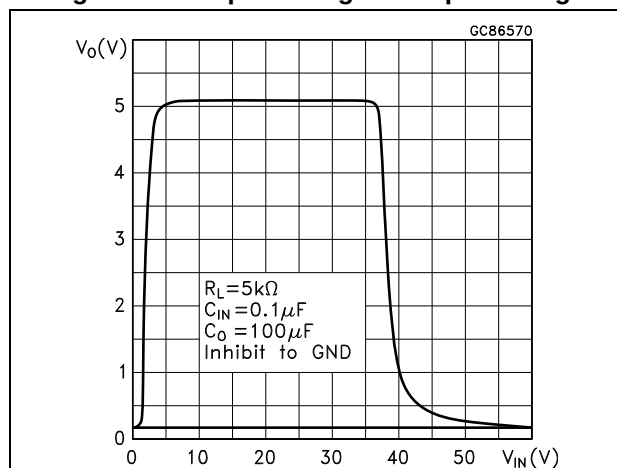


Figure 14. Short circuit current vs. drop voltage

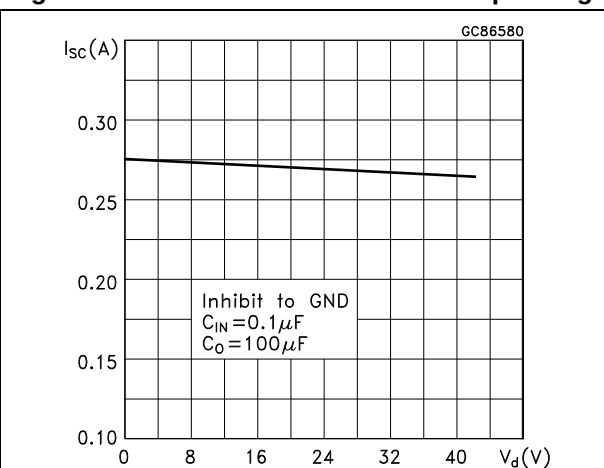


Figure 15. Quiescent current vs. temperature

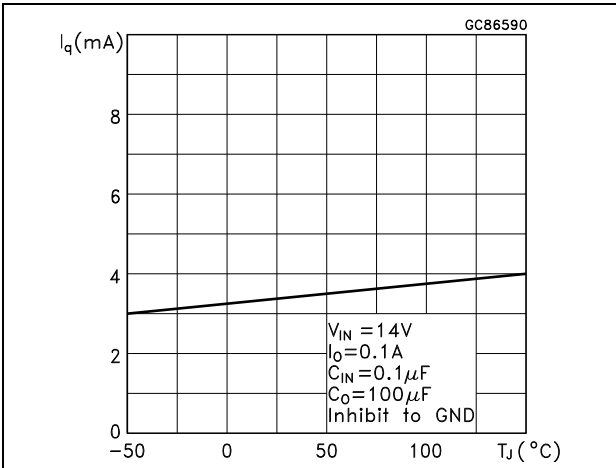


Figure 16. Quiescent current vs. input voltage

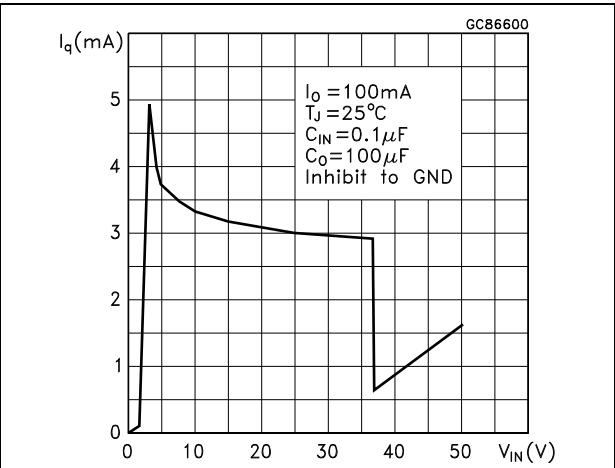


Figure 17. Quiescent current vs. output current

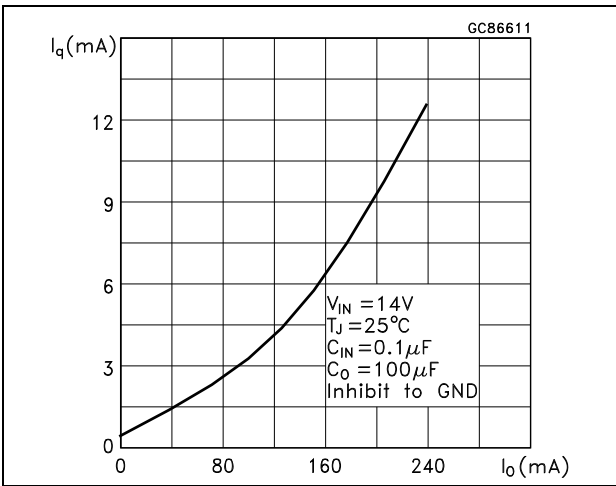


Figure 18. Supply voltage rejection vs. temperature

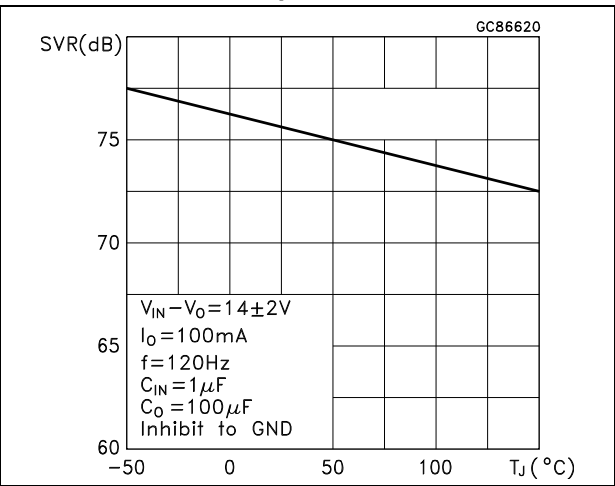


Figure 19. Supply voltage rejection vs. frequency

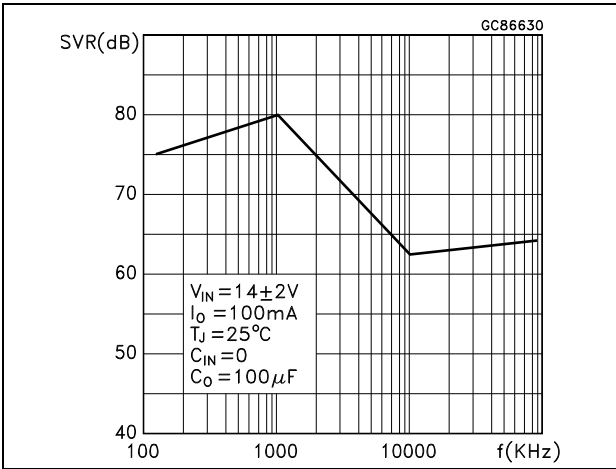


Figure 20. Supply voltage rejection vs. output current

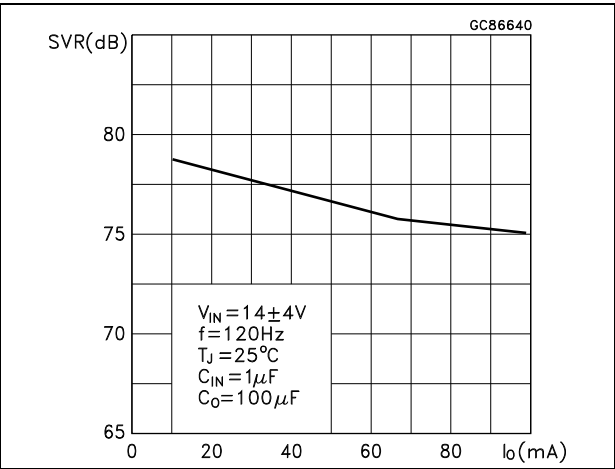


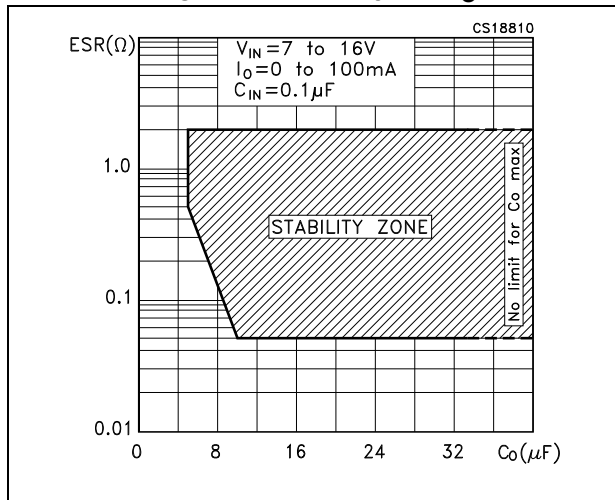
Figure 21. Stability vs. C_O 

Figure 22. Line transient

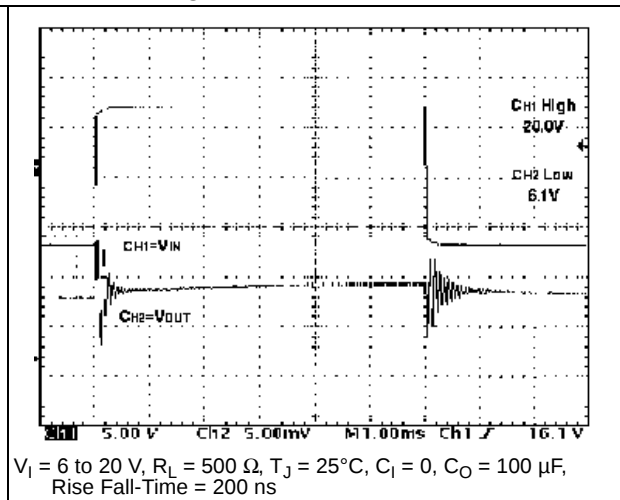
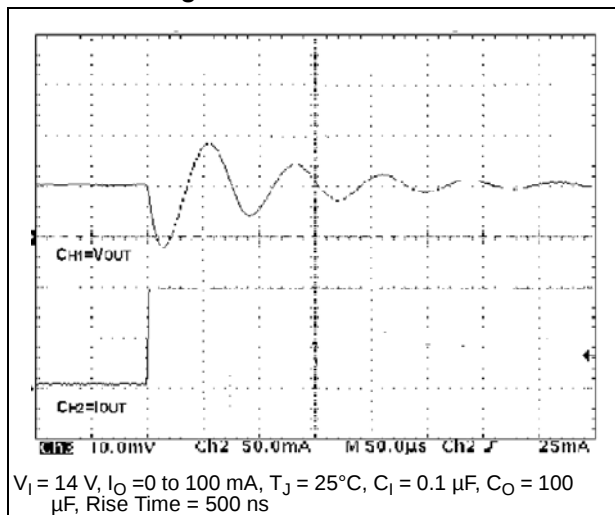


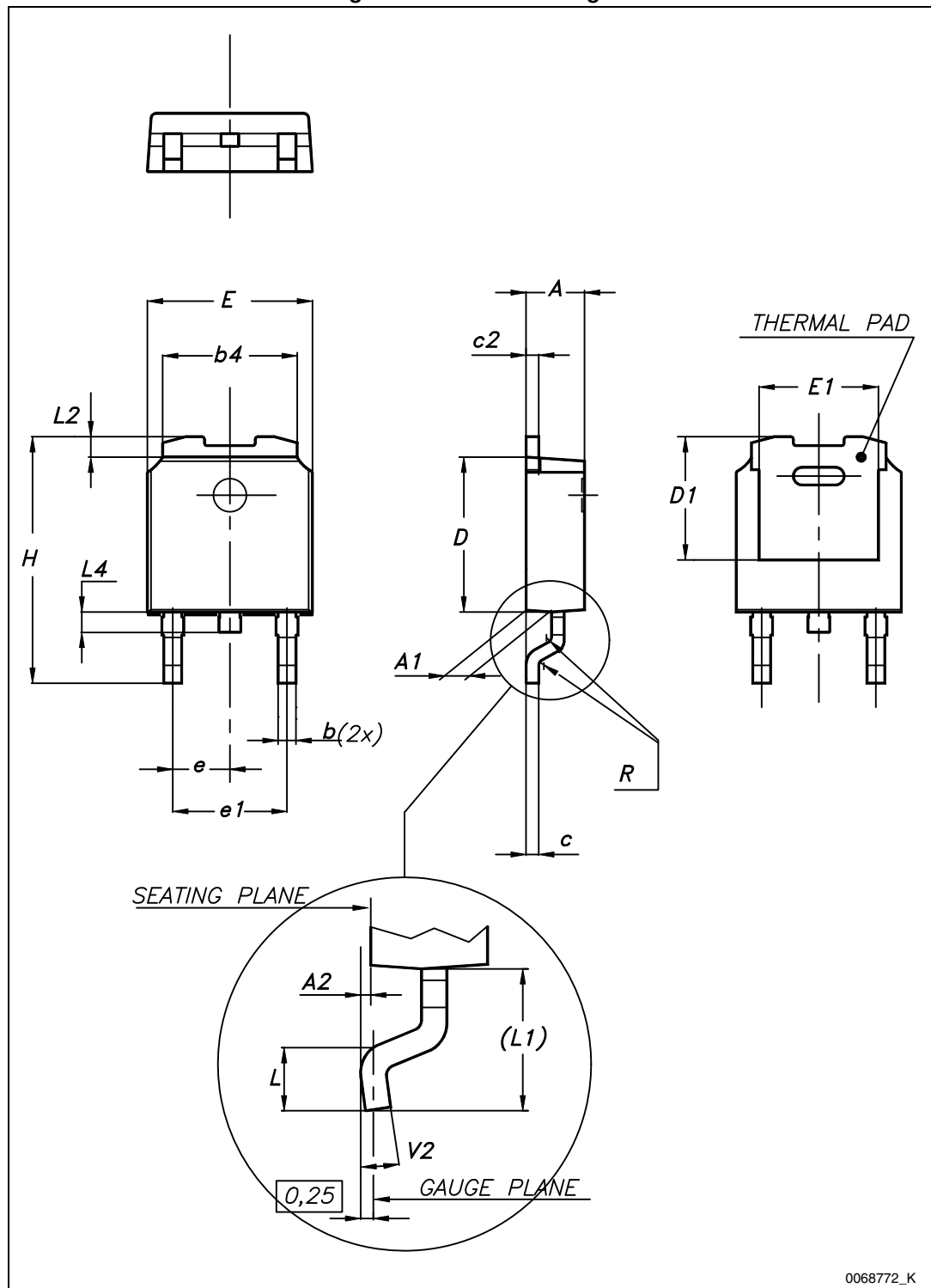
Figure 23. Load transient



7 Package mechanical data

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.

Figure 24. DPAK drawings

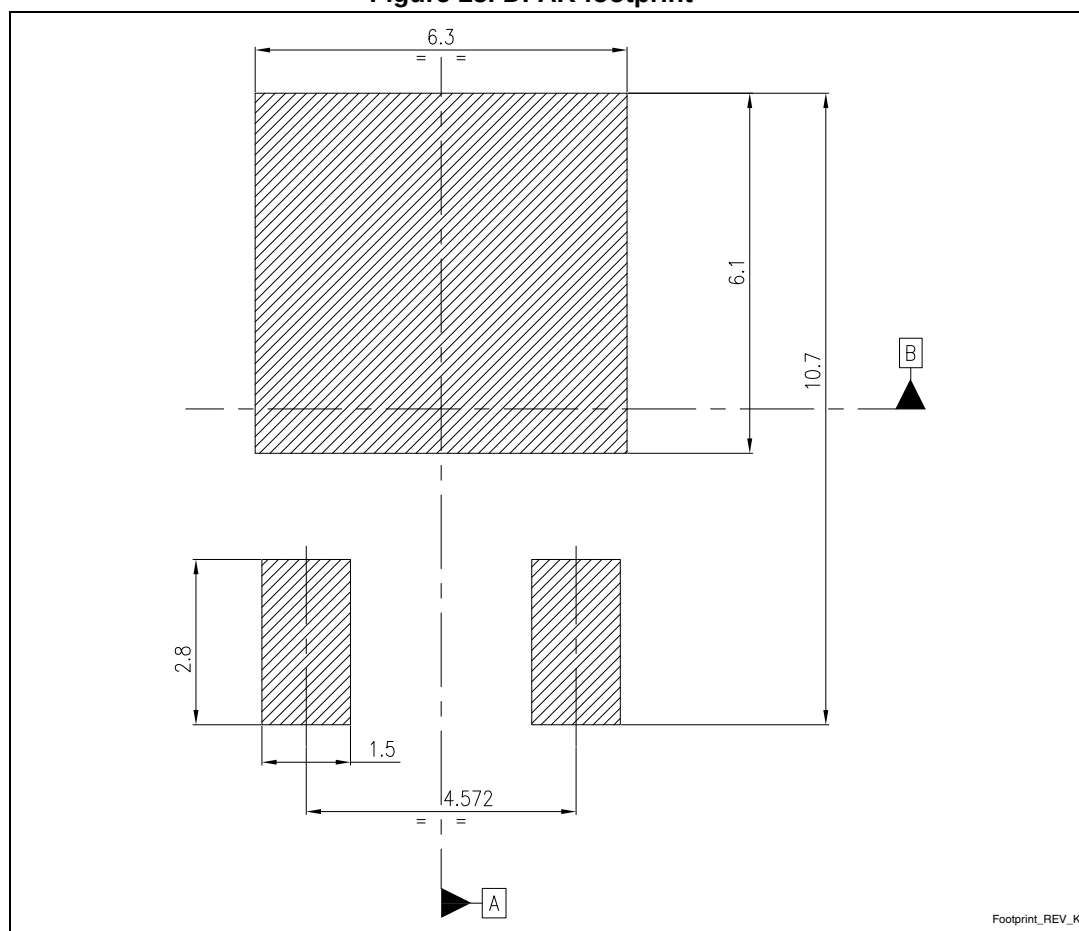


0068772_K

Table 7. DPAK mechanical data

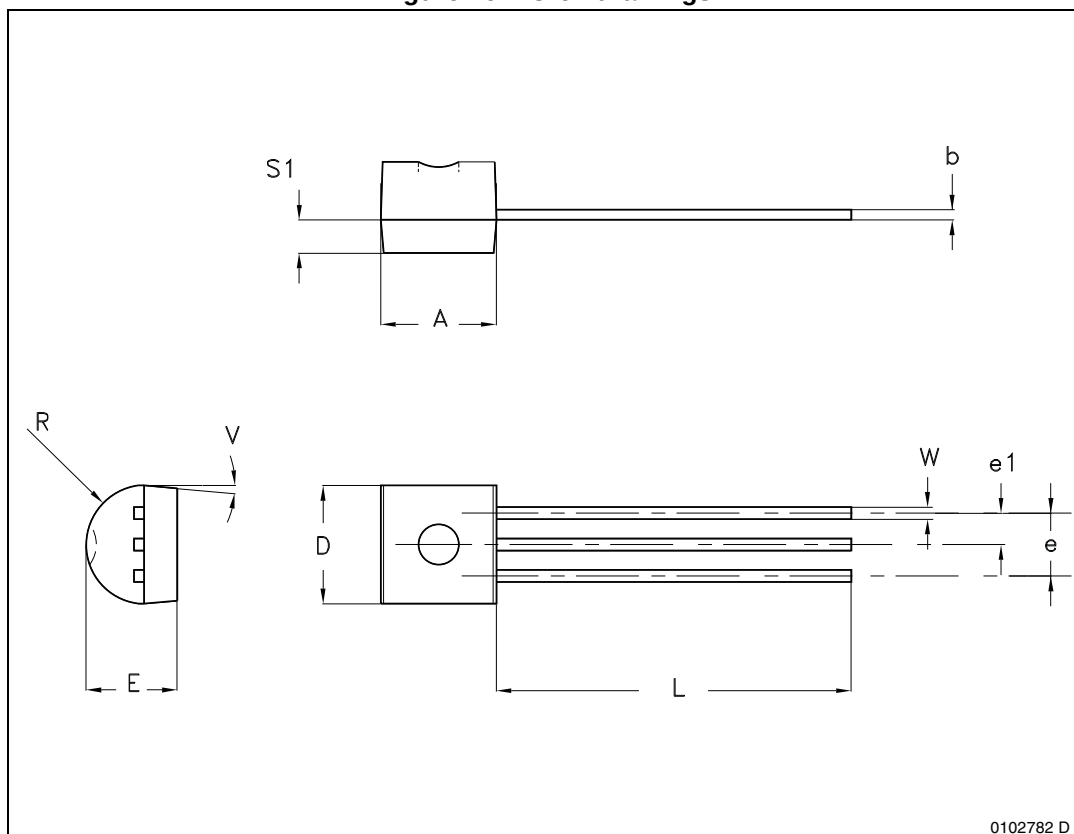
Dim.	mm		
	Min.	Typ.	Max.
A	2.20		2.40
A1	0.90		1.10
A2	0.03		0.23
b	0.64		0.90
b4	5.20		5.40
c	0.45		0.60
c2	0.48		0.60
D	6.00		6.20
D1		5.10	
E	6.40		6.60
E1		4.70	
e		2.28	
e1	4.40		4.60
H	9.35		10.10
L	1.00		1.50
(L1)		2.80	
L2		0.80	
L4	0.60		1.00
R		0.20	
V2	0°		8°

Figure 25. DPAK footprint (a)



a. All dimensions are in millimeters.

Figure 26. TO-92 drawings



0102782 D

Table 8. 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°	

Figure 27. SO-8 drawings

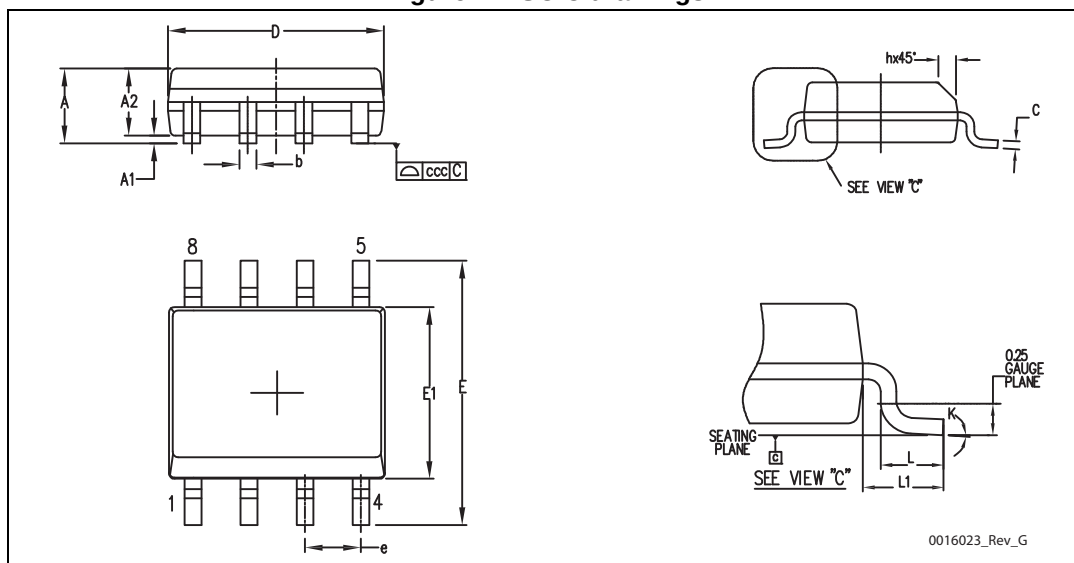


Table 9. SO-8 mechanical data

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

8 Packaging mechanical data

Figure 28. Tape for DPAK

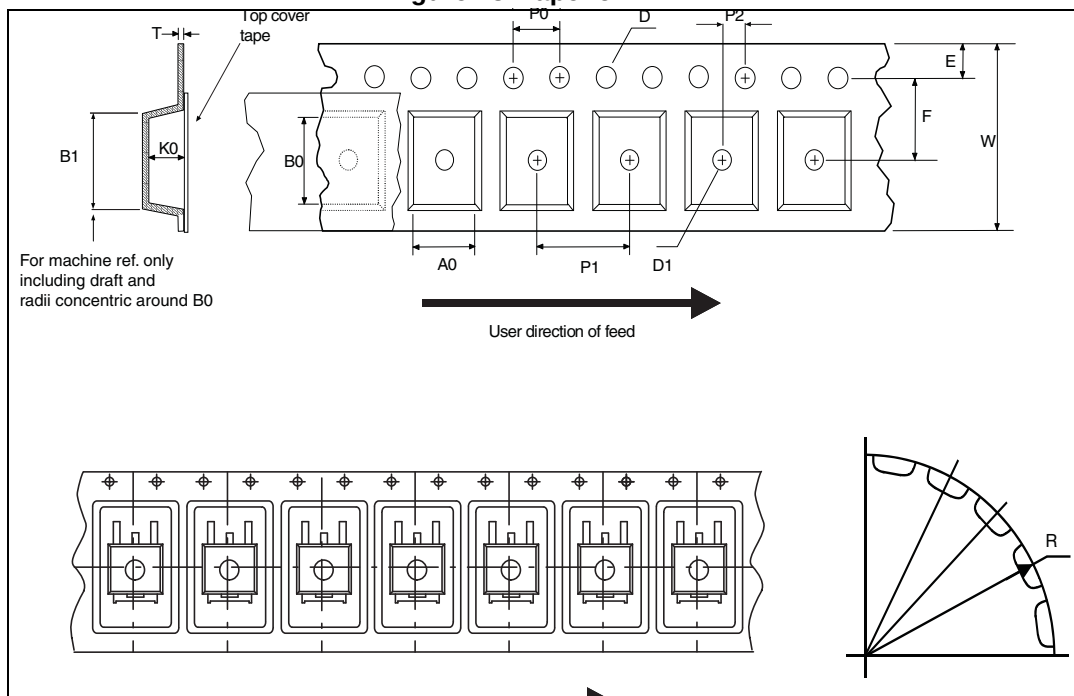


Figure 29. Reel for DPAK

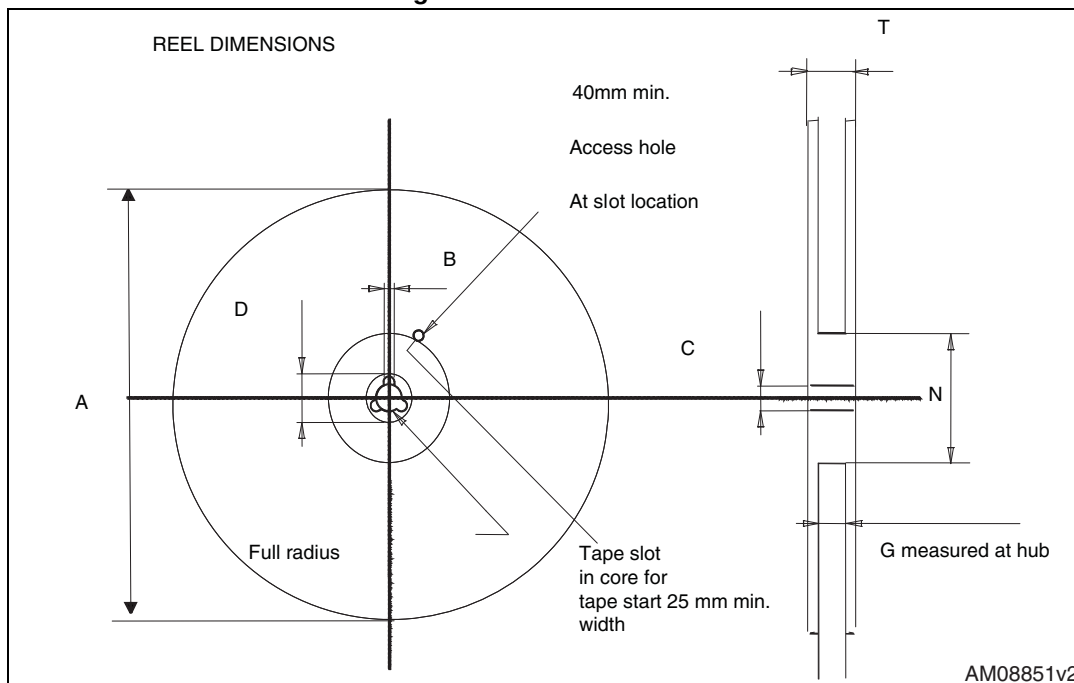


Table 10. DPAK tape and reel mechanical data

Tape			Reel		
Dim.	mm		Dim.	mm	
	Min.	Max.		Min.	Max.
A0	6.8	7	A		330
B0	10.4	10.6	B	1.5	
B1		12.1	C	12.8	13.2
D	1.5	1.6	D	20.2	
D1	1.5		G	16.4	18.4
E	1.65	1.85	N	50	
F	7.4	7.6	T		22.4
K0	2.55	2.75			
P0	3.9	4.1	Base qty.		2500
P1	7.9	8.1	Bulk qty.		2500
P2	1.9	2.1			
R	40				
T	0.25	0.35			
W	15.7	16.3			

Figure 30. SO-8 tape and reel dimensions

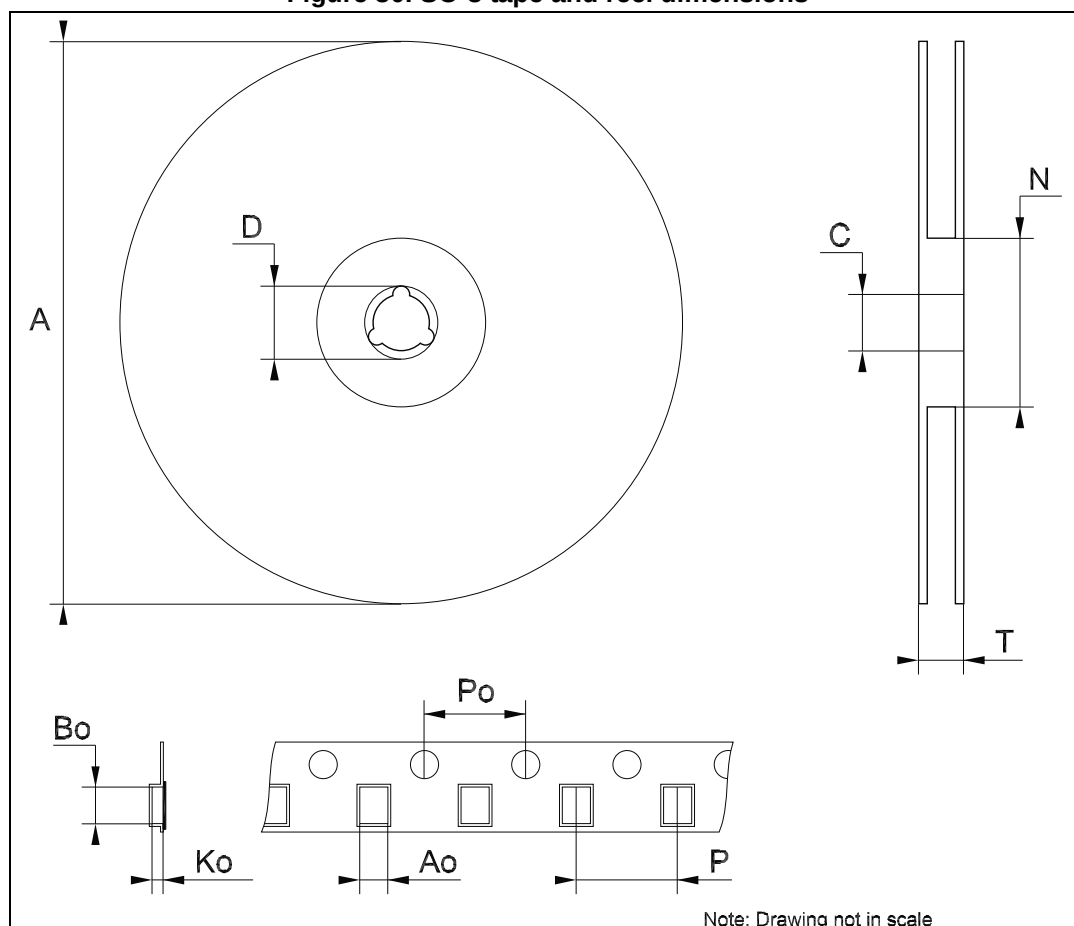


Table 11. SO-8 tape and reel mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A			330
C	12.8		13.2
D	20.2		
N	60		
T			22.4
Ao	8.1		8.5
Bo	5.5		5.9
Ko	2.1		2.3
Po	3.9		4.1
P	7.9		8.1

9 Revision history

Table 12. Document revision history

Date	Revision	Changes
21-Jun-2004	12	Document updated.
16-Jun-2006	13	Order codes updated.
27-Jul-2007	14	Added Table 1 in cover page.
21-Aug-2007	15	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_I values Table 4 on page 7 , Table 5 on page 8 and Table 6 on page 9 .
02-Nov-2011	20	Modified: Figure 4 on page 6 . Added: (*) <i>ADJ pin on the Adjustable version, Not Connected in the fixed output version. on page 4 and Inhibit pin: regulator is enabled when $V_{INH} < 1.2\text{ V}$, disabled when $V_{INH} > 3.25\text{ V}$ on page 6.</i>
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 mechanical data . Added Section 8: Packaging mechanical data . Minor text changes.

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