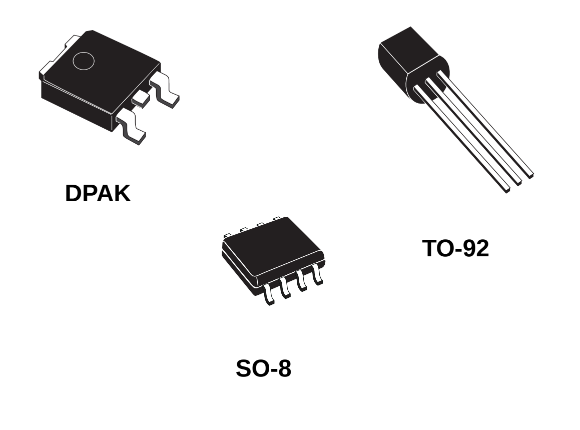
LM2931

life.augmented

Very low drop voltage regulators with inhibit function

Datasheet - production data



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)

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.

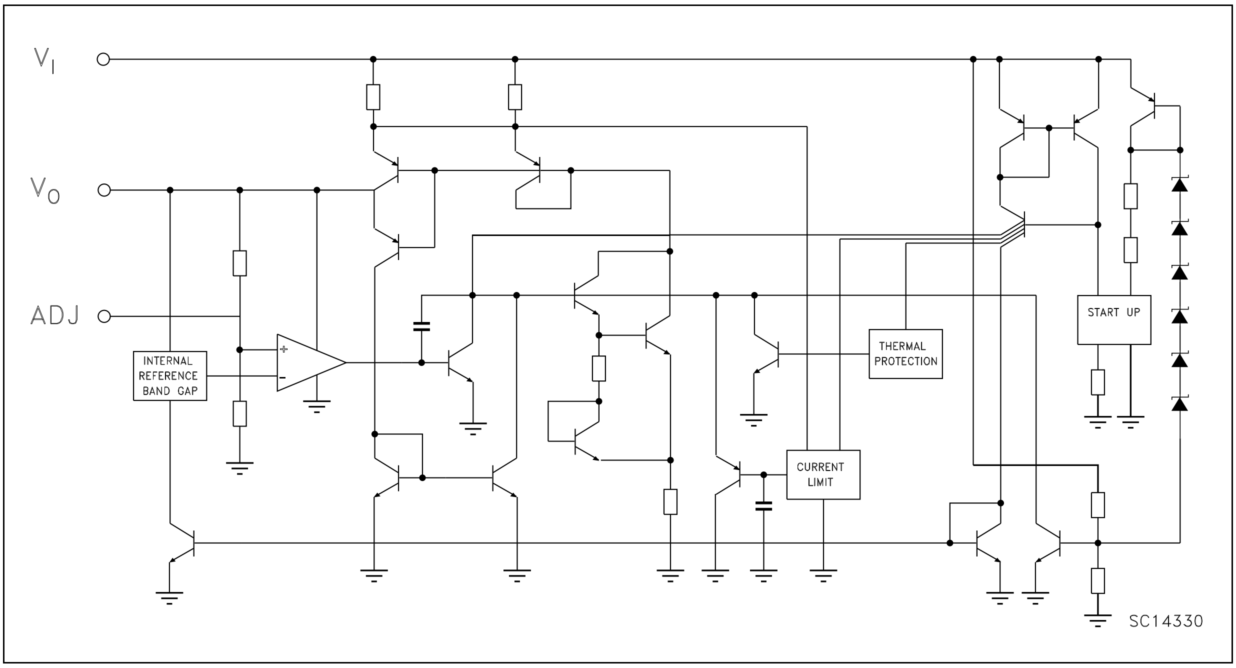
Table 1. Device summary

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

Contents

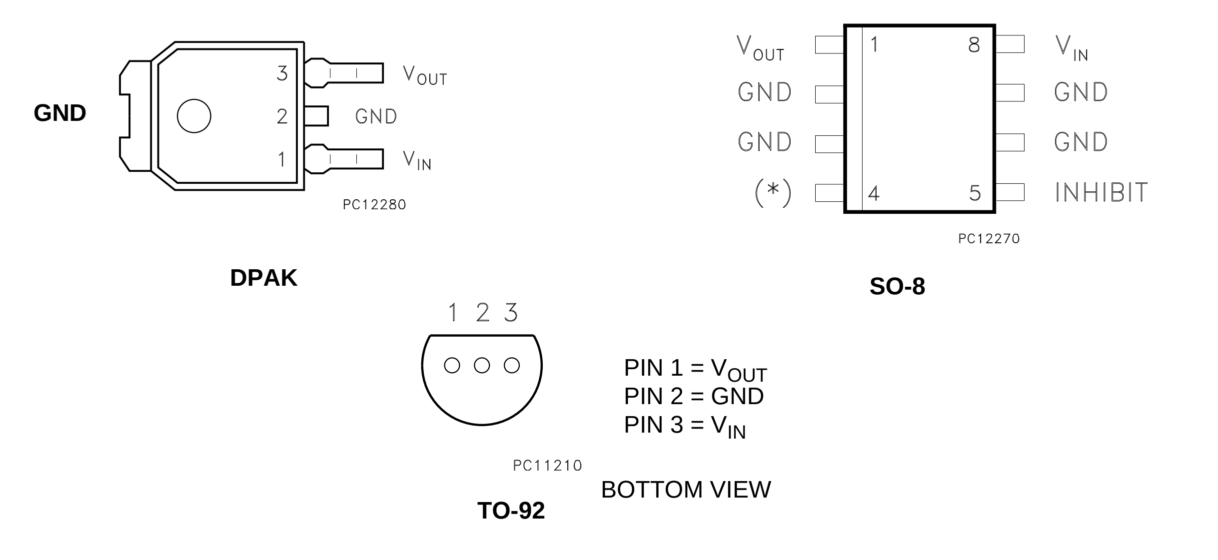
1 Diagram

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 (τ < 100 ms)	60	V
V_I	Transient reverse input voltage (τ < 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

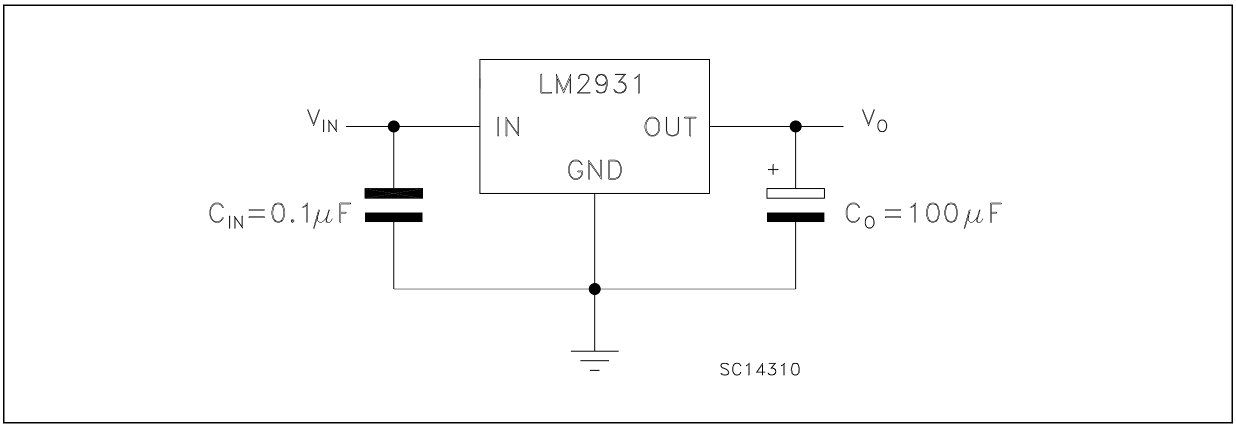
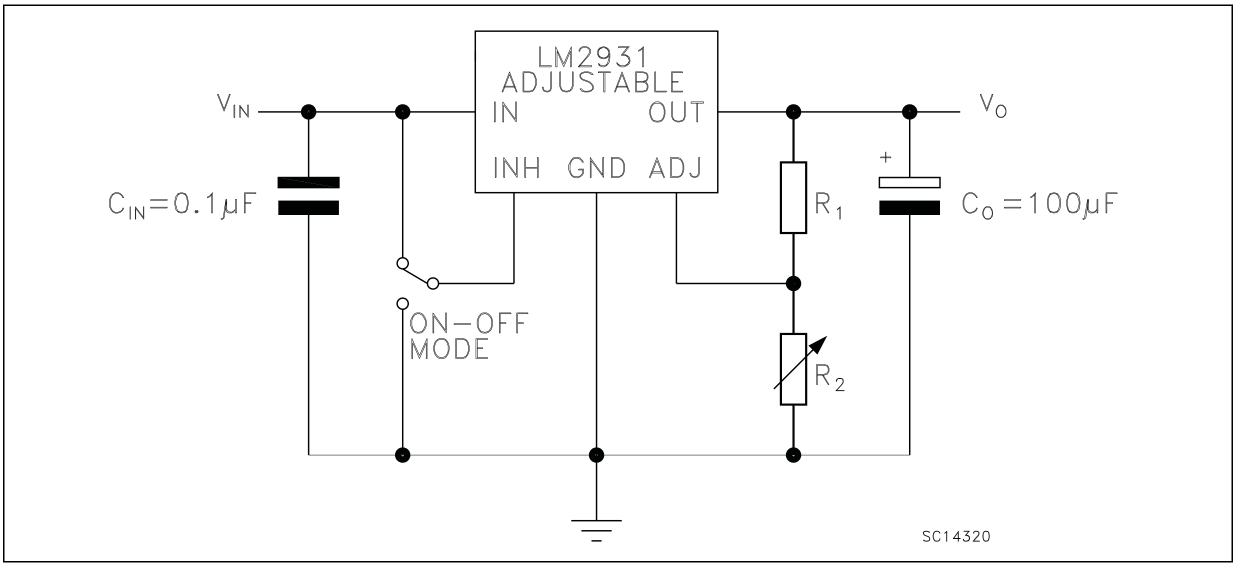


Figure 4. Application circuit for adjustable output



Note: *R_1 suggested value = 27 kΩ*

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

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 °C, C_I = 0.1 µF, C_O = 100 µF, V_I = 14 V, I_O = 10 mA, V_{INH} = 0 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 mA, T_J = -40 to 125°C	26			V
V_O	Output voltage		3.135	3.3	3.425	V
V_O	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
ΔV_O	Line regulation	V_I = 9 to 16 V		2	10	mV
		V_I = 6 to 26 V		4	33	
ΔV_O	Load regulation	I_O = 5 to 100 mA		10	33	mV
V_d	Dropout voltage (1) (2)	I_O = 10 mA		90	250	mV
		I_O = 100 mA		250	600	
I_d	Quiescent current ON MODE	I_O = 100 mA		2.5	30	mA
	OFF MODE	V_{INH} = 2.5 V, R_{LOAD} = 330 Ω		0.3	1	mA
I_{SC}	Short circuit current		100	300		mA
SVR	Supply voltage rejection	I_O = 100 mA, V_I = 14 ± 2 V f = 120 Hz, T_J = -40 to 125°C	55	78		dB
V_{IL}	Control input voltage low	T_J = -40 to 125°C		2	1.2	V
V_{IH}	Control input voltage high	T_J = -40 to 125°C	3.25	2		V
I_{INH}	Inhibit input current	V_{INH} = 2.5 V		22	50	µA
V_I	Transient input voltage	R_{LOAD} = 330 Ω, τ < 100ms	60	70		V
V_I	Reverse polarity input voltage	V_O = ± 0.3 V, R_{LOAD} = 330 Ω	-15	-50		V
V_I	Reverse polarity input voltage transient	R_{LOAD} = 330 Ω, τ < 100ms	-50			V
eN	Output noise voltage	B =10 Hz to 100 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 °C, C_I = 0.1 µF, C_O = 100 µF, V_I = 14 V, I_O = 10 mA, V_{INH} = 0 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 mA, T_J = -40 to 125°C	26			V
V_O	Output voltage		4.81	5	5.19	V
V_O	Output voltage	I_O = 100 mA, V_I = 6 to 26 V T_J = -40 to 125°C	4.75	5	5.25	V
ΔV_O	Line regulation	V_I = 9 to 16 V		2	10	mV
		V_I = 6 to 26 V		4	30	
ΔV_O	Load regulation	I_O = 5 to 100 mA		15	50	mV
V_d	Dropout voltage (1) (2)	I_O = 10 mA		90	200	mV
		I_O = 100 mA		250	600	
I_d	Quiescent current ON MODE	I_O = 100 mA		2.5	30	mA
	OFF MODE	V_{INH} = 2.5 V, R_{LOAD} = 500 Ω		0.3	1	mA
I_{SC}	Short circuit current		100	300		mA
SVR	Supply voltage rejection	I_O = 100 mA, V_I = 14 ± 2 V f = 120 Hz, T_J = -40 to 125°C	55	75		dB
V_{IL}	Control input voltage low	T_J = -40 to 125°C		2	1.2	V
V_{IH}	Control input voltage high	T_J = -40 to 125°C	3.25	2		V
I_{INH}	Inhibit input current	V_{INH} = 2.5 V		22	50	µA
V_I	Transient input voltage	R_{LOAD} = 500 Ω, τ < 100ms	60	70		V
V_I	Reverse polarity input voltage	V_O = ± 0.3 V, R_{LOAD} = 500 Ω	-15	-50		V
V_I	Reverse polarity input voltage transient	R_{LOAD} = 500 Ω, τ < 100ms	-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 KΩ and R_2 = 40.5 kΩ, T_J = 25 °C, C_I = 0.1 µF, C_O = 100 µF, V_I = 14 V, I_O = 10 mA, V_{INH} = 0 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 mA, T_J = -40 to 125°C	26			V
V_{REF}	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
ΔV_O	Line regulation	V_I = 3.6 to 26 V		0.6	4.5	mV
ΔV_O	Load regulation	I_O = 5 to 100 mA		9	30	mV
V_d	Dropout voltage (1) (2)	I_O = 10 mA		90	200	mV
		I_O = 100 mA		250	600	
I_d	Quiescent current ON MODE	I_O = 100 mA		2.5	30	mA
	OFF MODE	V_{INH} = 2.5 V, R_{LOAD} = 300 Ω		0.3	1	mA
I_{SC}	Short circuit current		100	300		mA
SVR	Supply voltage rejection	I_O = 100 mA, V_I = 14 ± 2 V f = 120 Hz, T_J = -40 to 125°C	55	80		dB
V_{IL}	Control input voltage low	T_J = -40 to 125°C		2	1.2	V
V_{IH}	Control input voltage high	T_J = -40 to 125°C	3.25	2		V
I_{INH}	Inhibit input current	V_{INH} = 2.5 V		22	50	µA
V_I	Transient input voltage	R_{LOAD} = 300 Ω, τ < 100ms	60	70		V
V_I	Reverse polarity input voltage	V_O = ± 0.3 V, R_{LOAD} = 300 Ω	-15	-50		V
V_I	Reverse polarity input voltage transient	R_{LOAD} = 300 Ω, τ < 100ms	-50			V
eN	Output noise voltage	B = 10 Hz to 100 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 µF, C_O = 100 µF.

Figure 5. Output voltage vs. temperature

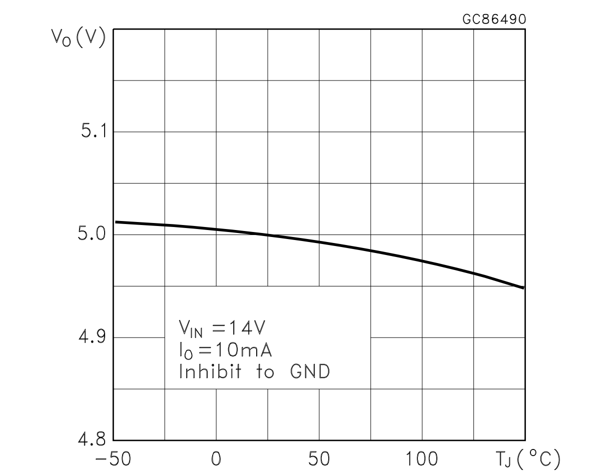


Figure 6. Output voltage vs. temperature

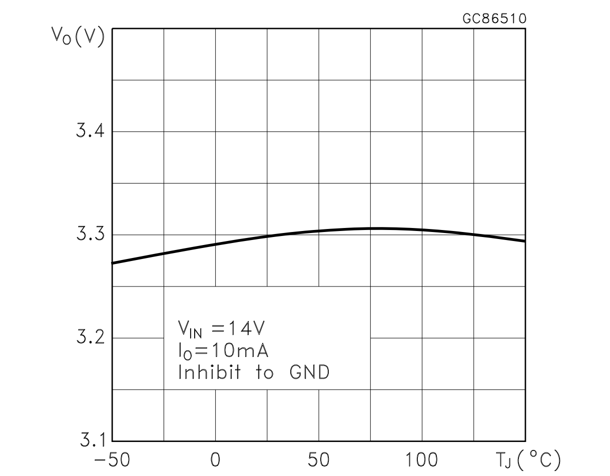


Figure 7. Reference voltage vs. temperature

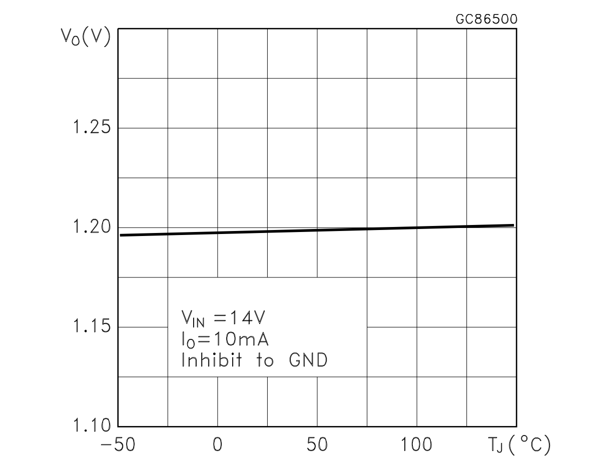


Figure 8. Line regulation vs. temperature

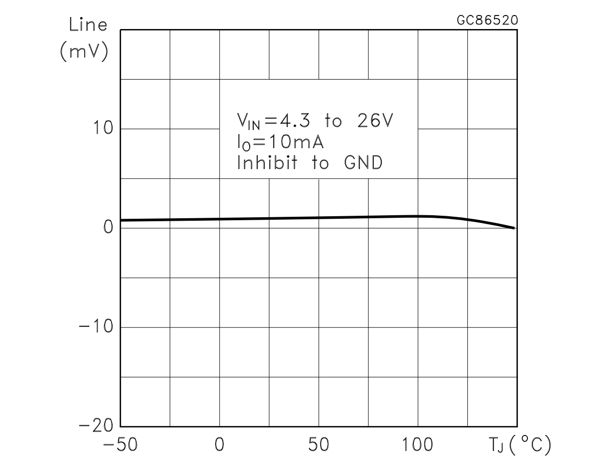


Figure 9. Load regulation vs. temperature

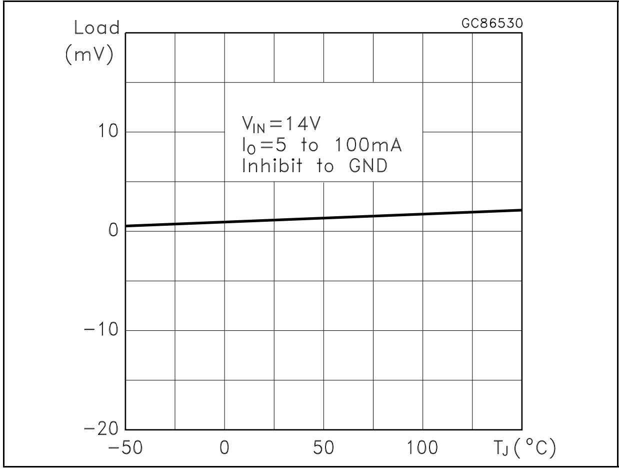


Figure 10. Dropout voltage vs. temperature

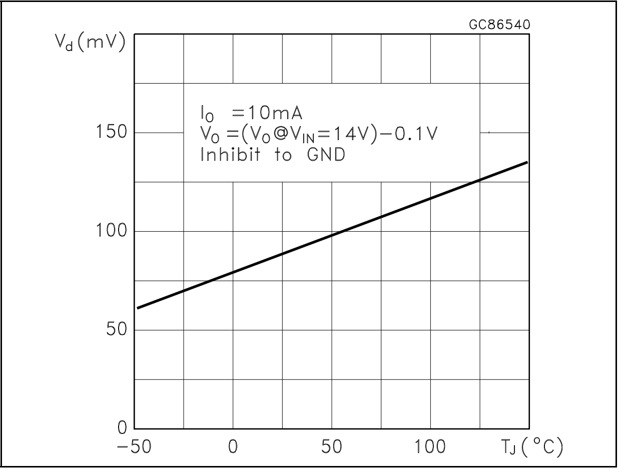


Figure 11. Dropout voltage vs. temperature

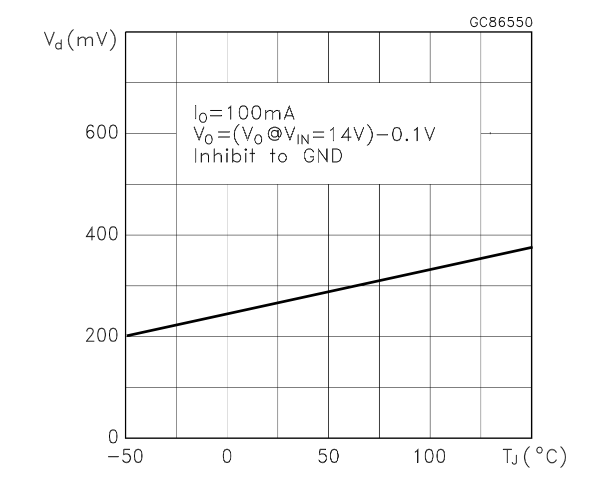


Figure 12. Dropout voltage vs. output current

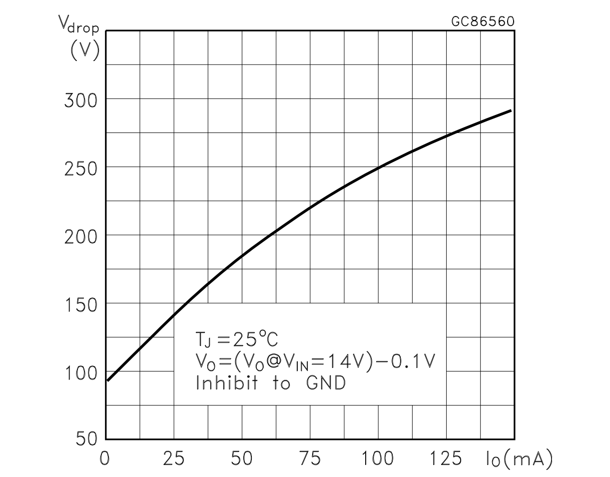


Figure 13. Output voltage vs. input voltage

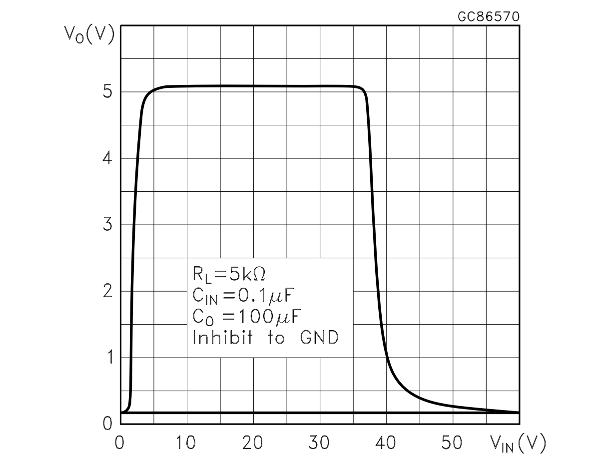


Figure 14. Short circuit current vs. drop voltage

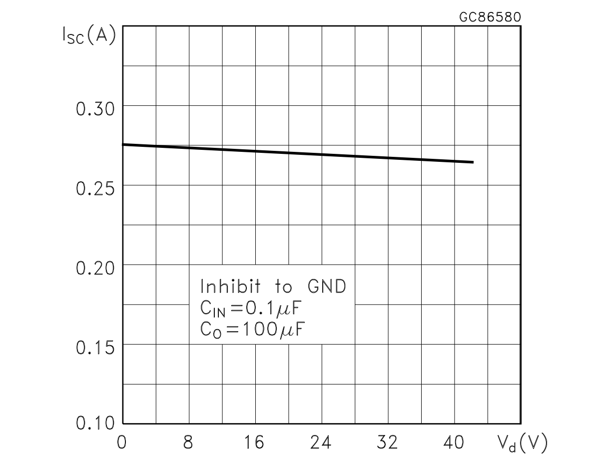


Figure 15. Quiescent current vs. temperature

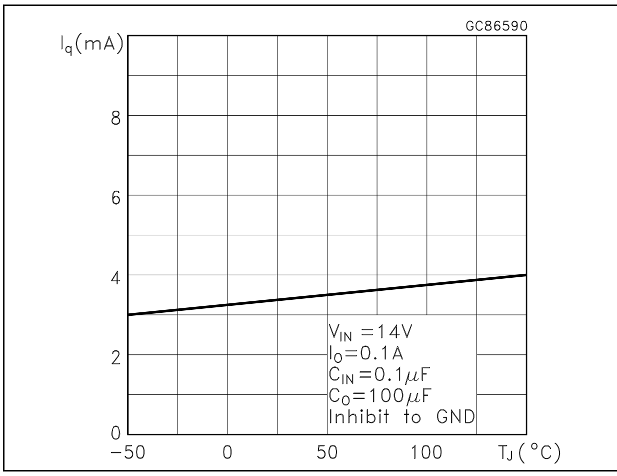


Figure 16. Quiescent current vs. input voltage

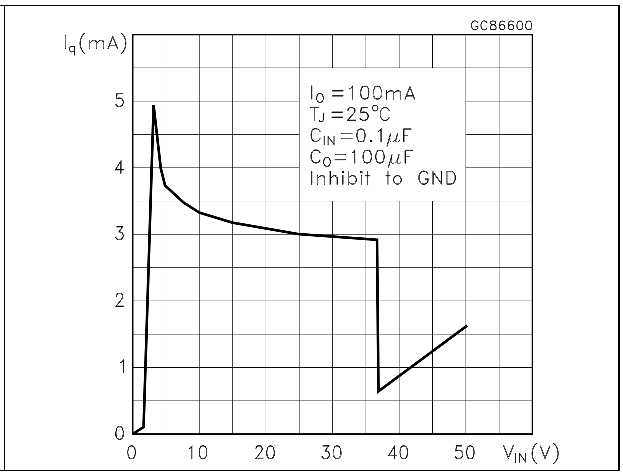


Figure 17. Quiescent current vs. output current

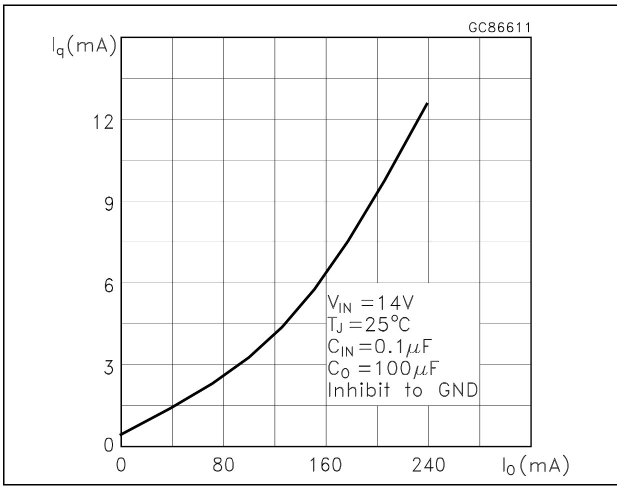


Figure 18. Supply voltage rejection vs. temperature

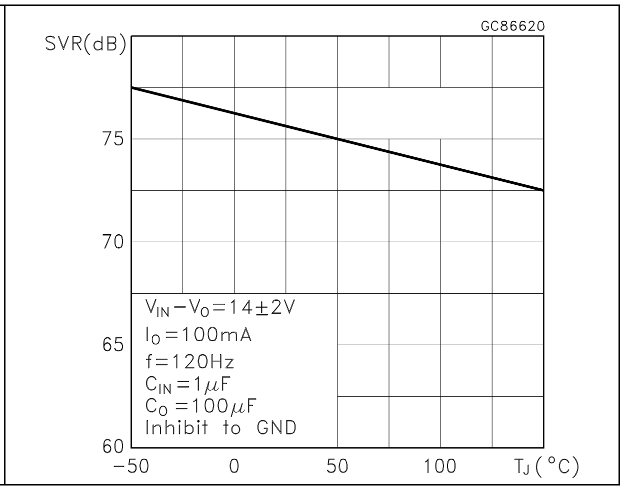


Figure 19. Supply voltage rejection vs. frequency

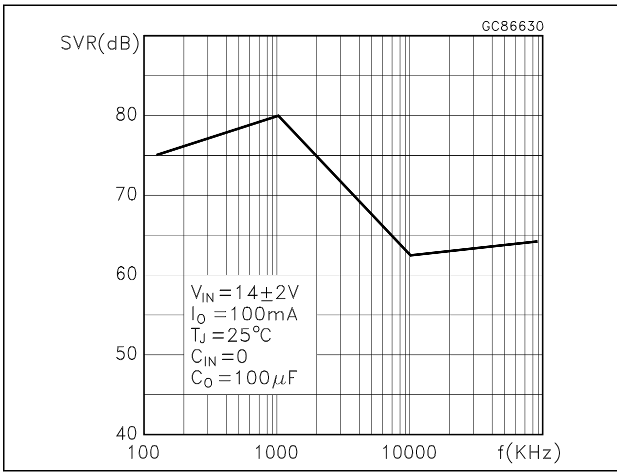


Figure 20. Supply voltage rejection vs. output current

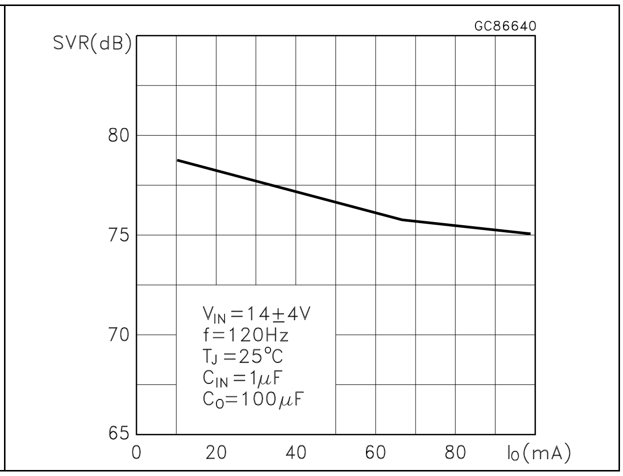


Figure 21. Stability vs. C_O

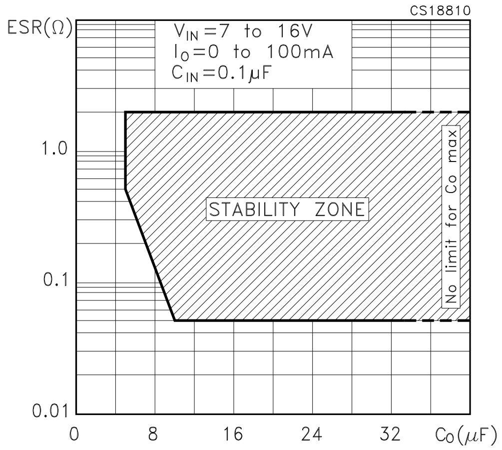
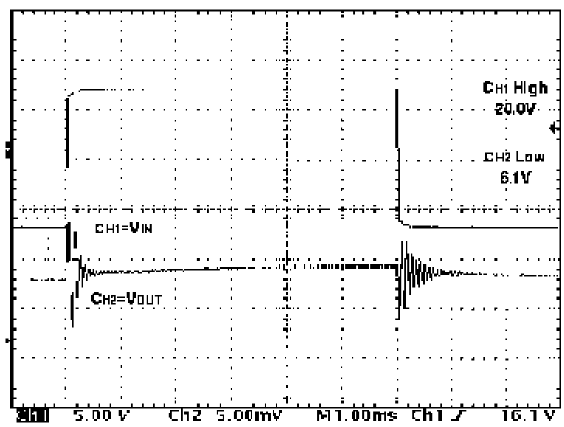
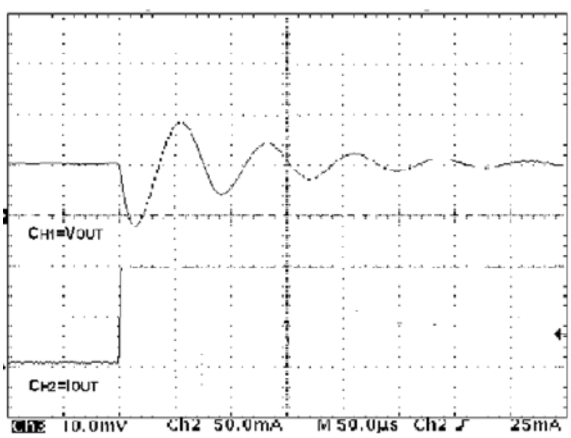


Figure 22. Line transient



V_I = 6 to 20 V, R_L = 500 Ω, T_J = 25°C, C_I = 0, C_O = 100 µF, Rise Fall-Time = 200 ns

Figure 23. Load transient



V_I = 14 V, I_O =0 to 100 mA, T_J = 25°C, C_I = 0.1 µF, C_O = 100 µF, Rise Time = 500 ns

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

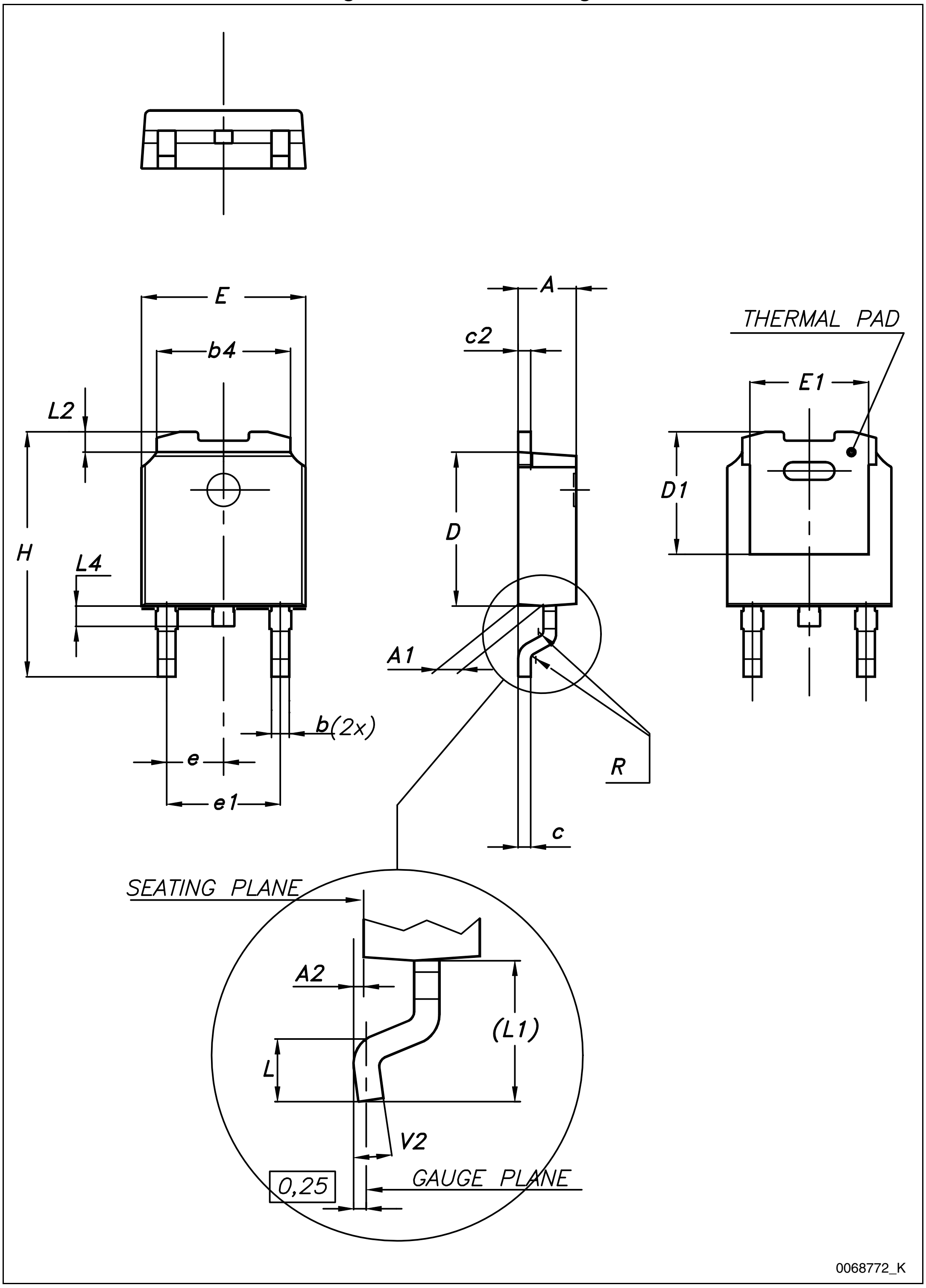
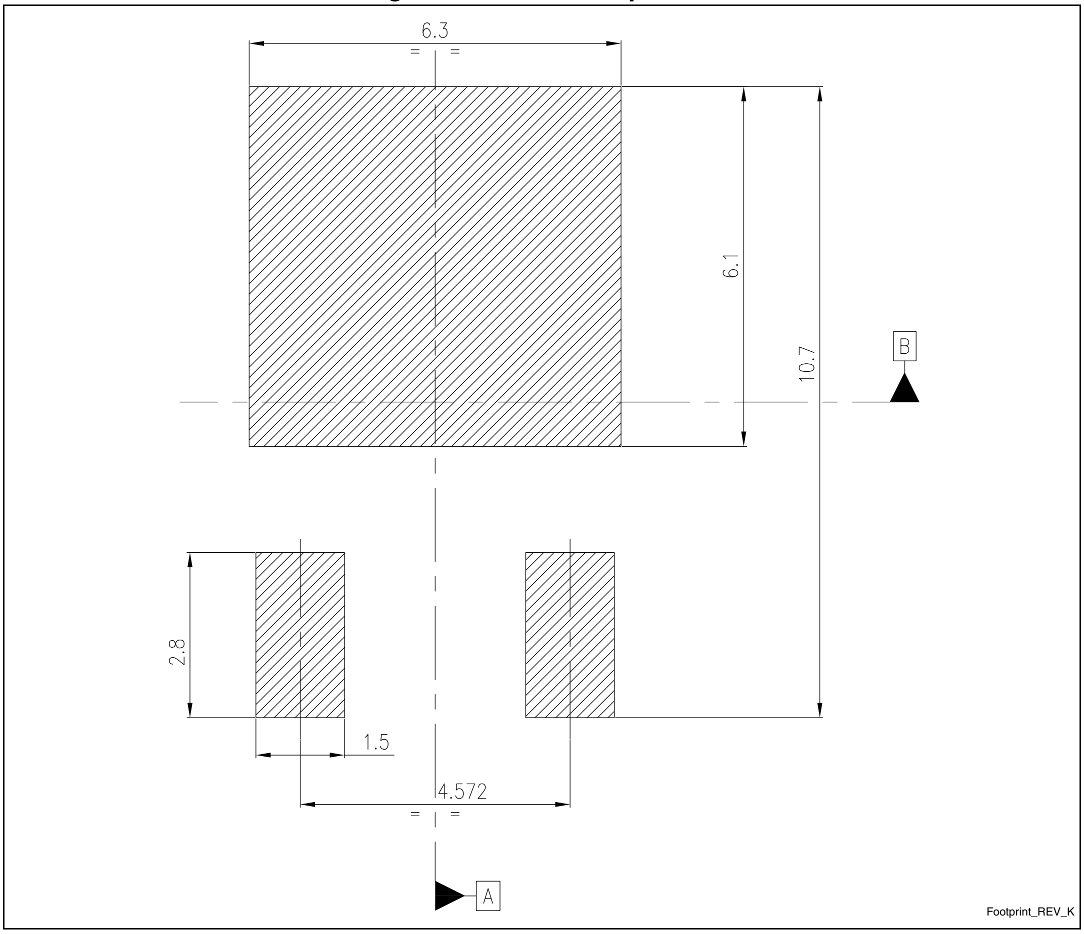


Table 7. DPAK mechanical data

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

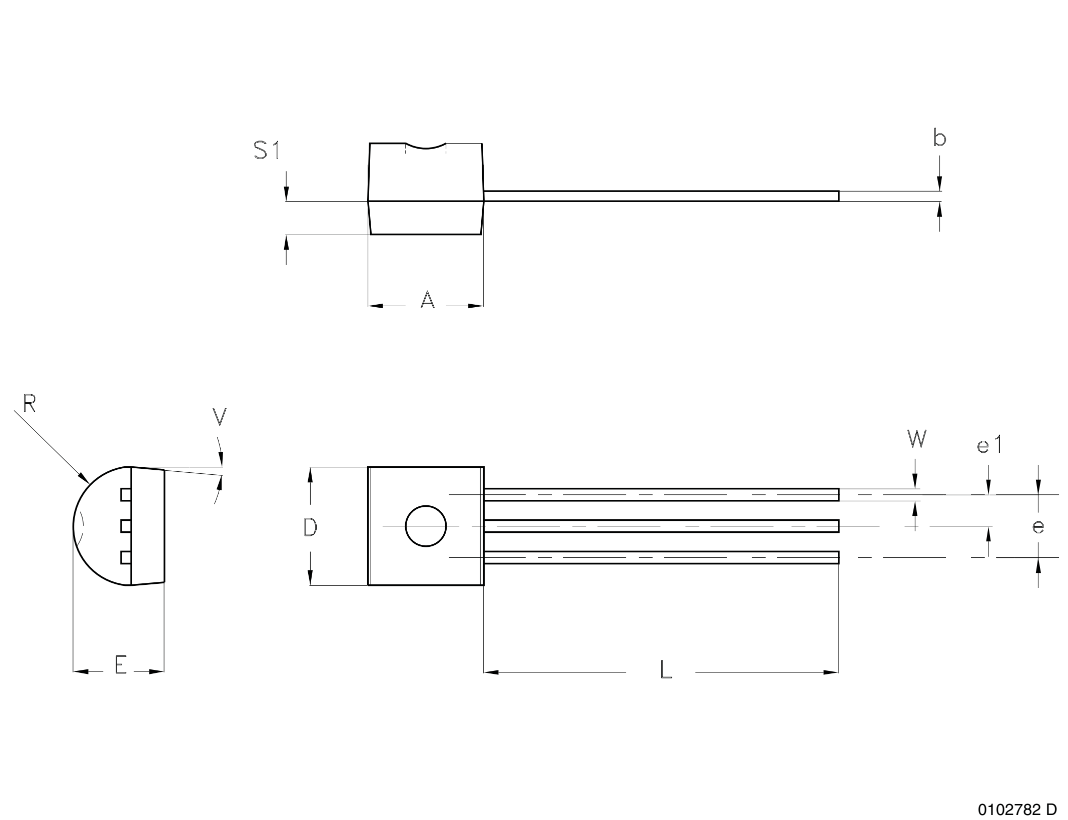


Table 8. TO-92 mechanical data

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

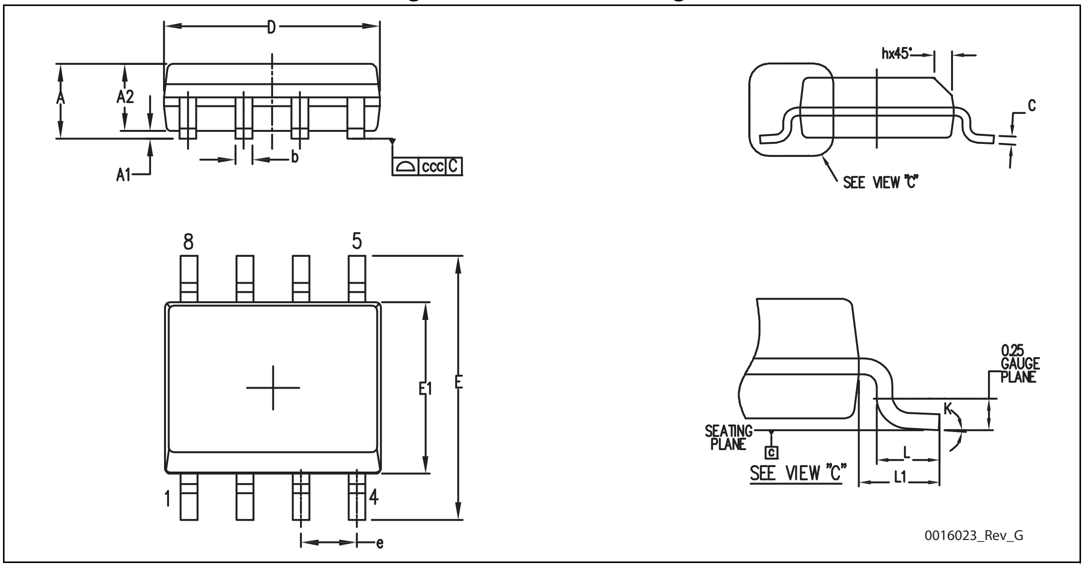


Table 9. SO-8 mechanical data

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

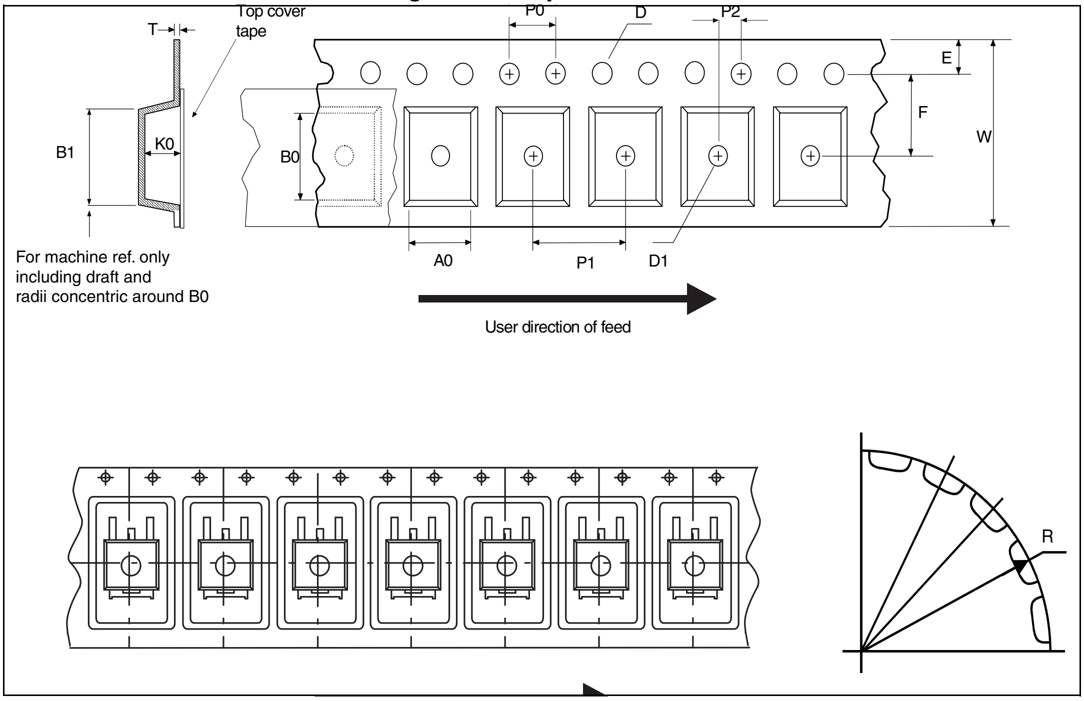


Figure 29. Reel for DPAK

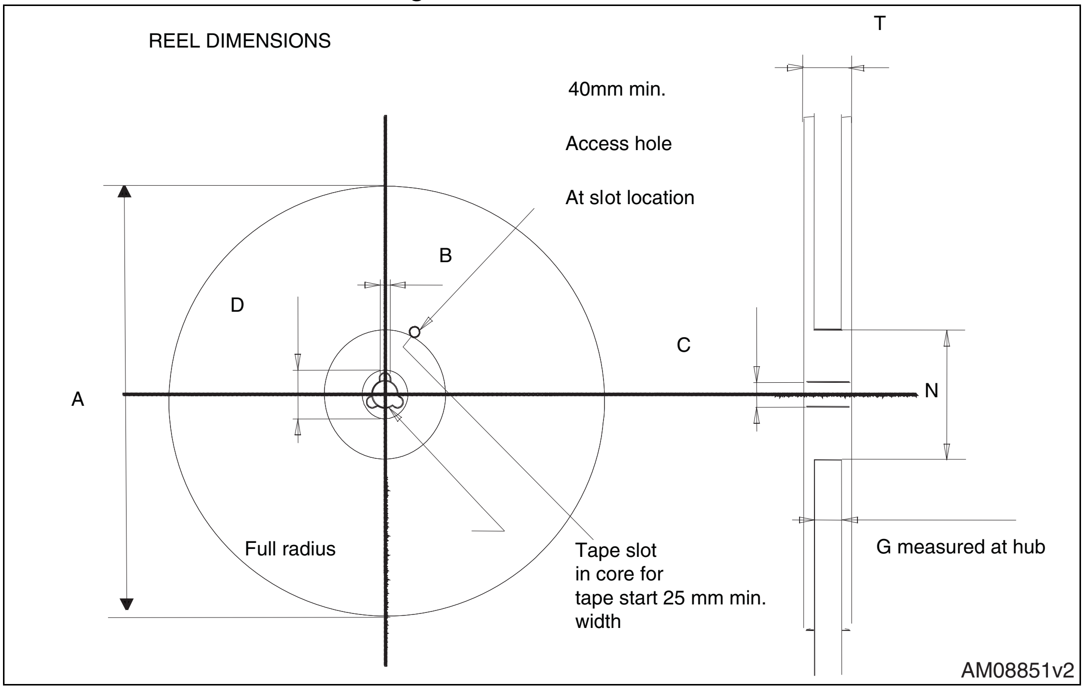


Table 10. DPAK tape and reel mechanical data

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

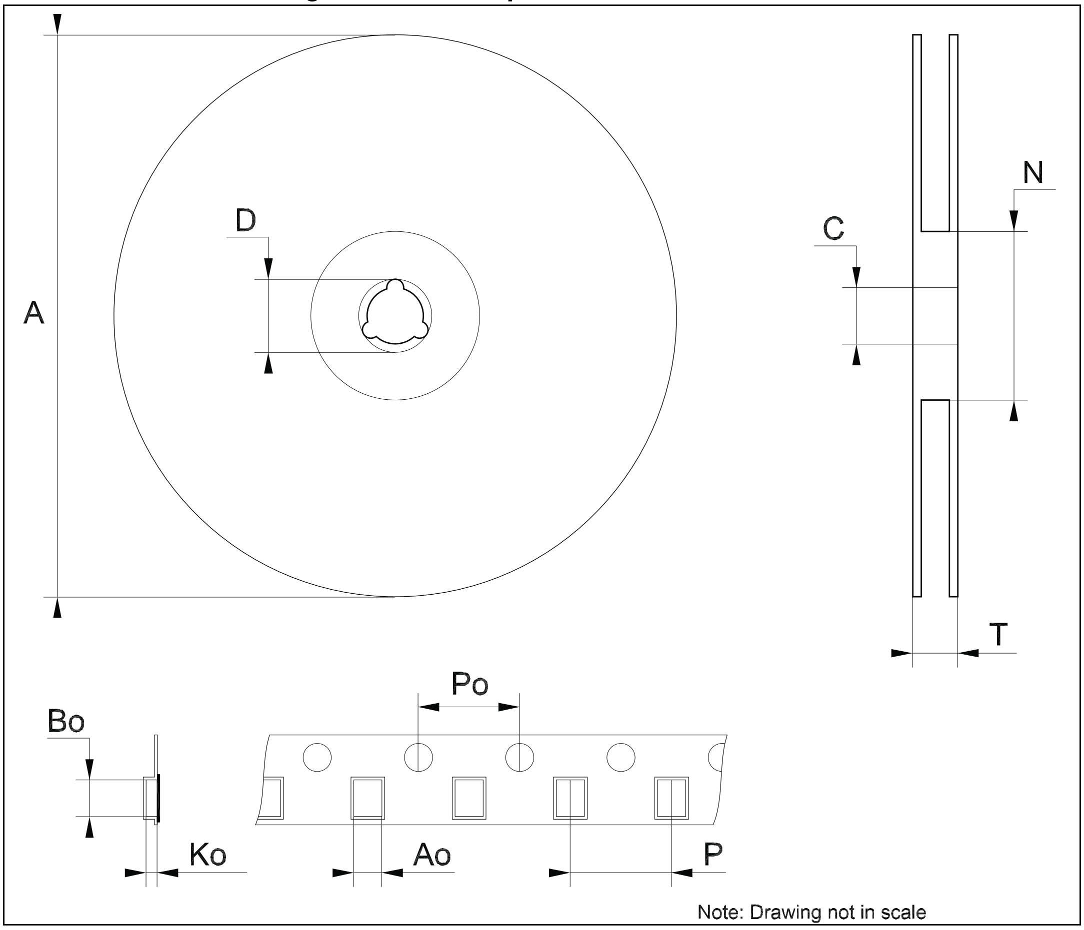


Table 11. SO-8 tape and reel mechanical data

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*: (*) 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 V , disabled when* V_{INH} *> 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 mechanical data*. Added *Section 8: Packaging mechanical data*. Minor text changes.