



# LM2931XX - LM2931AXX33 LM2931AXX50 - LM2931BXX50

## Very low drop voltage regulators with inhibit function

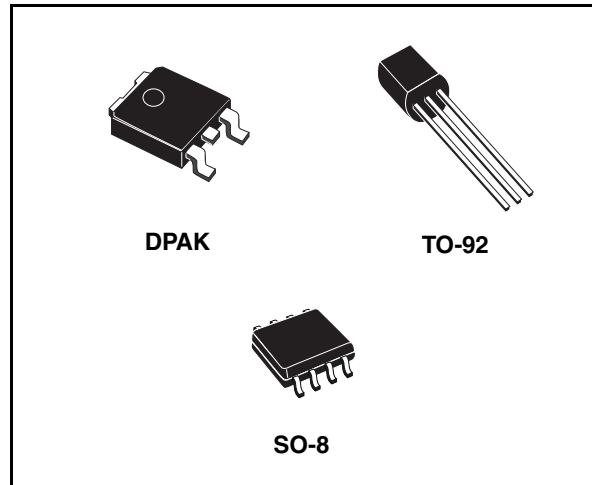
### Features

- Very low dropout voltage (0.15 V 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 & 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 LM2931xx 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 to the older L78Lxx family, a shut down logic control function is available.

This means that when the device is used as a local regulator is possible to put a part of the



board in stand-by decreasing the total power consumption. Ideal for automotive application the LM2931xx is protected from reverse battery installations or 2 battery jumps. During the transient, such as a load dump (60 V) when the input voltage can exceed the specified maximum operating input voltage (26 V), the regulator will automatically shut down to protect both internal circuit and the load.

**Table 1. Device summary**

Order codes				Output voltage
Packages				
DPAK	TO-92 (BAG)	TO-92 (Ammopak) <sup>(1)</sup>	SO-8	
	LM2931AZ33R		LM2931AD33R	3.3 V
LM2931ADT50R	LM2931AZ50R		LM2931AD50R	5.0 V
	LM2931BZ50R	LM2931BZ50AP	LM2931BD50R	5.0 V
			LM2931D-R	2.5 to 26 V

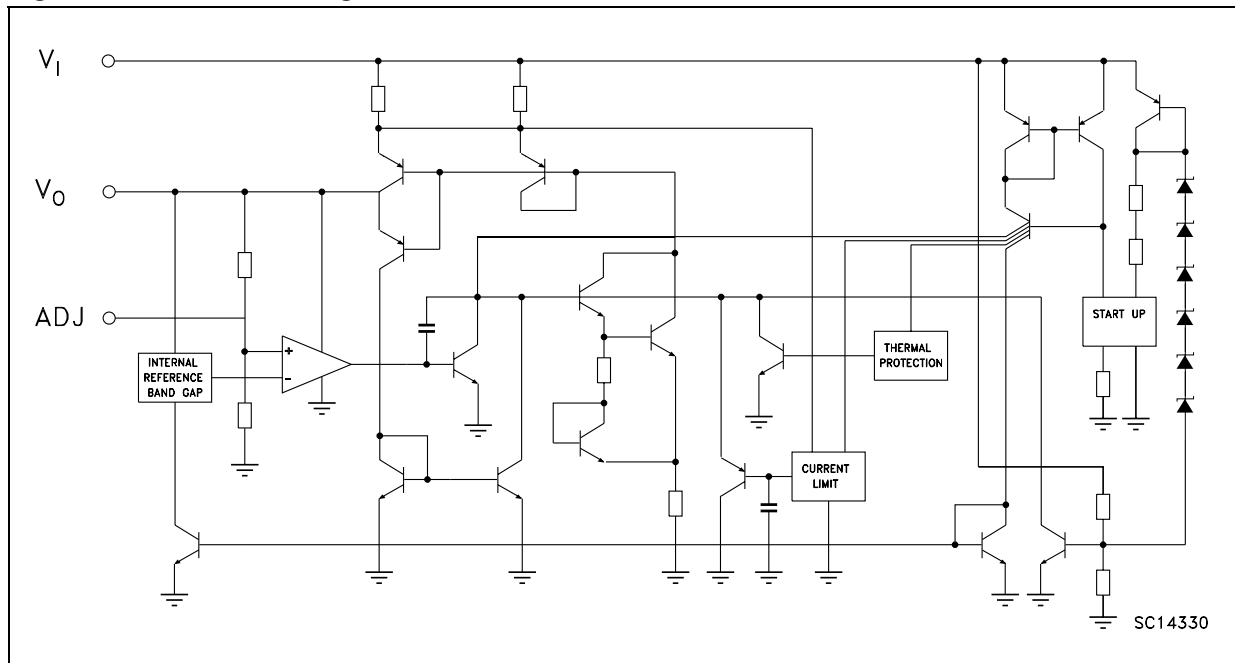
1. Please note that in these cases pins are shaped according to tape & reel specifications.

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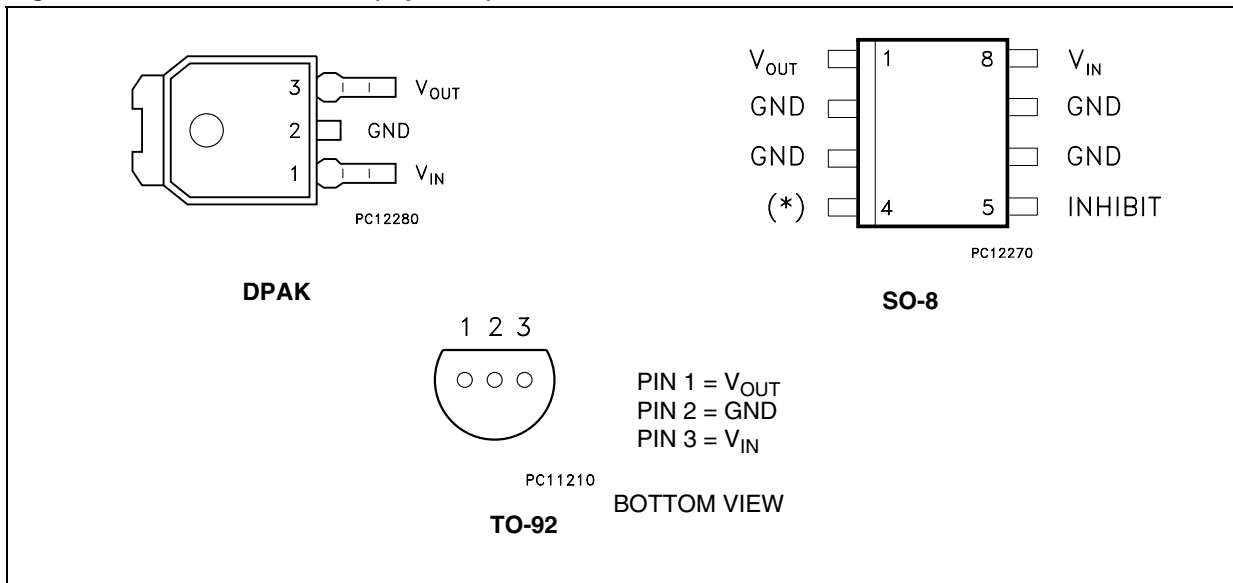
# 1 Diagram

Figure 1. Schematic diagram



## 2 Pin configuration

Figure 2. Pin connections (top view)



### 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 <sup>(1)</sup>	100	200	°C/W

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

## 4 Application circuits

Figure 3. Application circuit for fixed output

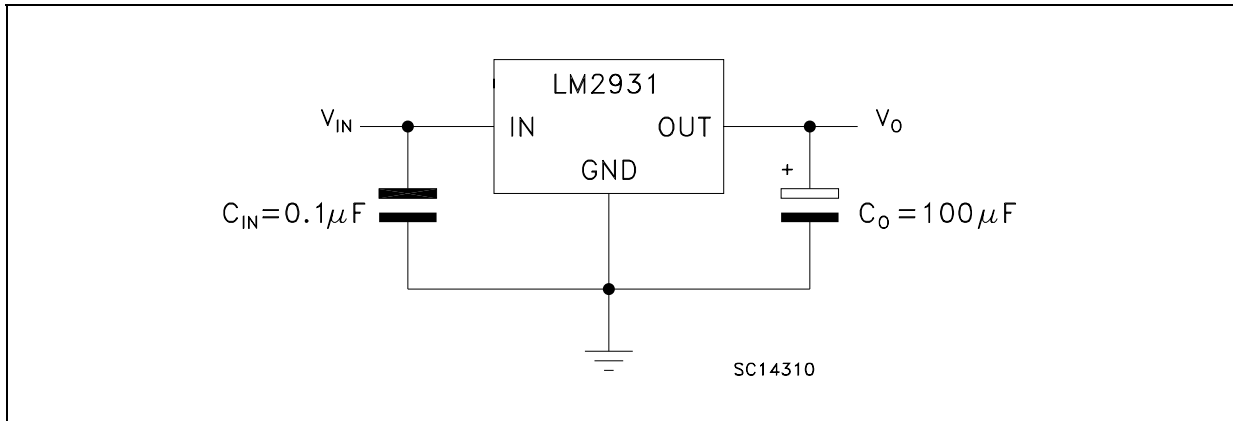
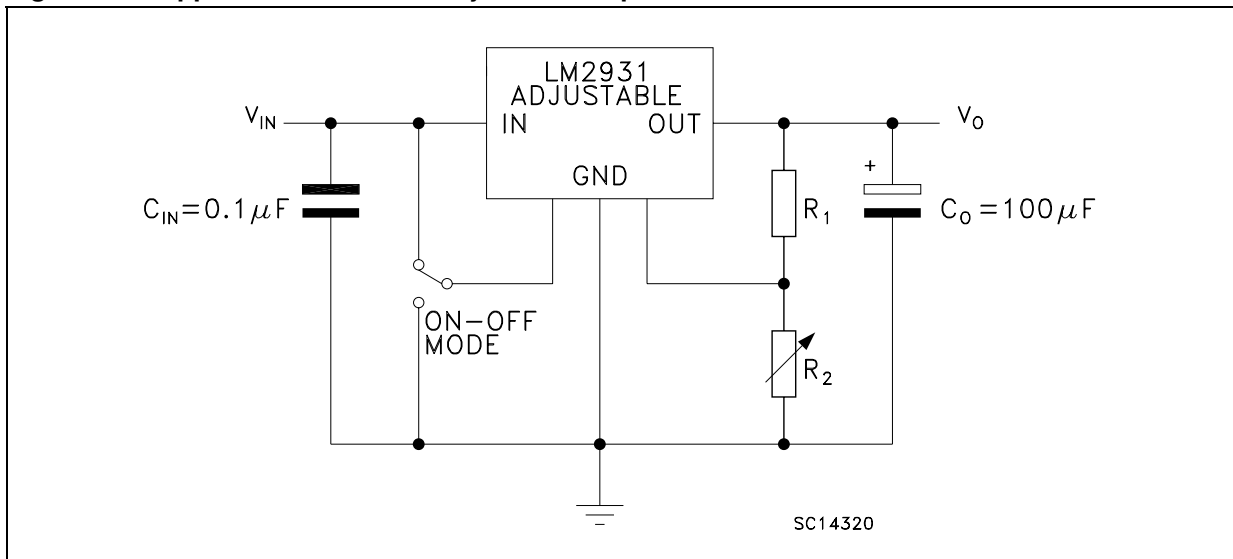


Figure 4. Application circuit for adjustable output



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

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

## 5 Electrical characteristics

**Table 4. Electrical characteristics of LM2931Axx33** (refer to the application circuit [Figure 3](#),  $T_J = 25\text{ }^\circ\text{C}$ ,  $C_I = 0.1\text{ }\mu\text{F}$ ,  $C_O = 100\text{ }\mu\text{F}$ ,  $V_I = 14\text{ V}$ ,  $I_O = 10\text{ mA}$ ,  $V_{INH} = 0\text{ V}$ , unless otherwise specified).

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	37		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
$\Delta V_O$	Line regulation	$V_I = 9\text{ to }16\text{ V}$		2	10	mV
		$V_I = 6\text{ to }26\text{ V}$		4	33	
$\Delta V_O$	Load regulation	$I_O = 5\text{ to }100\text{ mA}$		10	33	mV
$V_d$	Dropout voltage <sup>(1) (2)</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	$I_O = 100\text{ mA}$ , $V_I = 14 \pm 2\text{ V}$ $f = 120\text{ Hz}$ , $T_J = -40\text{ to }125^\circ\text{C}$	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	$\mu\text{A}$
$V_I$	Transient input voltage	$R_{LOAD} = 330\text{ }\Omega$ , $\tau < 100\text{ ms}$	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	$R_{LOAD} = 330\text{ }\Omega$ , $\tau < 100\text{ ms}$	-50			V
eN	Output noise voltage	$B = 10\text{ Hz to }100\text{ kHz}$		330		$\mu\text{V}_{RMS}$

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.

**Table 5. Electrical characteristics of LM2931Axx50** (refer to the application circuit [Figure 3](#),  $T_J = 25\text{ }^\circ\text{C}$ ,  $C_I = 0.1\text{ }\mu\text{F}$ ,  $C_O = 100\text{ }\mu\text{F}$ ,  $V_I = 14\text{ V}$ ,  $I_O = 10\text{ mA}$ ,  $V_{INH} = 0\text{ V}$ , unless otherwise specified).

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	37		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
$\Delta V_O$	Line regulation	$V_I = 9\text{ to }16\text{ V}$		2	10	mV
		$V_I = 6\text{ to }26\text{ V}$		4	30	
$\Delta V_O$	Load regulation	$I_O = 5\text{ to }100\text{ mA}$		15	50	mV
$V_d$	Dropout voltage <sup>(1)</sup> <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	$V_{INH} = 2.5\text{ V}$ , $R_{LOAD} = 500\text{ }\Omega$		0.3	1	mA
$I_{SC}$	Short circuit current		100	300		mA
SVR	Supply voltage rejection	$I_O = 100\text{ mA}$ , $V_I = 14 \pm 2\text{ V}$ $f = 120\text{ Hz}$ , $T_J = -40\text{ to }125^\circ\text{C}$	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	$\mu\text{A}$
$V_I$	Transient input voltage	$R_{LOAD} = 500\text{ }\Omega$ , $\tau < 100\text{ms}$	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	$R_{LOAD} = 500\text{ }\Omega$ , $\tau < 100\text{ms}$	-50			V
eN	Output noise voltage	$B = 10\text{ Hz to }100\text{ kHz}$		500		$\mu\text{V}_{RMS}$

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.



**Table 6. Electrical characteristics of LM2931Bxx50** (refer to the application circuit [Figure 3](#),  $T_J = 25\text{ }^\circ\text{C}$ ,  $C_I = 0.1\text{ }\mu\text{F}$ ,  $C_O = 100\text{ }\mu\text{F}$ ,  $V_I = 14\text{ V}$ ,  $I_O = 10\text{ mA}$ ,  $V_{INH} = 0\text{ V}$ , unless otherwise specified).

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	37		V
$V_O$	Output voltage		4.75	5	5.25	V
$V_O$	Output voltage	$I_O = 100\text{ mA}$ , $V_I = 6\text{ to }26\text{ V}$ $T_J = -40\text{ to }125^\circ\text{C}$	4.5	5	5.5	V
$\Delta V_O$	Line regulation	$V_I = 9\text{ to }16\text{ V}$		2	10	mV
		$V_I = 6\text{ to }26\text{ V}$		4	30	
$\Delta V_O$	Load regulation	$I_O = 5\text{ to }100\text{ mA}$		15	50	mV
$V_d$	Dropout voltage <sup>(1)</sup> <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	$V_{INH} = 2.5\text{ V}$ , $R_{LOAD} = 500\text{ }\Omega$		0.3	1	mA
$I_{SC}$	Short circuit current		100	300		mA
SVR	Supply voltage rejection	$I_O = 100\text{ mA}$ , $V_I = 14 \pm 2\text{ V}$ $f = 120\text{ Hz}$ , $T_J = -40\text{ to }125^\circ\text{C}$	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	$\mu\text{A}$
$V_I$	Transient input voltage	$R_{LOAD} = 500\text{ }\Omega$ , $\tau < 100\text{ms}$	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	$R_{LOAD} = 500\text{ }\Omega$ , $\tau < 100\text{ms}$	-50			V
eN	Output noise voltage	$B = 10\text{ Hz to }100\text{ kHz}$		500		$\mu\text{V}_{RMS}$

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.

**Table 7. Electrical characteristics of LM2931xx** (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).

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	37		V
$V_{REF}$	Reference voltage <sup>(1)</sup>		1.14	1.2	1.26	V
$V_{REF}$	Reference voltage <sup>(1)</sup>	$I_O = 100\text{ mA}$ , $T_J = -40\text{ to }125^\circ\text{C}$	1.08	1.2	1.32	V
$\Delta V_O$	Line regulation	$V_I = 3.6\text{ to }26\text{ V}$		0.6	4.5	mV
$\Delta V_O$	Load regulation	$I_O = 5\text{ to }100\text{ mA}$		9	30	mV
$V_d$	Dropout voltage <sup>(1) (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	$I_O = 100\text{ mA}$ , $V_I = 14 \pm 2\text{ V}$ $f = 120\text{ Hz}$ , $T_J = -40\text{ to }125^\circ\text{C}$	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	$\mu\text{A}$
$V_I$	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		$\mu\text{V}_{RMS}$

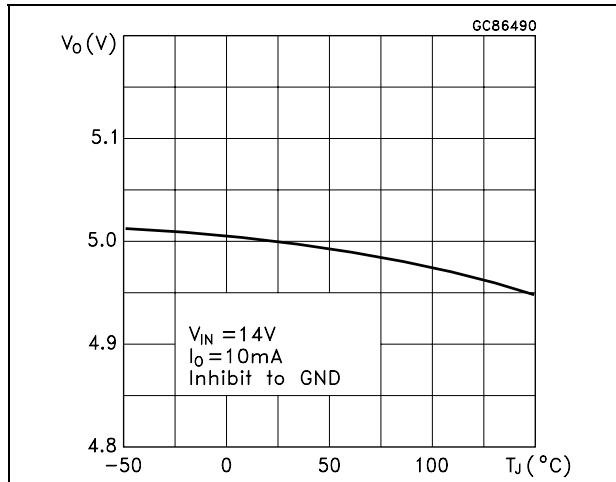
1. Reference voltage is measured from  $V_{OUT}$  to ADJ pin.

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

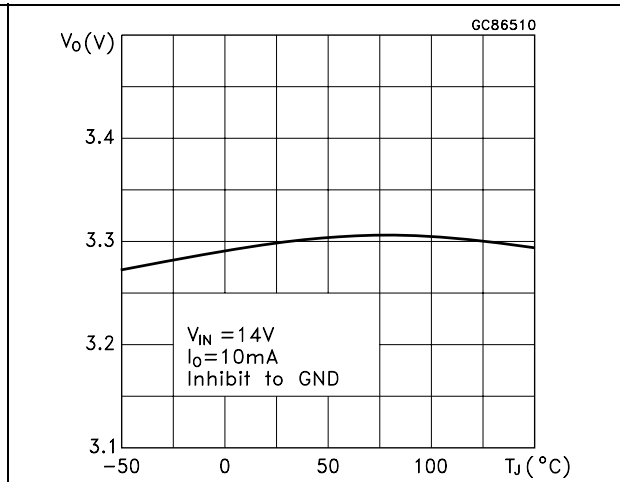
## 6 Typical characteristics

(unless otherwise specified  $C_I = 0.1 \mu\text{F}$ ,  $C_O = 100 \mu\text{F}$ )

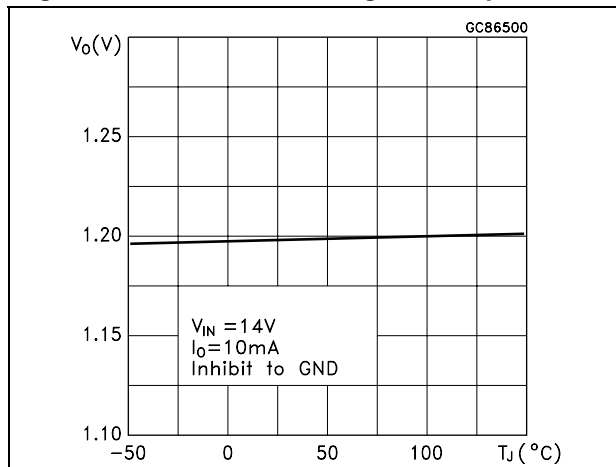
**Figure 5. Output voltage vs temperature**



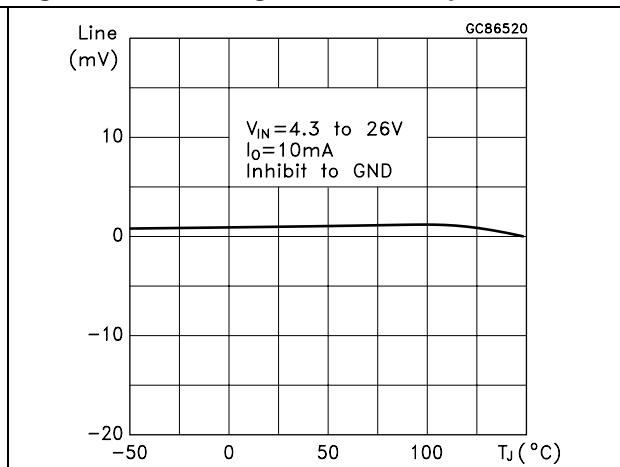
**Figure 6. Output voltage vs temperature**



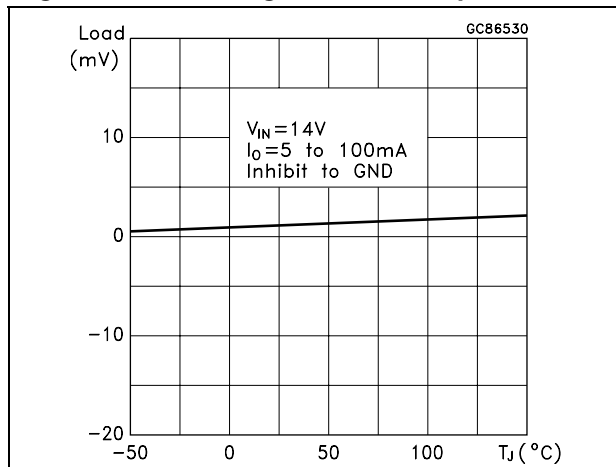
**Figure 7. Reference voltage vs temperature**



**Figure 8. Line regulation vs temperature**



**Figure 9. Load regulation vs temperature**



**Figure 10. Dropout voltage vs temperature**

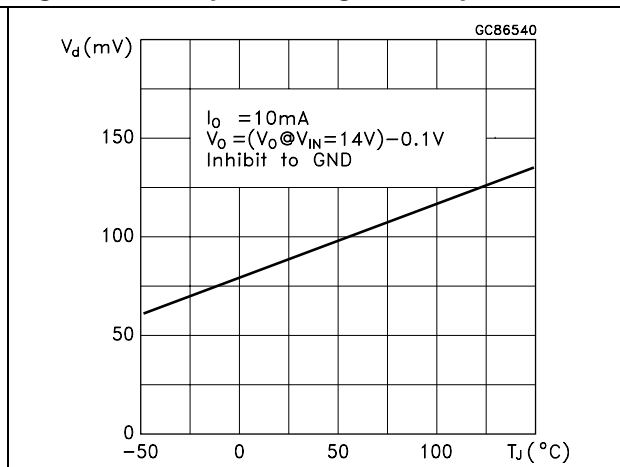


Figure 11. Dropout voltage vs temperature

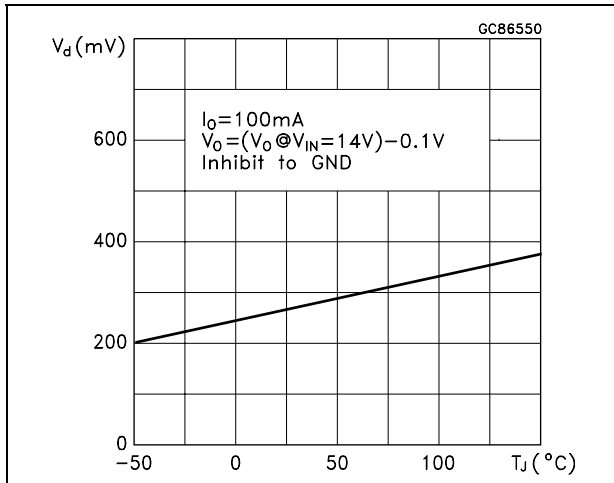


Figure 12. Dropout voltage vs output current

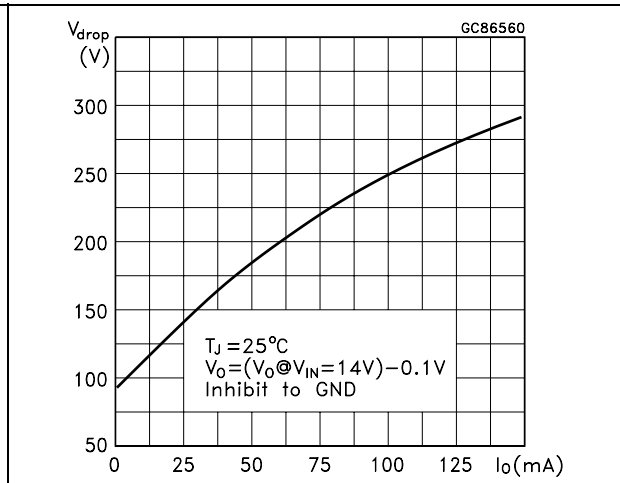


Figure 13. Output voltage vs input voltage

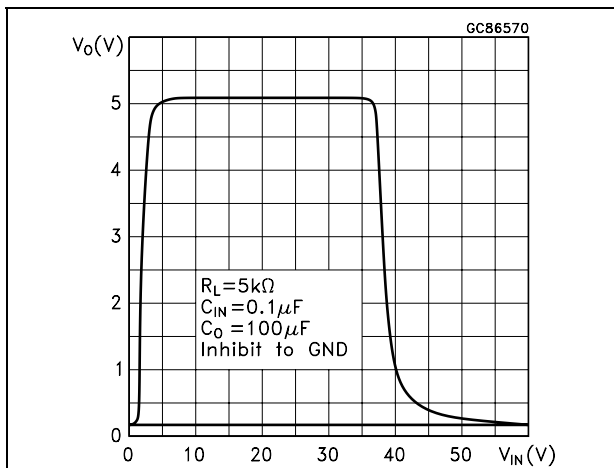


Figure 14. Short circuit current vs drop voltage

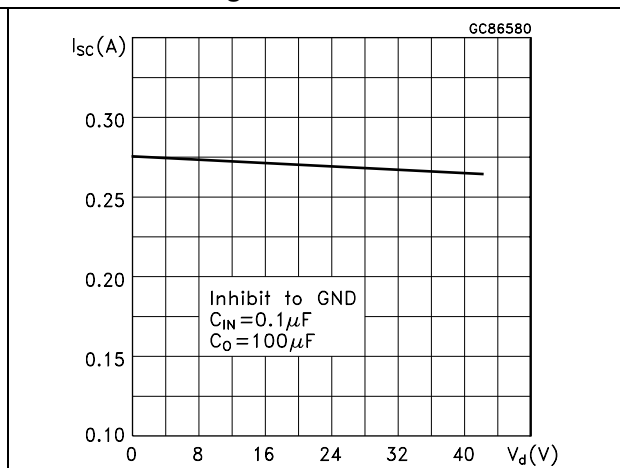


Figure 15. Quiescent current vs temperature

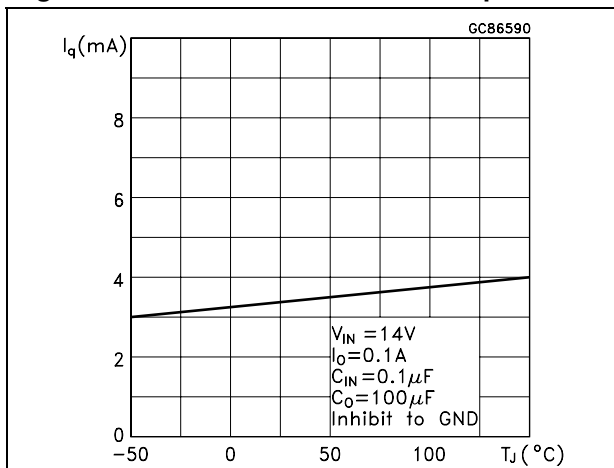


Figure 16. Quiescent current vs input voltage

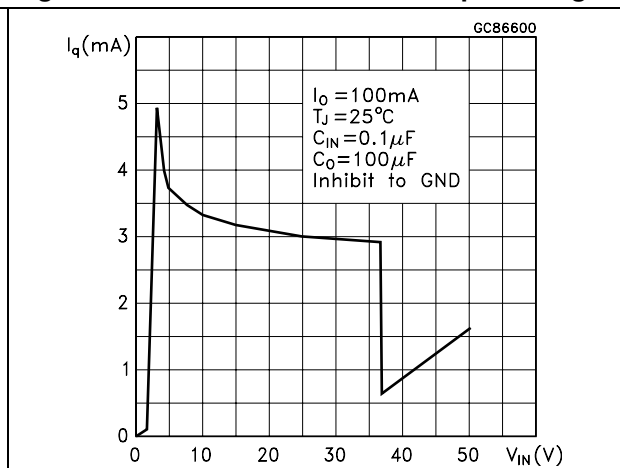


Figure 17. Quiescent current vs output current Figure 18. Supply voltage rejection vs temperature

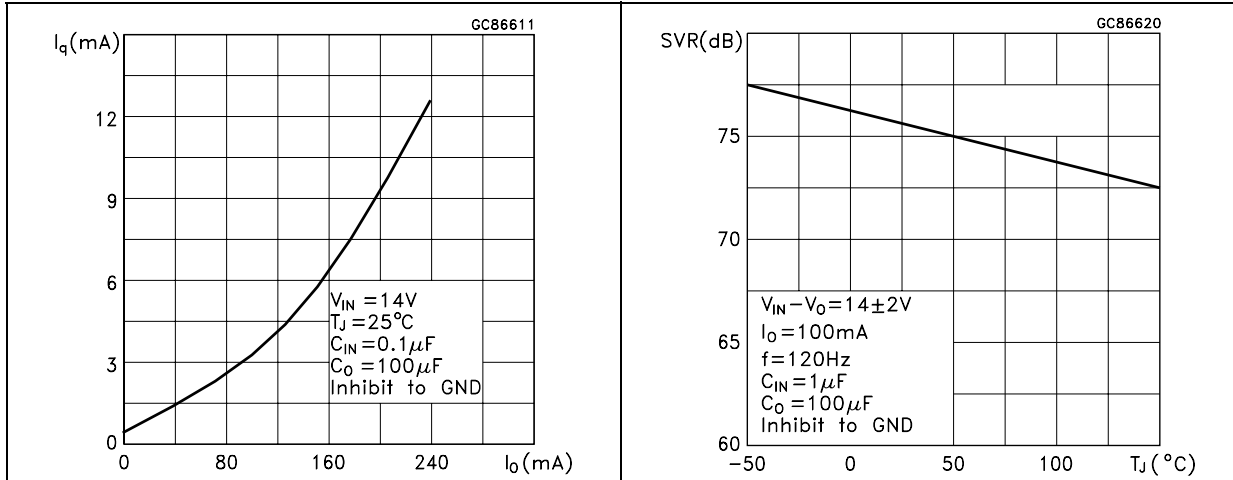


Figure 19. Supply voltage rejection vs frequency

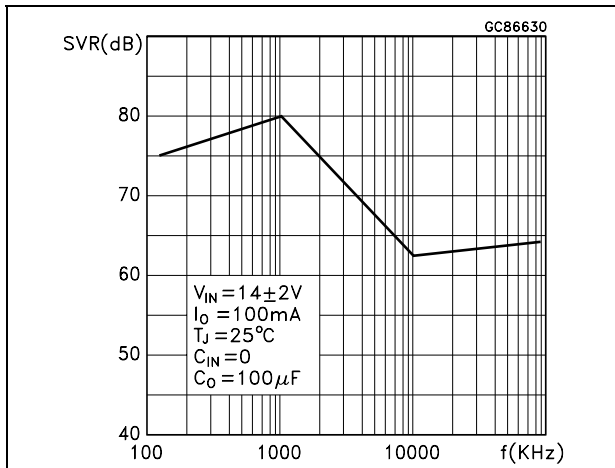


Figure 20. Supply voltage rejection vs output current

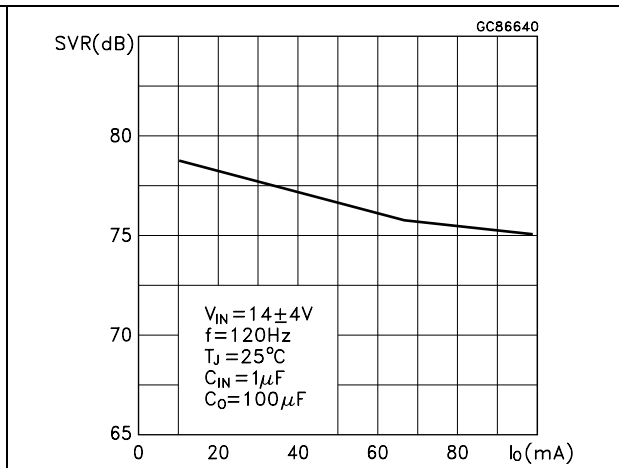


Figure 21. Stability vs  $C_O$

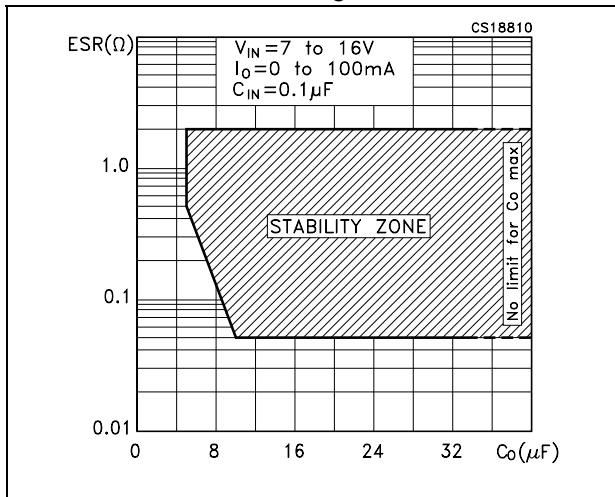


Figure 22. Line transient

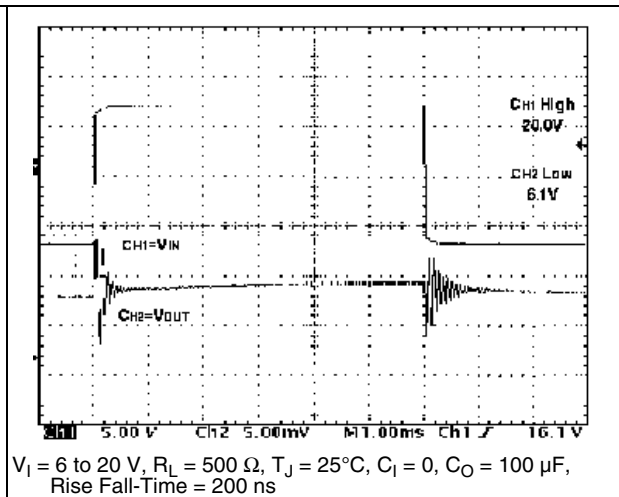
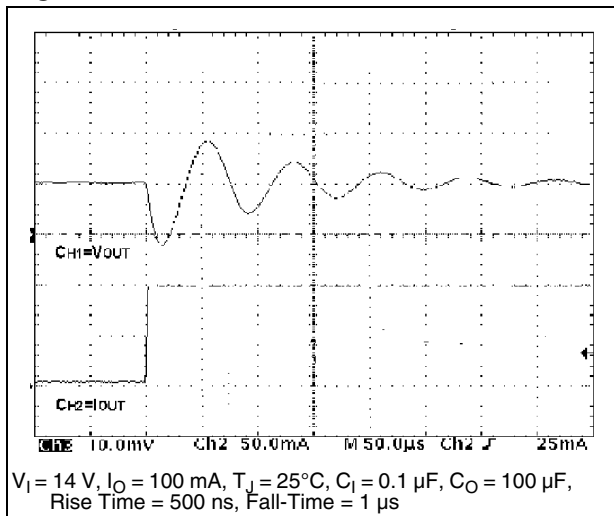


Figure 23. Line transient

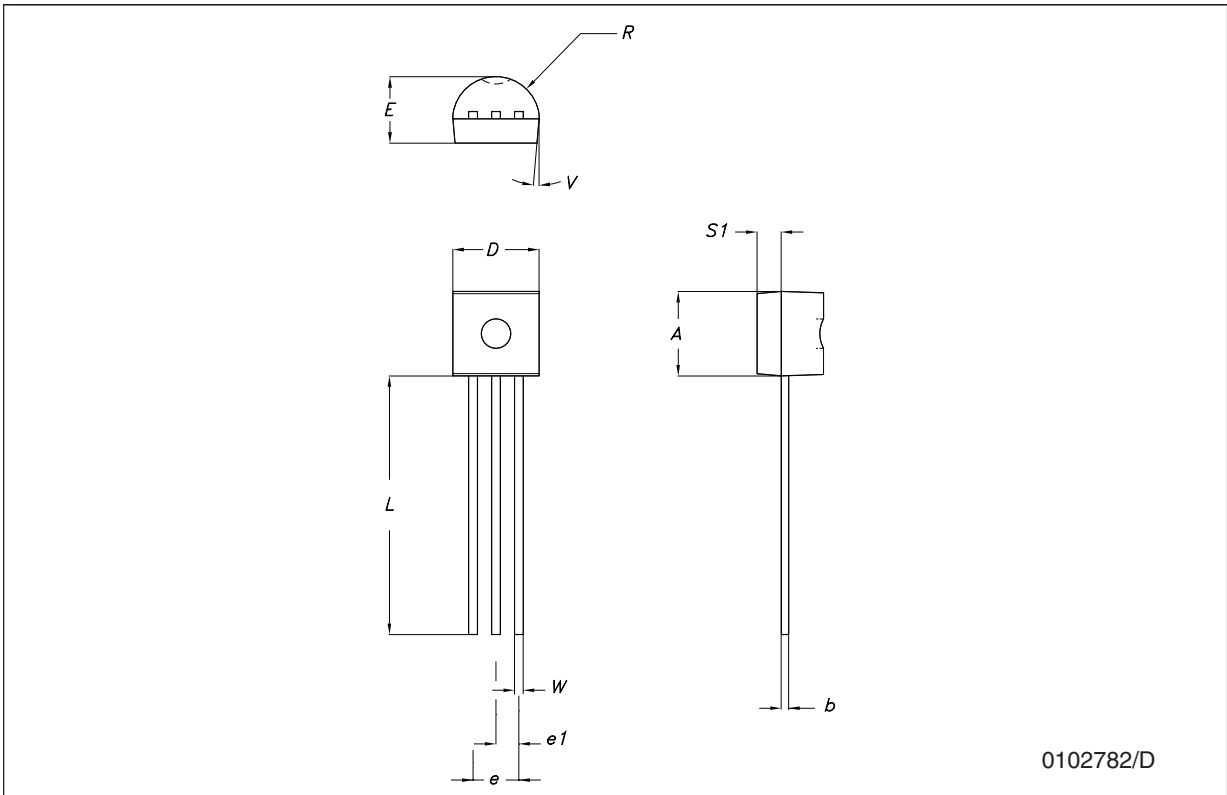


## 7 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK<sup>®</sup> packages. These packages have a lead-free second level interconnect. The category of second Level Interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an ST trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com).

**TO-92 mechanical data**

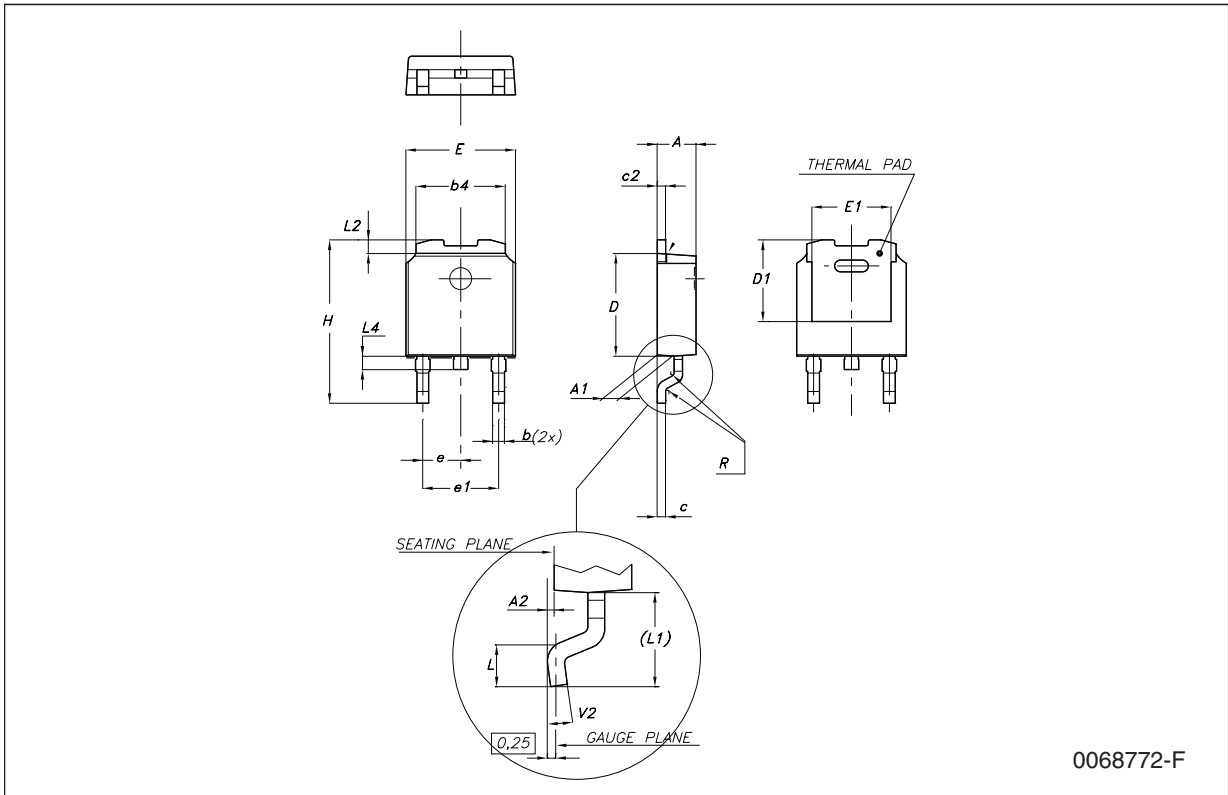
Dim.	mm.			mils.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	4.32		4.95	170.1		194.9
b	0.36		0.51	14.2		20.1
D	4.45		4.95	175.2		194.9
E	3.30		3.94	129.9		155.1
e	2.41		2.67	94.9		105.1
e1	1.14		1.40	44.9		55.1
L	12.7		15.49	500.0		609.8
R	2.16		2.41	85.0		94.9
S1	0.92		1.52	36.2		59.8
W	0.41		0.56	16.1		22.0
$\alpha$		5°			5°	





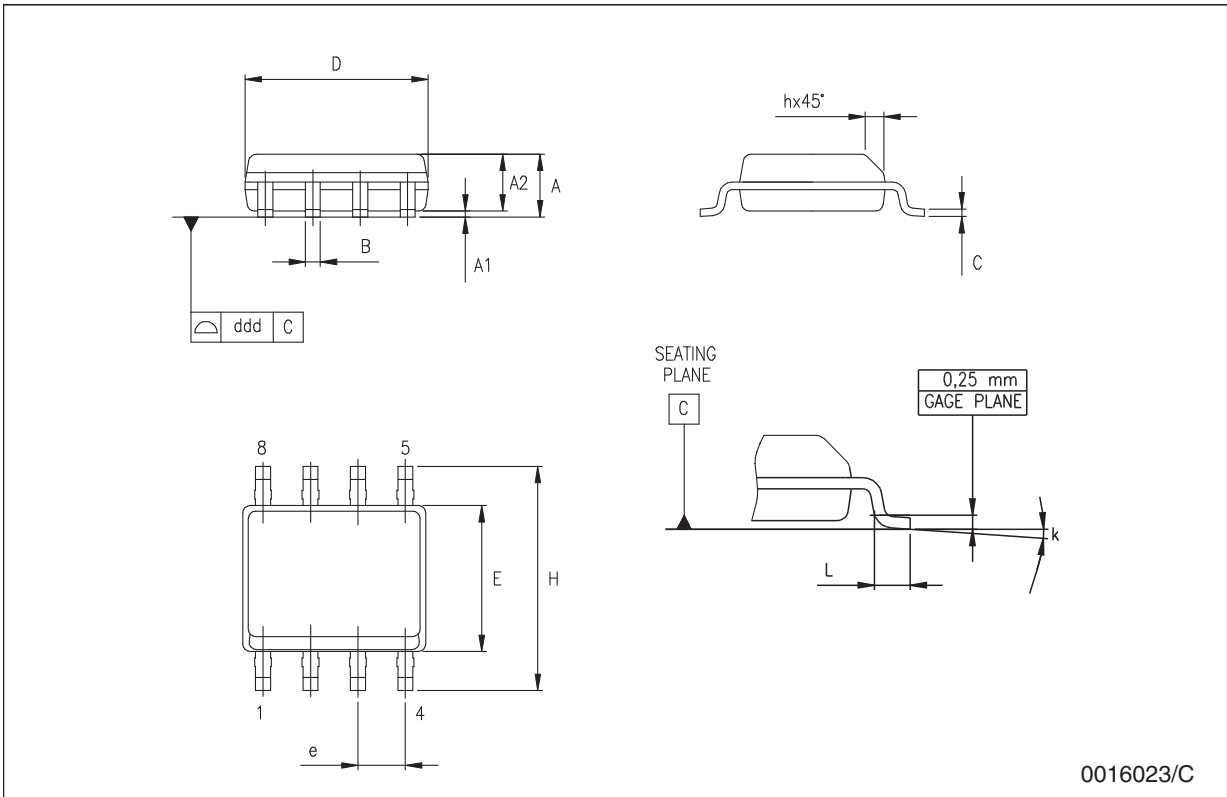
**DPAK mechanical data**

Dim.	mm.			inch.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	2.2		2.4	0.086		0.094
A1	0.9		1.1	0.035		0.043
A2	0.03		0.23	0.001		0.009
B	0.64		0.9	0.025		0.035
b4	5.2		5.4	0.204		0.212
C	0.45		0.6	0.017		0.023
C2	0.48		0.6	0.019		0.023
D	6		6.2	0.236		0.244
D1		5.1			0.200	
E	6.4		6.6	0.252		0.260
E1		4.7			0.185	
e		2.28			0.090	
e1	4.4		4.6	0.173		0.181
H	9.35		10.1	0.368		0.397
L	1			0.039		
(L1)		2.8			0.110	
L2		0.8			0.031	
L4	0.6		1	0.023		0.039
R		0.2			0.008	
V2	0°		8°	0°		8°



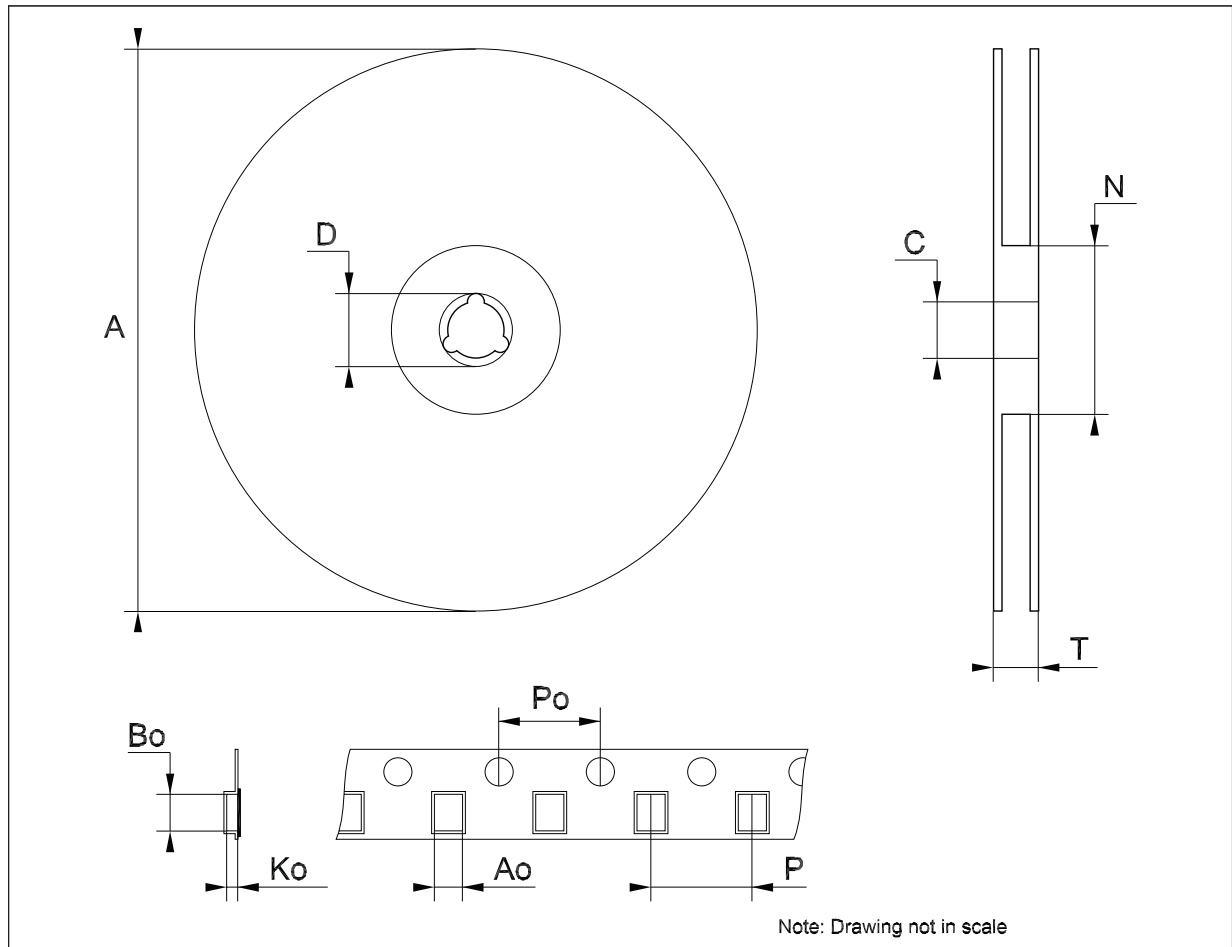
**SO-8 mechanical data**

Dim.	mm.			inch.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	1.35		1.75	0.053		0.069
A1	0.10		0.25	0.04		0.010
A2	1.10		1.65	0.043		0.065
B	0.33		0.51	0.013		0.020
C	0.19		0.25	0.007		0.010
D	4.80		5.00	0.189		0.197
E	3.80		4.00	0.150		0.157
e		1.27			0.050	
H	5.80		6.20	0.228		0.244
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
k	8° (max.)					
ddd			0.1			0.04



**Tape & reel DPAK-PPAK mechanical data**

Dim.	mm.			inch.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			330			12.992
C	12.8	13.0	13.2	0.504	0.512	0.519
D	20.2			0.795		
N	60			2.362		
T			22.4			0.882
Ao	6.80	6.90	7.00	0.268	0.272	0.276
Bo	10.40	10.50	10.60	0.409	0.413	0.417
Ko	2.55	2.65	2.75	0.100	0.104	0.105
Po	3.9	4.0	4.1	0.153	0.157	0.161
P	7.9	8.0	8.1	0.311	0.315	0.319



**Tape & reel SO-8 mechanical data**

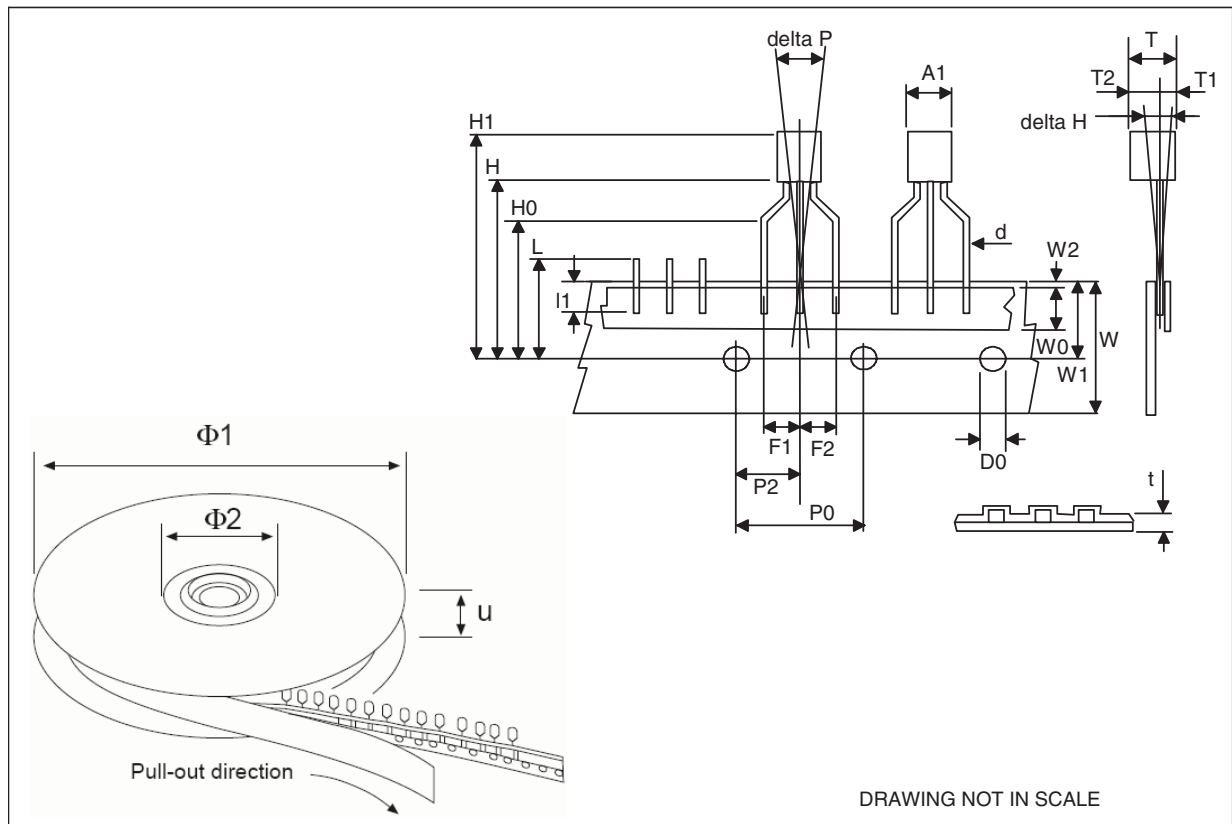
Dim.	mm.			inch.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			330			12.992
C	12.8		13.2	0.504		0.519
D	20.2			0.795		
N	60			2.362		
T			22.4			0.882
Ao	8.1		8.5	0.319		0.335
Bo	5.5		5.9	0.216		0.232
Ko	2.1		2.3	0.082		0.090
Po	3.9		4.1	0.153		0.161
P	7.9		8.1	0.311		0.319



Note: Drawing not in scale

**Tape & reel for TO-92 mechanical data**

Dim.	mm.			inch.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A1		4.80			0.189	
T		3.80			0.150	
T1		1.60			0.063	
T2		2.30			0.091	
d		0.48			0.019	
P0	12.5		12.9	0.492		0.508
P2	5.65		7.05	0.222		0.278
F1, F2	2.44	2.54	2.94	0.096	0.100	0.116
delta H		±2			0.079	
W	17.5	18.00	19.0	0.689	0.709	0.748
W0	5.7		6.3	0.224		0.248
W1	8.5		9.25	0.335		0.364
W2		0.50			0.20	
H		18.50	18.70		0.728	0.726
H0	15.50		16.50	0.610		0.650
H1		25.00			0.984	
D0	3.8		4.2	0.150		0.165
t		0.90			0.035	
L1		3			0.118	
delta P		±1			0.039	
u		50			1.968	
Φ1		360			14.173	
Φ2		30			1.181	



## 8 Revision history

**Table 8. Document revision history**

Date	Revision	Changes
21-Jun-2004	12	Document updated.
16-Jun-2006	13	Order codes updated.
27-Jul-2007	14	Added <a href="#">Table 1</a> in cover page.
21-Aug-2007	15	Added root part number - (see <a href="#">Table 1</a> )
22-Nov-2007	16	Modified: <a href="#">Table 1</a> .
11-Feb-2008	17	Modified: <a href="#">Table 1 on page 1</a> .
10-Jul-2008	18	Removed package TO-220, modified <a href="#">Table 1 on page 1</a> .

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