LD2981 series

Ultra low drop voltage regulators with inhibit
Low ESR output capacitors compatible

Feature summary

- Stable with low ESR ceramic capacitors
- Ultra low dropout voltage (0.17V typ. at 100mA load, 7mV typ. at 1mA load)
- Very low quiescent current (80µA typ. at no load in on mode; max 1µA in off mode)
- Guaranteed output current up to 100mA
- Logic-controlled electronic shutdown
- Output voltage of 1.5; 1.8; 2.5; 3.0; 3.3; 3.6; 3.8; 5.0V
- Internal current and thermal limit
- ± 0.75% Tolerance output voltage available (A version)
- Output low noise voltage 160µVRMS
- Temperature range: -40 to 125°C
- Smallest package SOT23-5L and SOT-89
- Fast dynamic response to line and load changes

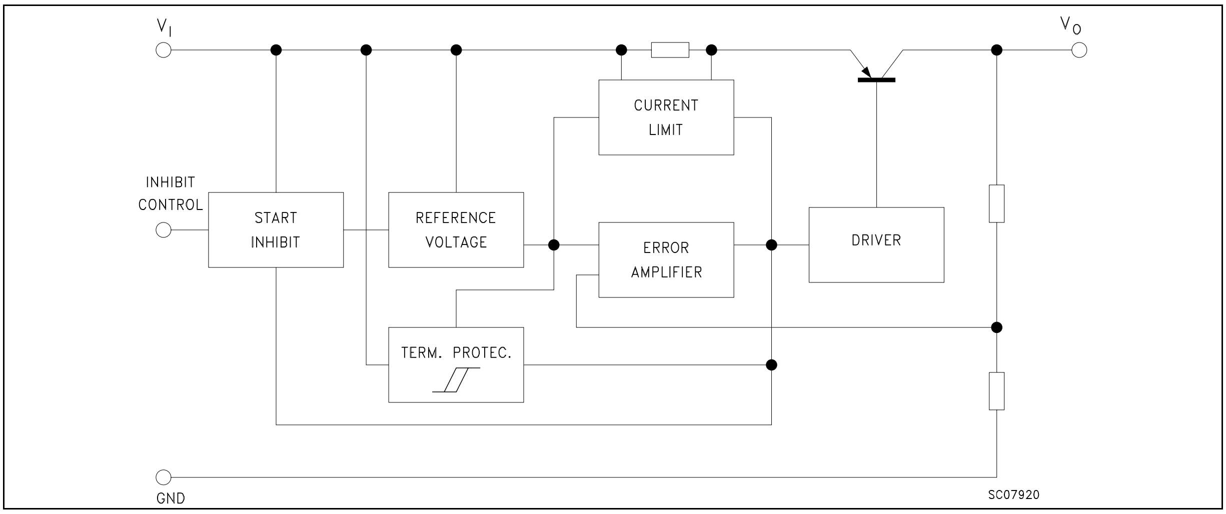
SOT23-5L SOT-89

Description

The LD2981 series are 100mA fixed-output voltage regulator. The low drop-voltage and the ultra low quiescent current make them suitable for low noise, low power applications and in battery powered systems.

The quiescent current in sleep mode is less than 1µA when INHIBIT pin is pulled low. Shutdown Logic Control function is available on pin n.3 (TTL compatible). This means that when the device is used as local regulator, it is possible to put a part of the board in standby, decreasing the total power consumption. The LD2981 is designed to work with low ESR ceramic capacitor. Typical applications are in cellular phone, palmtop/laptop computer, personal digital assistant (PDA), personal stereo, camcorder and camera.

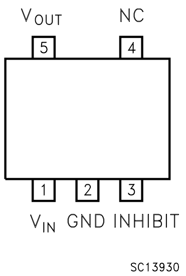
Schematic diagram



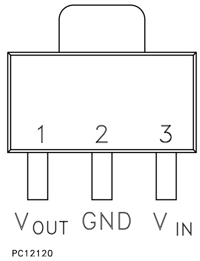
Contents

1 Pin configuration

Figure 1. Pin connections (top view)



SOT23-5L



TO-92

Table 1. Pin description

Pin N° SOT23-5L	Pin N° SOT-89	Symbol	Name and Function
1	3	V_{IN}	Input port
2	2	GND	Ground pin
3		INHIBIT	Control switch ON/OFF. Inhibit is not internally pulled-up; it cannot be left floating. Disable the device when connected to GND or to a positive voltage less than 0.18V
4		NC	Not connected
5	1	V_{OUT}	Output port

Table 2. Thermal data

Symbol	Parameter	SOT23-5L	SOT-89	Unit
R_{thJC}	Thermal resistance junction-case	81	15	°C/W
R_{thJA}	Thermal resistance junction-ambient	255	110	°C/W

2 Maximum ratings

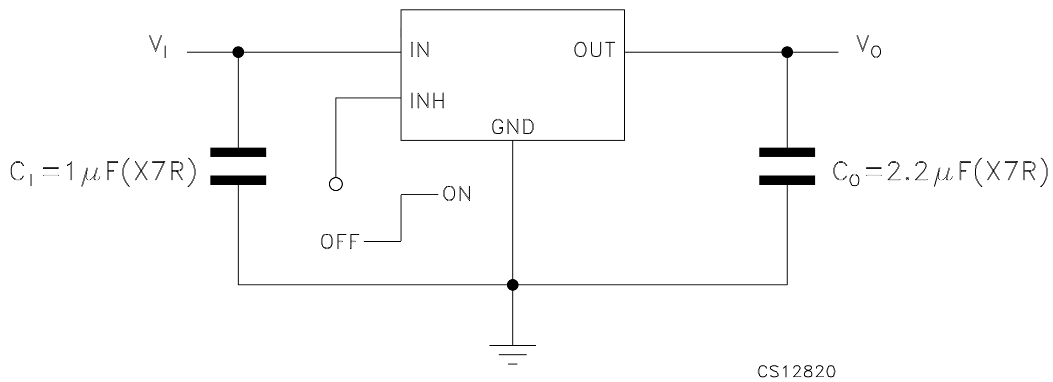
Table 3. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_I	DC Input voltage	-0.3 to 16	V
V_{INH}	INHIBIT Input voltage	-0.3 to 16	V
I_O	Output current	Internally limited	
P_D	Power dissipation	Internally limited	
T_{STG}	Storage temperature range	-55 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.

3 Typical application

Figure 2. Application circuit



Note: Inhibit Pin is not internally pulled-up then it must not be left floating. Disable the device when connected to GND or to a positive voltage less than 0.18V.

4 Electrical characteristics

Table 4. Electrical characteristics for LD2981AB (T_J = 25°C, $V_I = V_{O(NOM)}$ +1V, C_I = 1µF(X7R), C_O = 2.2µF(X7R), I_O = 1mA, V_{INH} = 2V, unless otherwise specified).

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{OP}	Operating input voltage		2.5		16	V
V_O	Output voltage	I_O = 1 mA	2.481	2.5	2.518	V
		I_O = 1 to 100 mA	2.475		2.525	
		I_O = 1 to 100 mA, T_J= -40 to 125°C	2.437		2.562	
V_O	Output voltage	I_O = 1 mA	2.828	2.85	2.872	V
		I_O = 1 to 100 mA	2.822		2.878	
		I_O = 1 to 100 mA, T_J= -40 to 125°C	2.779		2.921	
V_O	Output voltage	I_O = 1 mA	2.977	3	3.023	V
		I_O = 1 to 100 mA	2.970		3.030	
		I_O = 1 to 100 mA, T_J= -40 to 125°C	2.925		3.075	
V_O	Output voltage	I_O = 1 mA	3.176	3.2	3.224	V
		I_O = 1 to 100 mA	3.168		3.232	
		I_O = 1 to 100 mA, T_J= -40 to 125°C	3.12		3.28	
V_O	Output voltage	I_O = 1 mA	3.275	3.3	3.325	V
		I_O = 1 to 100 mA	3.267		3.333	
		I_O = 1 to 100 mA, T_J= -40 to 125°C	3.217		3.383	
V_O	Output voltage	I_O = 1 mA	3.573	3.6	3.627	V
		I_O = 1 to 100 mA	3.564		3.636	
		I_O = 1 to 100 mA, T_J= -40 to 125°C	3.510		3.690	
V_O	Output voltage	I_O = 1 mA	3.771	3.8	3.829	V
		I_O = 1 to 100 mA	3.762		3.838	
		I_O = 1 to 100 mA, T_J= -40 to 125°C	3.705		3.895	
V_O	Output voltage	I_O = 1 mA	3.97	4	4.03	V
		I_O = 1 to 100 mA	3.96		4.04	
		I_O = 1 to 100 mA, T_J= -40 to 125°C	3.9		4.1	
V_O	Output voltage	I_O = 1 mA	4.664	4.7	4.735	V
		I_O = 1 to 100 mA	4.653		4.747	
		I_O = 1 to 100 mA, T_J= -40 to 125°C	4.582		4.817	
V_O	Output voltage	I_O = 1 mA	4.813	4.85	4.887	V
		I_O = 1 to 100 mA	4.801		4.899	
		I_O = 1 to 100 mA, T_J= -40 to 125°C	4.729		4.971	
V_O	Output voltage	I_O = 1 mA	4.962	5	5.038	V
		I_O = 1 to 100 mA	4.950		5.050	
		I_O = 1 to 100 mA, T_J= -40 to 125°C	4.875		5.125	
ΔV_O	Line regulation	$V_{O(NOM)} + 1 < V_{IN} < 16$ V, I_O = 1 mA		0.003	0.014	%/V
		T_J= -40 to 125°C			0.032	

Table 4. Electrical characteristics for LD2981AB (T_J = 25°C, $V_I = V_{O(NOM)}$ +1V, C_I = 1µF(X7R), C_O = 2.2µF(X7R), I_O = 1mA, V_{INH} = 2V, unless otherwise specified).

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_Q	Quiescent current ON MODE	I_O = 0		80	100	µA
		I_O = 0, T_J= -40 to 125°C			150	
		I_O = 1 mA		100	150	
		I_O = 1 mA, T_J= -40 to 125°C			200	
		I_O = 25 mA		250	400	
		I_O = 25 mA, T_J= -40 to 125°C			800	
		I_O = 100 mA		1000	1300	
		I_O = 100 mA, T_J= -40 to 125°C			2600	
	OFF MODE	V_{INH} < 0.3 V			0.8	
		V_{INH} < 0.15 V, T_J= -40 to 125°C			2	
V_{DROP}	Dropout voltage (*Note: 1*)	I_O = 0		1	3	mV
		I_O = 0, T_J= -40 to 125°C			5	
		I_O = 1mA		7	10	
		I_O = 1mA, T_J= -40 to 125°C			15	
		I_O = 25mA		70	100	
		I_O = 25mA, T_J= -40 to 125°C			150	
		I_O = 100mA		180	250	
		I_O = 100mA, T_J= -40 to 125°C			375	
I_{SC}	Short circuit current	R_L = 0		150		mA
SVR	Supply voltage rejection	C_O = 10µF, f = 1KHz		63		dB
V_{INH}	Inhibit input logic low	LOW = Output OFF, T_J= -40 to 125°C			0.18	V
V_{INL}	Inhibit input logic high	HIGH = Output ON, T_J= -40 to 125°C	1.6			V
I_{INH}	Inhibit input current	V_{INH} = 0V, T_J= -40 to 125°C		0	-1	µA
		V_{INH} = 5V, T_J= -40 to 125°C		5	15	
e_N	Output noise voltage	B_W = 300 Hz to 50 KHz, C_O = 10µF		160		$µV_{RMS}$
T_{SHDN}	Thermal shutdown			170		°C

Note: 1 For V_O < 2.5V dropout voltage can be calculated according to the minimum input voltage in full temperature range.

Table 5. Electrical characteristics for LD2981C (T_j = 25°C, $V_I = V_{O(NOM)}$ +1V, C_I = 1µF(X7R), C_O = 2.2µF(X7R), I_O = 1mA, V_{INH} = 2V, unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{OP}	Operating input voltage		2.5		16	V
V_O	Output voltage	I_O = 1 mA	1.478	1.5	1.522	V
		I_O = 1 to 100 mA	1.470		1.530	
		I_O = 1 to 100 mA, T_J= -40 to 125°C	1.445		1.555	
V_O	Output voltage	I_O = 1 mA	1.777	1.8	1.822	V
		I_O = 1 to 100 mA	1.764		1.836	
		I_O = 1 to 100 mA, T_J= -40 to 125°C	1.737		1.863	
V_O	Output voltage	I_O = 1 mA	2.468	2.5	2.531	V
		I_O = 1 to 100 mA	2.45		2.55	
		I_O = 1 to 100 mA, T_J= -40 to 125°C	2.412		2.587	
V_O	Output voltage	I_O = 1 mA	2.814	2.85	2.885	V
		I_O = 1 to 100 mA	2.793		2.907	
		I_O = 1 to 100 mA, T_J= -40 to 125°C	2.75		2.949	
V_O	Output voltage	I_O = 1 mA	2.962	3	3.037	V
		I_O = 1 to 100 mA	2.94		3.06	
		I_O = 1 to 100 mA, T_J= -40 to 125°C	2.895		3.105	
V_O	Output voltage	I_O = 1 mA	3.16	3.2	3.24	V
		I_O = 1 to 100 mA	3.136		3.264	
		I_O = 1 to 100 mA, T_J= -40 to 125°C	3.088		3.312	
V_O	Output voltage	I_O = 1 mA	3.258	3.3	3.341	V
		I_O = 1 to 100 mA	3.234		3.366	
		I_O = 1 to 100 mA, T_J= -40 to 125°C	3.184		3.415	
V_O	Output voltage	I_O = 1 mA	3.555	3.6	3.645	V
		I_O = 1 to 100 mA	3.528		3.672	
		I_O = 1 to 100 mA, T_J= -40 to 125°C	3.474		3.726	
V_O	Output voltage	I_O = 1 mA	3.752	3.8	3.847	V
		I_O = 1 to 100 mA	3.724		3.876	
		I_O = 1 to 100 mA, T_J= -40 to 125°C	3.667		3.933	
V_O	Output voltage	I_O = 1 mA	3.95	4	4.05	V
		I_O = 1 to 100 mA	3.92		4.08	
		I_O = 1 to 100 mA, T_J= -40 to 125°C	3.86		4.14	
V_O	Output voltage	I_O = 1 mA	4.641	4.7	4.758	V
		I_O = 1 to 100 mA	4.606		4.794	
		I_O = 1 to 100 mA, T_J= -40 to 125°C	4.535		4.864	
V_O	Output voltage	I_O = 1 mA	4.789	4.85	4.91	V
		I_O = 1 to 100 mA	4.753		4.947	
		I_O = 1 to 100 mA, T_J= -40 to 125°C	4.68		5.019	

Table 5. Electrical characteristics for LD2981C (T_j = 25°C, $V_I = V_{O(NOM)}$ +1V, C_I = 1µF(X7R), C_O = 2.2µF(X7R), I_O = 1mA, V_{INH} = 2V, unless otherwise specified)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_O	Output voltage	I_O = 1 mA	4.937	5	5.062	V
		I_O = 1 to 100 mA	4.9		5.1	
		I_O = 1 to 100 mA, T_J= -40 to 125°C	4.825		5.175	
ΔV_O	Line regulation	$V_{O(NOM)}$ + 1 < V_{IN} < 16 V, I_O = 1 mA		0.003	0.014	%/V
		T_J= -40 to 125°C			0.032	
I_Q	Quiescent current ON MODE	I_O = 0		80	100	µA
		I_O = 0, T_J= -40 to 125°C			150	
		I_O = 1 mA		100	150	
		I_O = 1 mA, T_J= -40 to 125°C			200	
		I_O = 25 mA		250	400	
		I_O = 25 mA, T_J= -40 to 125°C			800	
		I_O = 100 mA		1000	1300	
		I_O = 100 mA, T_J= -40 to 125°C			2600	
	OFF MODE	V_{INH} < 0.3 V			0.8	
		V_{INH} < 0.15 V, T_J= -40 to 125°C			2	
V_{DROP}	Dropout voltage (Note: 1)	I_O = 0		1	3	mV
		I_O = 0, T_J= -40 to 125°C			5	
		I_O = 1 mA		7	10	
		I_O = 1 mA, T_J= -40 to 125°C			15	
		I_O = 25 mA		70	100	
		I_O = 25 mA, T_J= -40 to 125°C			150	
		I_O = 100 mA		180	250	
		I_O = 100 mA, T_J= -40 to 125°C			375	
I_{SC}	Short circuit current	R_L = 0		150		mA
SVR	Supply voltage rejection	C_O = 10µF, f = 1KHz		63		dB
V_{INH}	Inhibit input logic low	LOW = Output OFF, T_J= -40 to 125°C			0.18	V
V_{INL}	Inhibit input logic high	HIGH = Output ON, T_J= -40 to 125°C	1.6			V
I_{INH}	Inhibit input current	V_{INH} = 0V, T_J= -40 to 125°C		0	-1	µF
		V_{INH} = 5V, T_J= -40 to 125°C		5	15	
e_N	Output noise voltage	B_W = 300 Hz to 50 KHz, C_O = 10µF		160		μV_{RMS}
T_{SHDN}	Thermal shutdown			170		°C

Note: 1 For V_O < 2.5V dropout voltage can be calculated according to the minimum input voltage in full temperature range.

5 Typical performance characteristics

($T_J = 25°C$, $V_I = V_{O(NOM)}$ +1V, C_I = 1µF(X7R), C_O = 2.2µF(X7R), V_{INH} = 2V, unless otherwise specified).

Figure 3. Output voltage vs temperature

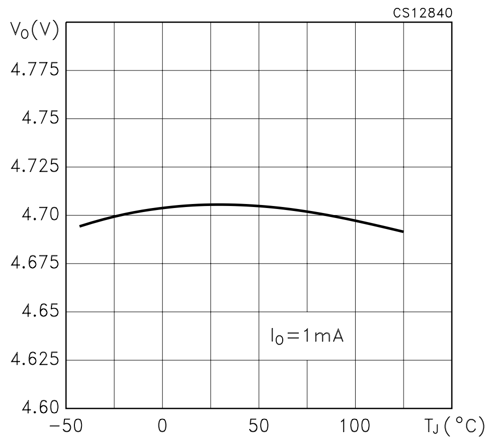


Figure 4. Output voltage vs temperature

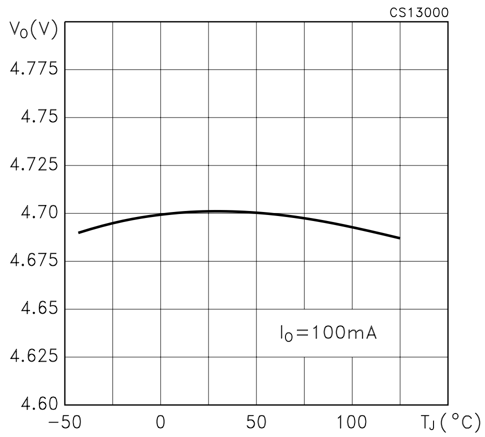


Figure 5. Line regulation vs temperature

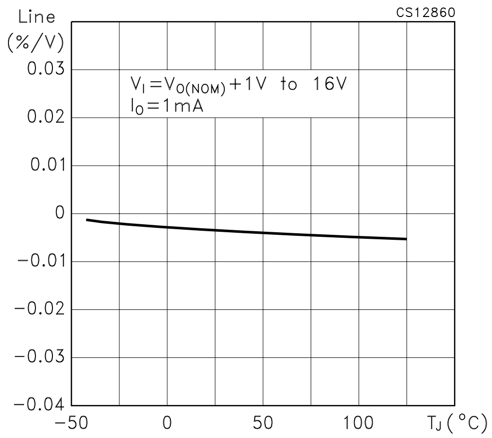


Figure 6. Load regulation vs temperature

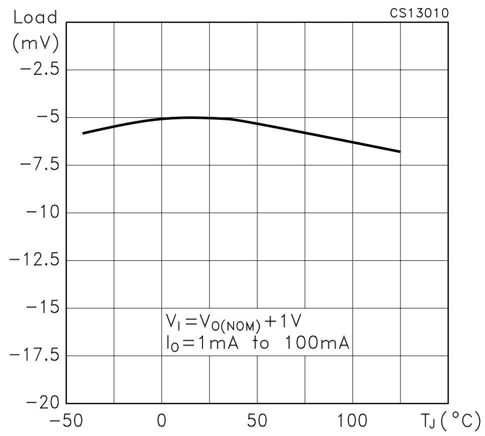


Figure 7. Dropout voltage vs temperature

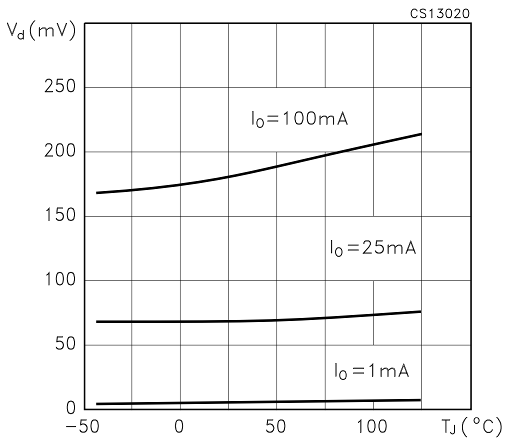


Figure 8. Quiescent current vs temperature

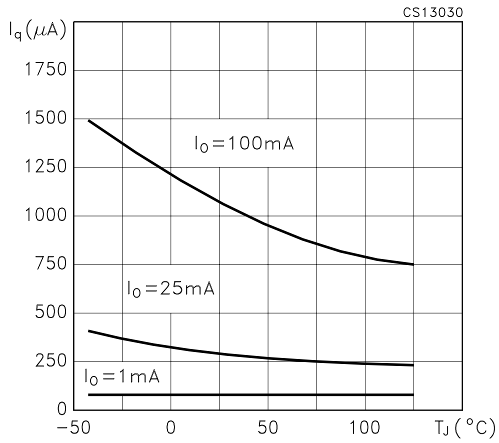


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Figure 9. Quiescent current vs output current

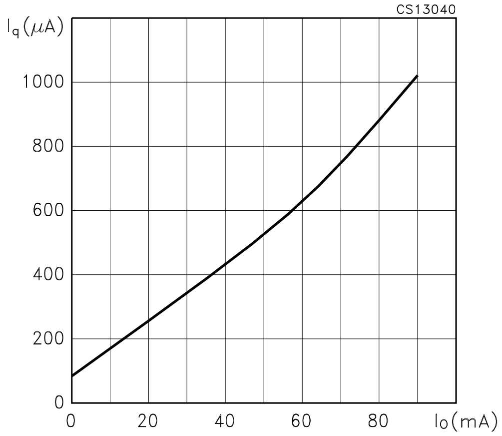

Figure 10. Off mode quiescent current vs temperature

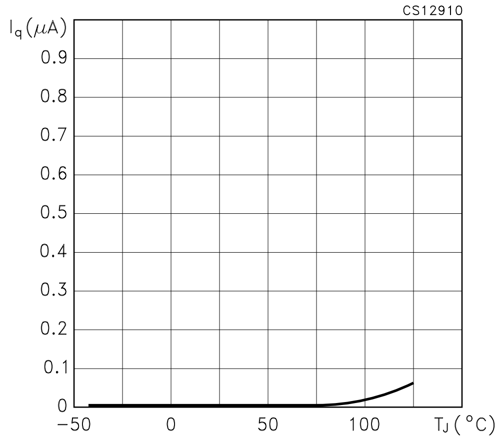

Figure 11. Quiescent current vs input voltage

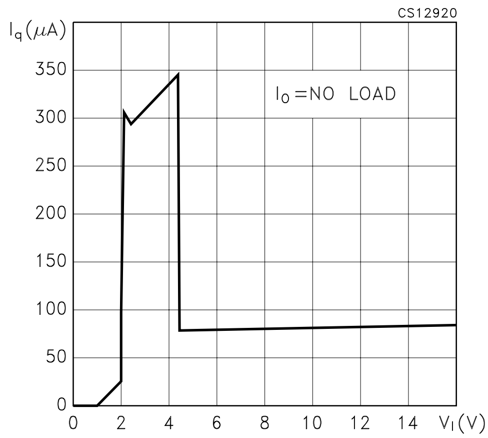

Figure 12. Dropout voltage vs output current

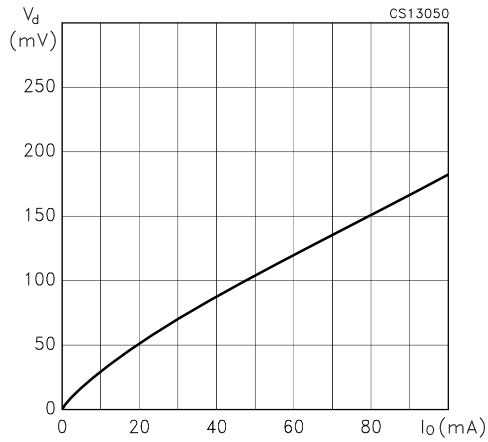

Figure 13. Inhibit input current vs temperature

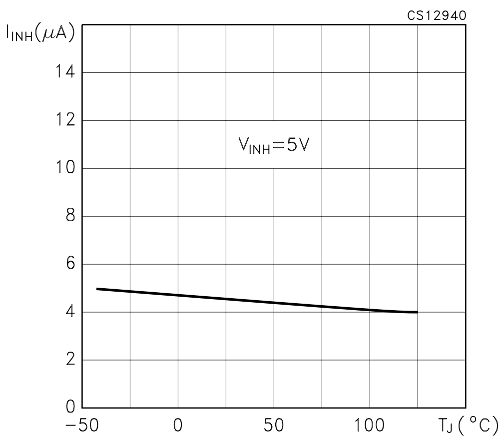

Figure 14. Inhibit voltage vs temperature

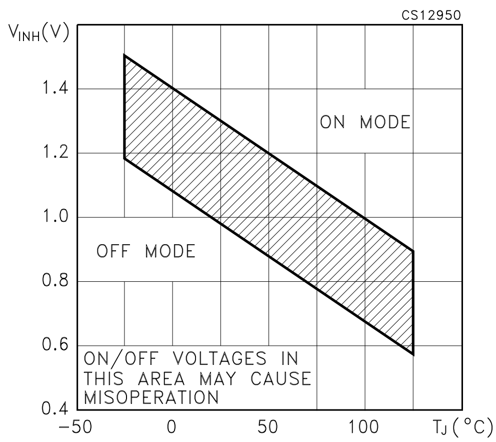

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Figure 15. Supply voltage rejection vs frequency

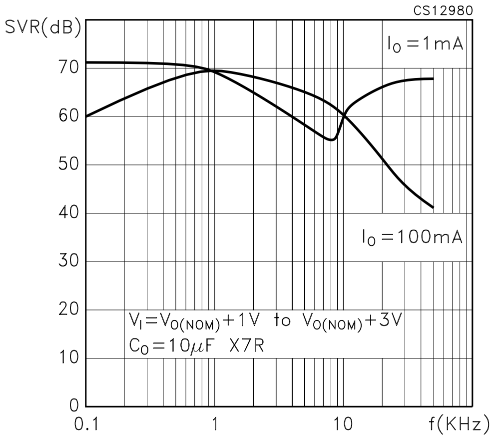


Figure 16. Noise voltage vs frequency

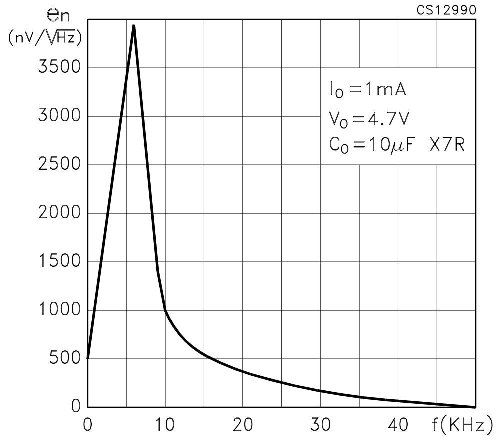


Figure 17. Best case: highest output version

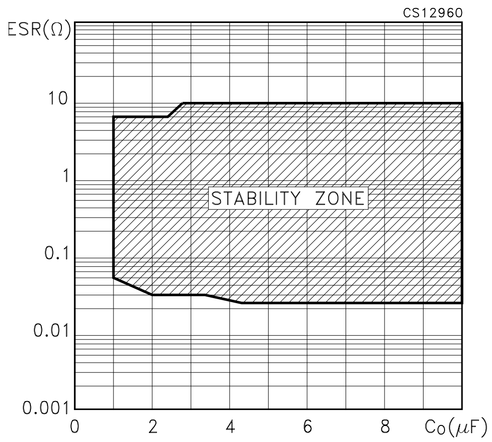


Figure 18. Worst case: lowest output version

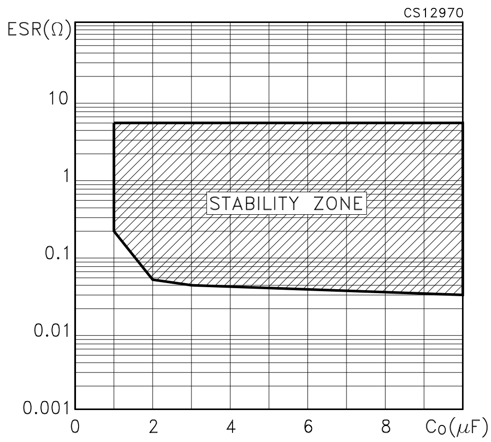
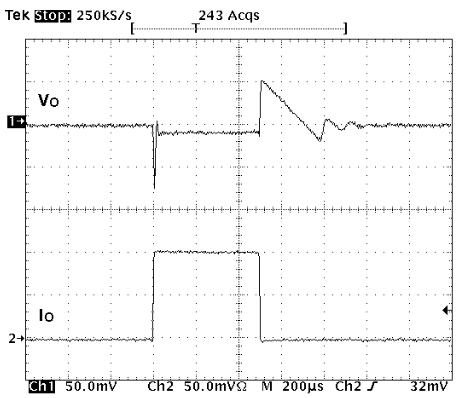
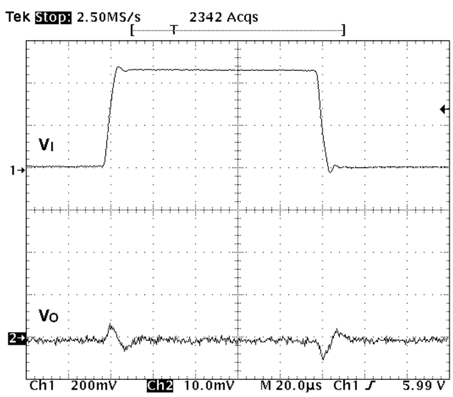


Figure 19. Load transient response



$V_O = 4.7V$, $I_O = 1$ to $100mA$, $C_O = 4.7\mu F$ (X7R)

Figure 20. Line transient response



$V_I = [V_{O(NOM)} + 1V]$, $V_O = 4.7V$, $I_O = 100mA$, $C_O = 4.7\mu F$ (X7R)

6 Application notes

6.1 External capacitors

Like any low-dropout regulator, the LD2981 requires external capacitors for regulator stability. This capacitor must be selected to meet the requirements of minimum capacitance and equivalent series resistance. We suggest to solder input and output capacitors as close as possible to the relative pins.

6.2 Input capacitor

An input capacitor whose value is 1µF is required with the LD2981 (amount of capacitance can be increased without limit). This capacitor must be located a distance of not more than 0.5" from the input pin of the device and returned to a clean analog ground. Any good quality ceramic, tantalum or film capacitors can be used for this capacitor.

6.3 Output capacitor

The LD2981 is designed specifically to work with ceramic output capacitors. It may also be possible to use Tantalum capacitors, but these are not as attractive for reasons of size and cost. By the way, the output capacitor must meet both the requirement for minimum amount of capacitance and ESR (equivalent series resistance) value. The *Figure 3.* and *Figure 4.* show the allowable ESR range as a function of the output capacitance. These curves represent the stability region over the full temperature and I_O range. Due to the different loop gain, the stability improves for higher output versions and so the suggested minimum output capacitor value, if low ESR ceramic type is used, is 1µF for output voltages equal or major than 3.8V, 2.2µF for output voltages from 2.85 to 3.3V, and 3.3µF for the other versions. However, if an output capacitor lower than the suggested one is used, it’s possible to make stable the regulator adding a resistor in series to the capacitor (see Figure1 & Figure2 to choose the right value according to the used version and keeping in account that the ESR of ceramic capacitors has been measured @ 100KHz).

6.4 Important

The output capacitor must maintain its ESR in the stable region over the full operating temperature to assure stability. Also, capacitor tolerance and variation with temperature must be considered to assure the minimum amount of capacitance is provided at all times. This capacitor should be located not more than 0.5" from the output pin of the device and returned to a clean analog ground.

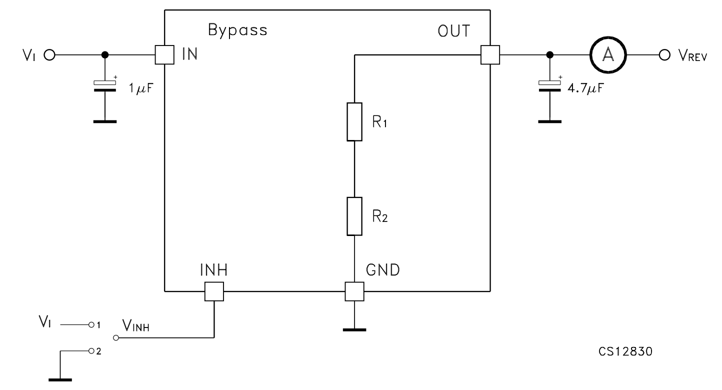
6.5 Inhibit input operation

The inhibit pin can be used to turn OFF the regulator when pulled low, so drastically reducing the current consumption down to less than 1µA. When the inhibit feature is not used, this pin must be tied to V_I to keep the regulator output ON at all times. To assure proper operation, the signal source used to drive the inhibit pin must be able to swing above and below the specified thresholds listed in the electrical characteristics section under V_{IH} V_{IL}. Any slew rate can be used to drive the inhibit.

6.6 Reverse current

The power transistor used in the LD2981 has not an inherent diode connected between the regulator input and output. If the output is forced above the input, no current will flow from the output to the input across the series pass transistor. When a V_{REV} voltage is applied on the output, the reverse current measured, according to the test circuit in *Figure 21.*, flows to the GND across the two feedback resistors. This current typical value is 160µA. R_1 and R_2 resistors are implanted type; typical values are, respectively, 42.6 KΩ and 51.150 KΩ

Figure 21. Reverse current test circuit

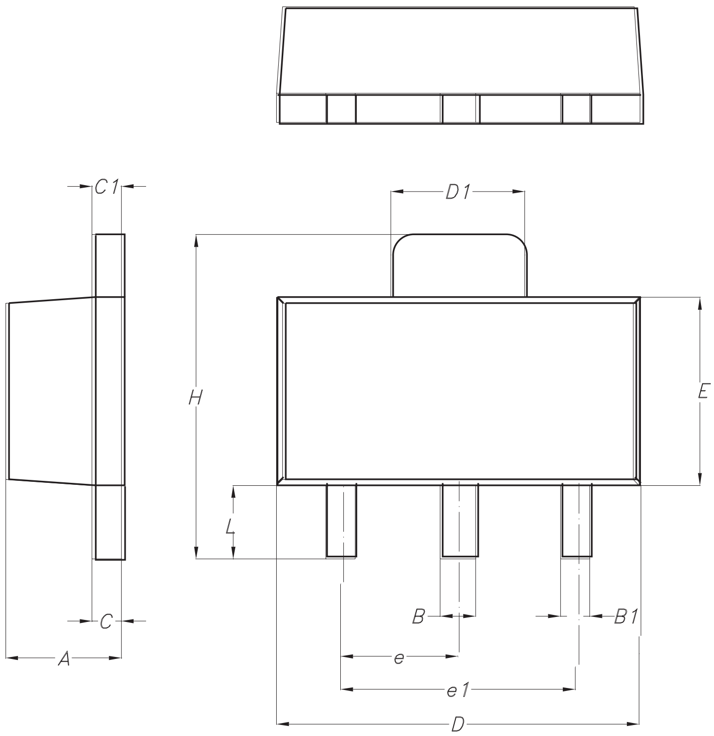


7 Package mechanical data

In order to meet environmental requirements, ST offers these devices in ECOPACK® 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.

SOT-89 MECHANICAL DATA

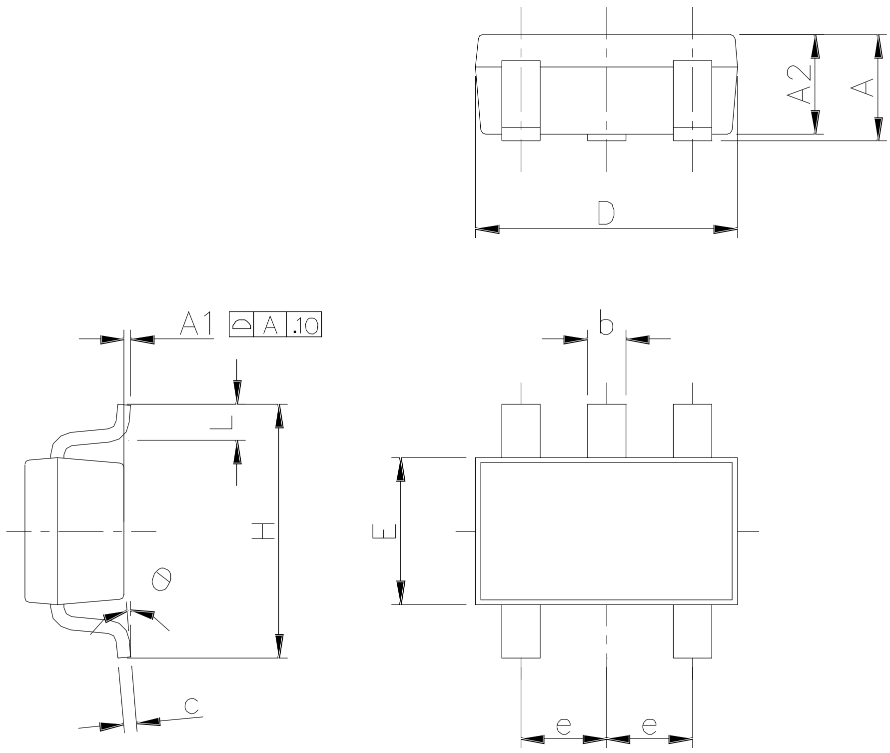
DIM.	mm.			mils		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	1.4		1.6	55.1		63.0
B	0.44		0.56	17.3		22.0
B1	0.36		0.48	14.2		18.9
C	0.35		0.44	13.8		17.3
C1	0.35		0.44	13.8		17.3
D	4.4		4.6	173.2		181.1
D1	1.62		1.83	63.8		72.0
E	2.29		2.6	90.2		102.4
e	1.42		1.57	55.9		61.8
e1	2.92		3.07	115.0		120.9
H	3.94		4.25	155.1		167.3
L	0.89		1.2	35.0		47.2



P025H

SOT23-5L MECHANICAL DATA

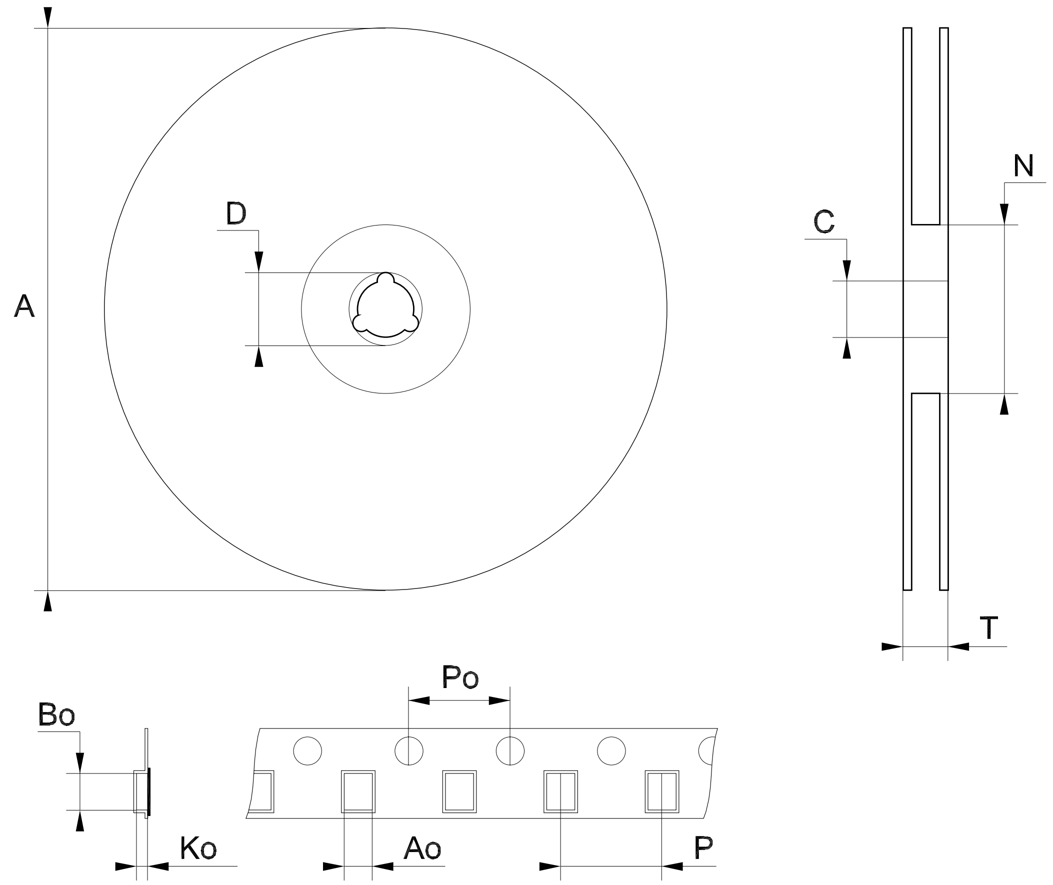
DIM.	mm.			mils		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A	0.90		1.45	35.4		57.1
A1	0.00		0.10	0.0		3.9
A2	0.90		1.30	35.4		51.2
b	0.35		0.50	13.7		19.7
C	0.09		0.20	3.5		7.8
D	2.80		3.00	110.2		118.1
E	1.50		1.75	59.0		68.8
e		0.95			37.4	
H	2.60		3.00	102.3		118.1
L	0.10		0.60	3.9		23.6



7049676C

Tape & Reel SOT23-xL MECHANICAL DATA

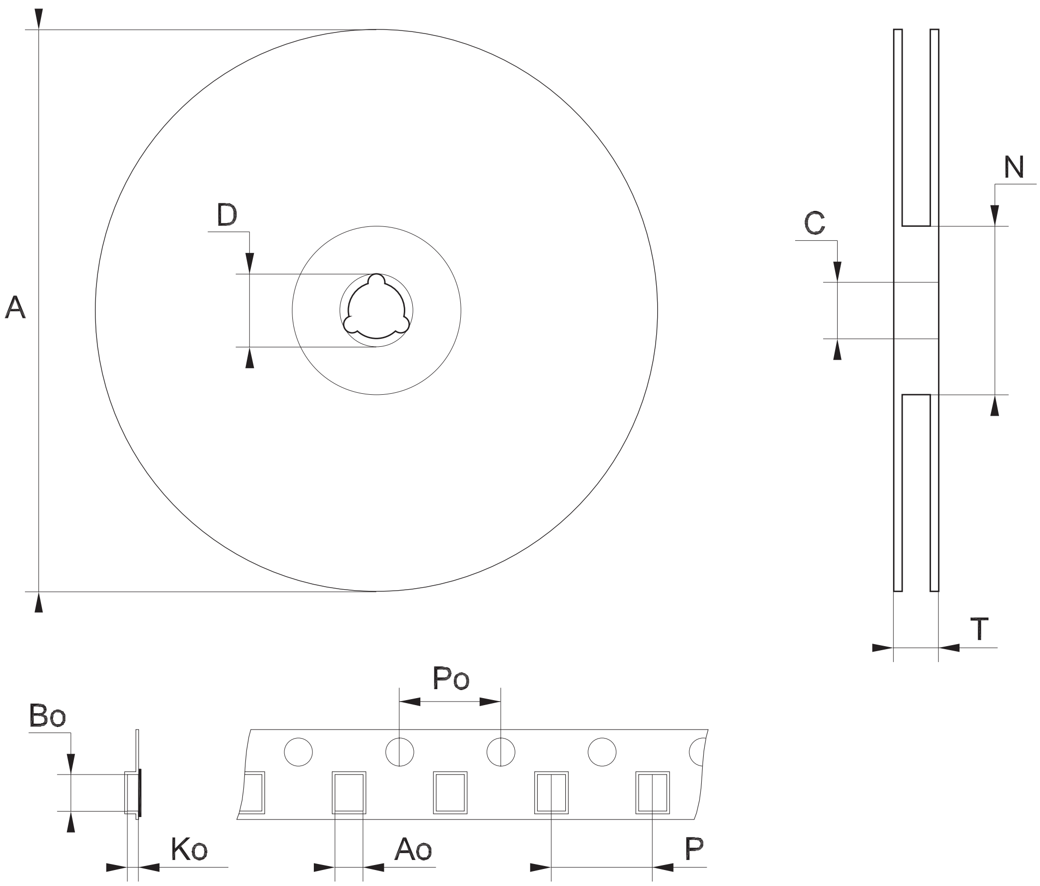
DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			180			7.086
C	12.8	13.0	13.2	0.504	0.512	0.519
D	20.2			0.795		
N	60			2.362		
T			14.4			0.567
Ao	3.13	3.23	3.33	0.123	0.127	0.131
Bo	3.07	3.17	3.27	0.120	0.124	0.128
Ko	1.27	1.37	1.47	0.050	0.054	0.0.58
Po	3.9	4.0	4.1	0.153	0.157	0.161
P	3.9	4.0	4.1	0.153	0.157	0.161



Note: Drawing not in scale

Tape & Reel SOT89 MECHANICAL DATA

DIM.	mm.			inch		
	MIN.	TYP	MAX.	MIN.	TYP.	MAX.
A			180			7.086
C	12.8	13.0	13.2	0.504	0.512	0.519
D	20.2			0.795		
N	60			2.362		
T			14.4			0.567
Ao	4.70	4.80	4.90	0.185	0.189	0.193
Bo	4.30	4.40	4.50	0.169	0.173	0.177
Ko	1.70	1.80	1.90	0.067	0.071	0.075
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



Note: Drawing not in scale

8 Order code

Table 6. Order code

Part number				Output voltage
AB Version		C Version		
SOT23-5L	SOT-89	SOT23-5L	SOT-89	
		LD2981CM15TR		1.5 V
		LD2981CM18TR	LD2981CU18TR	1.8 V
LD2981ABM25TR	LD2981ABU25TR (1)	LD2981CM25TR	LD2981CU25TR (1)	2.5 V
LD2981ABM30TR	LD2981ABU30TR (1)	LD2981CM30TR	LD2981CU30TR (1)	3.0 V
LD2981ABM33TR	LD2981ABU33TR	LD2981CM33TR	LD2981CU33TR	3.3 V
LD2981ABM36TR	LD2981ABU36TR (1)	LD2981CM36TR	LD2981CU36TR (1)	3.6 V
LD2981ABM38TR	LD2981ABU38TR (1)	LD2981CM38TR	LD2981CU38TR (1)	3.8 V
LD2981ABM50TR	LD2981ABU50TR	LD2981CM50TR	LD2981CU50TR	5.0 V

1. Available on request.

9 Revision history

Table 7. Revision history

Date	Revision	Changes
25-Jul-2006	12	Order Codes has been updated and new template.