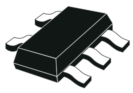
Ultra low drop voltage regulators compatible with low ESR output capacitors

Datasheet - production data



SOT23-5L

Features

- Stable with low ESR ceramic capacitors
- Ultra low dropout voltage (0.12 V typ. at 50 mA load, 7 mV typ. at 1 mA load)
- Very low quiescent current (80 μA typ. at no load in on mode; max 1 μA in off mode)
- Guaranteed output current up to 50 mA
- Logic-controlled electronic shutdown
- Output voltage of 1.8; 3.0; 3.3; 5.0 V
- Internal current and thermal limit
- ± 0.5% Tolerance output voltage available (A version)
- Output low noise voltage 160 μVRMS
- Temperature range: -40 to 125 °C
- Smallest package SOT23-5L
- Fast dynamic response to line and load changes

Description

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 1 μA when the INHIBIT pin is pulled low. A 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 LD2980 is designed to work with low ESR ceramic capacitors. Typical applications are cellular phone, laptop computer, personal digital assistant (PDA), personal stereo, camcorder and camera.

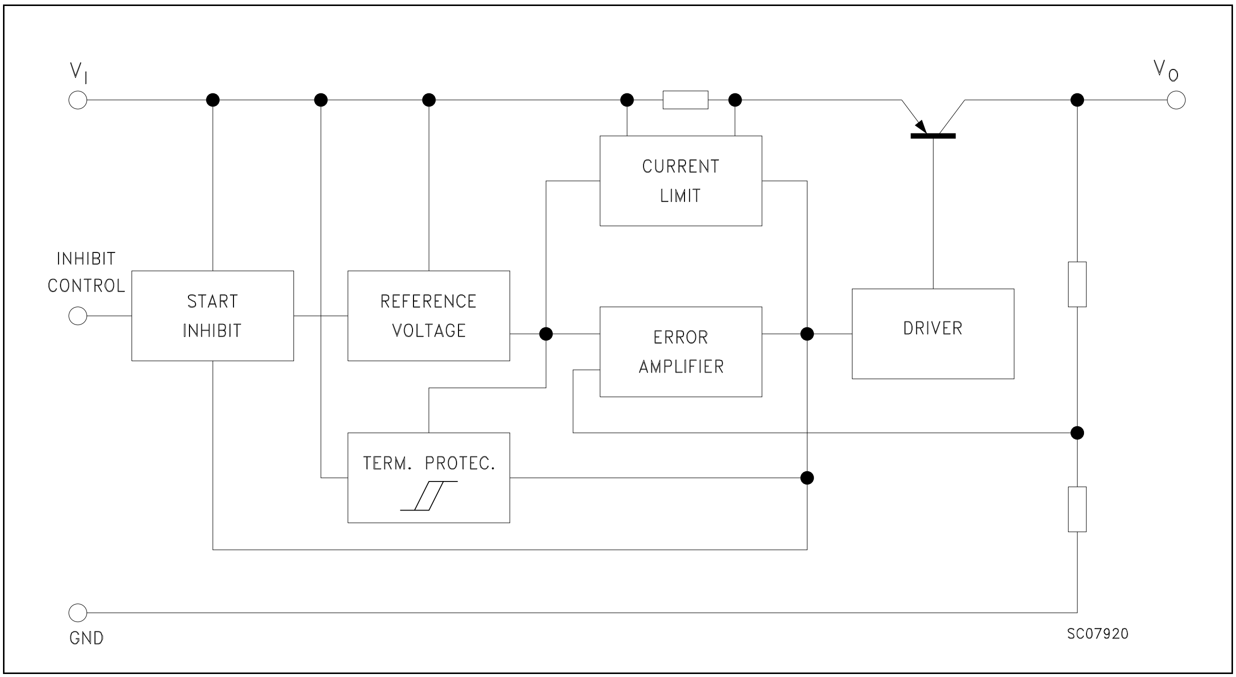
Table 1. Device summary

Part numbers		
AB version	**C version**	**Output voltage**
	LD2980CM18TR	1.8 V
LD2980ABM30TR		3.0 V
LD2980ABM33TR	LD2980CM33TR	3.3 V
LD2980ABM50TR	LD2980CM50TR	5.0 V

Contents

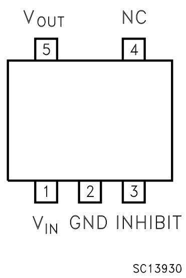
1 Diagram

Figure 1. Schematic diagram



2 Pin configuration

Figure 2. Pin connections (top view)



SOT23-5L

Table 2. Pin description

Pin n°	Symbol	Name and function
1	V_{IN}	Input port
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 0.18 V
4	NC	Not connected
5	V_{OUT}	Output port

Table 3. Thermal data

Symbol	Parameter	Value	Unit
R_{thJC}	Thermal resistance junction-case	81	°C/W
R_{thJA}	Thermal resistance junction-ambient	255	°C/W

3 Maximum ratings

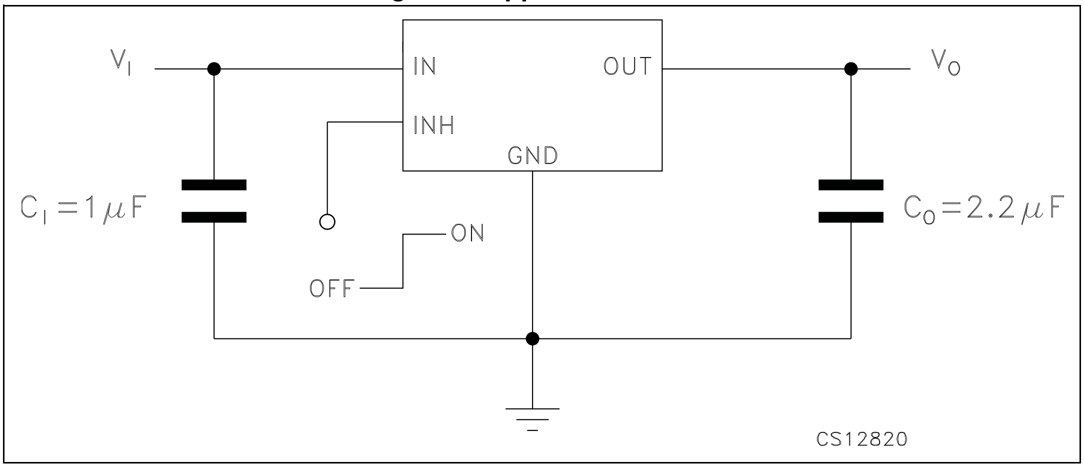
Table 4. Absolute maximum ratings

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.

4 Typical application

Figure 3. 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 0.18 V.

5 Electrical characteristics

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

Table 5. Electrical characteristics for LD2980ABM

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	2.985	3	3.015	V
		I_O = 1 to 50 mA	2.978		3.023	
		I_O = 1 to 50 mA, T_J= -40 to 125°C	2.925		3.075	
V_O	Output voltage	I_O = 1 mA	3.284	3.3	3.317	V
		I_O = 1 to 50 mA	3.275		3.325	
		I_O = 1 to 50 mA, T_J= -40 to 125°C	3.217		3.383	
V_O	Output voltage	I_O = 1 mA	4.975	5	5.025	V
		I_O = 1 to 50 mA	4.963		5.038	
		I_O = 1 to 50 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	
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 = 10 mA		175	250	
		I_O = 10 mA, T_J= -40 to 125°C			450	
		I_O = 50 mA		500	700	
		I_O = 50 mA, T_J= -40 to 125°C			1200	
	OFF MODE	V_{INH} < 0.18 V		0		
		V_{INH} < 0.18 V, T_J= -40 to 125°C			1	
V_{DROP}	Dropout voltage(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 = 10mA		40	60	
		I_O = 10mA, T_J= -40 to 125°C			90	
		I_O = 50mA		120	150	
		I_O = 50mA, T_J= -40 to 125°C			225	

Table 5. Electrical characteristics for LD2980ABM (continued)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
I_{SC}	Short circuit current	$R_L = 0$		150		mA
SVR	Supply voltage rejection	$C_O = 10\mu F$, f = 1kHz		63		dB
V_{INH}	Inhibit input logic low	LOW = Output OFF, T_J= -40 to 125°C		0.8	0.18	V
V_{INL}	Inhibit input logic high	HIGH = Output ON, T_J= -40 to 125°C	1.6	1.3		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, $C_O = 10\mu F$		160		μV_{RMS}
T_{SHDN}	Thermal shutdown			170		°C

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

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

Table 6. Electrical characteristics for LD2980CM

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	1.782	1.8	1.818	V
		I_O = 1 to 50 mA	1.773		1.827	
		I_O = 1 to 50 mA, T_J= -40 to 125°C	1.737		1.863	
V_O	Output voltage	I_O = 1 mA	3.267	3.3	3.333	V
		I_O = 1 to 50 mA	3.251		3.35	
		I_O = 1 to 50 mA, T_J= -40 to 125°C	3.184		3.415	
V_O	Output voltage	I_O = 1 mA	4.95	5	5.05	V
		I_O = 1 to 50 mA	4.925		5.075	
		I_O = 1 to 50 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 = 10 mA		175	250	
		I_O = 10 mA, T_J= -40 to 125°C			450	
		I_O = 50 mA		500	700	
		I_O = 50 mA, T_J= -40 to 125°C			1200	
	OFF MODE	V_{INH} < 0.18 V		0		
		V_{INH} < 0.18 V, T_J= -40 to 125°C			1	
V_{DROP}	Dropout voltage (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 = 10mA		40	60	
		I_O = 10mA, T_J= -40 to 125°C			90	
		I_O = 50mA		120	150	
		I_O = 50mA, T_J= -40 to 125°C			225	
I_{SC}	Short circuit current	R_L = 0		150		mA
SVR	Supply voltage rejection	C_O = 10μF, f = 1kHz		63		dB

Table 6. Electrical characteristics for LD2980CM (continued)

Symbol	Parameter	Test conditions	Min.	Typ.	Max.	Unit
V_{INH}	Inhibit input logic low	LOW = Output OFF, T_J= -40 to 125°C		0.8	0.18	V
V_{INL}	Inhibit input logic high	HIGH = Output ON, T_J= -40 to 125°C	1.6	1.3		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

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

6 Typical performance characteristics

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

Figure 4. Output voltage vs temperature

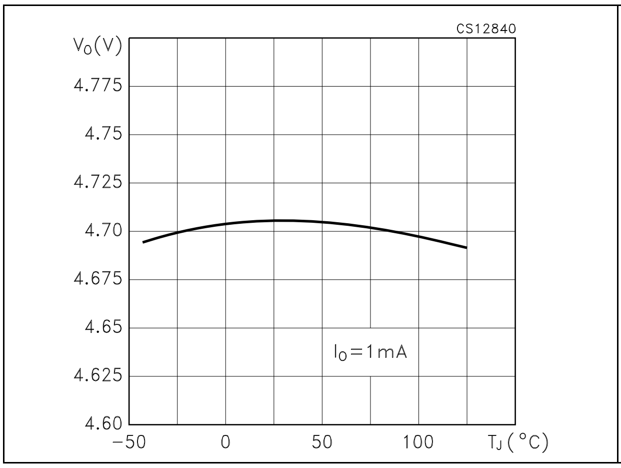


Figure 5. Output voltage vs temperature

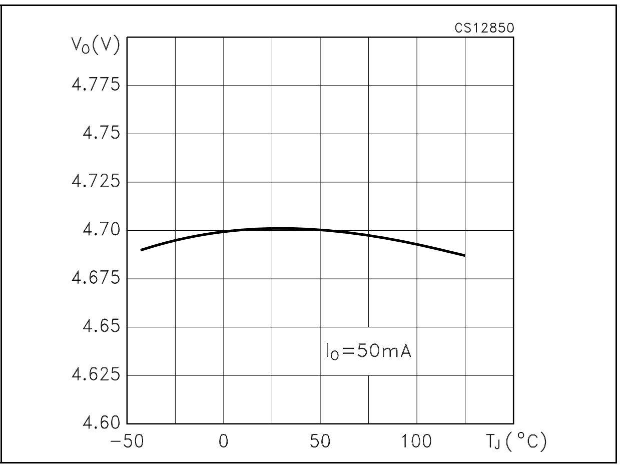


Figure 6. Line regulation vs temperature

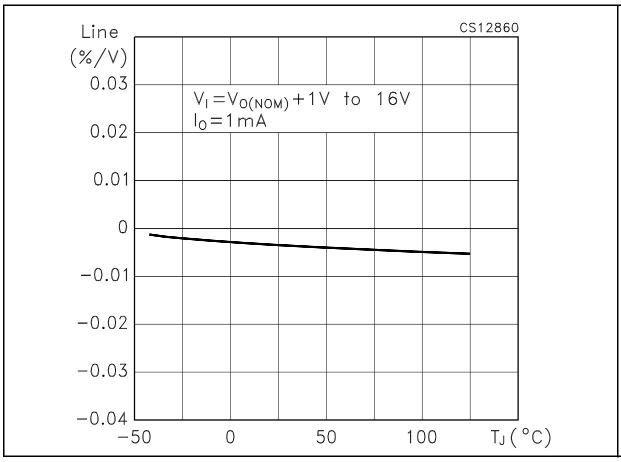


Figure 7. Load regulation vs temperature

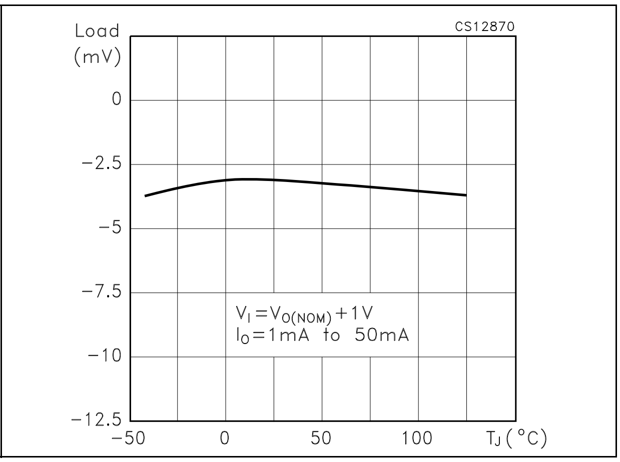


Figure 8. Dropout voltage vs temperature

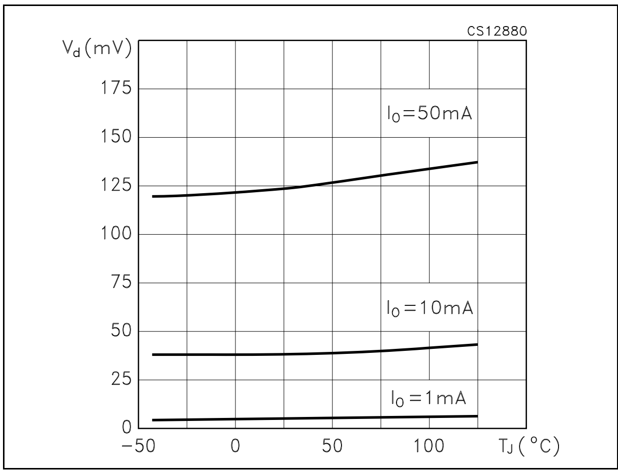


Figure 9. Quiescent current vs temperature

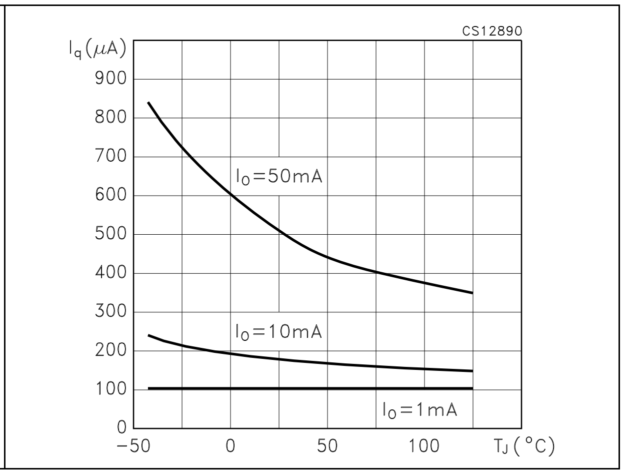


Figure 10. Quiescent current vs output current

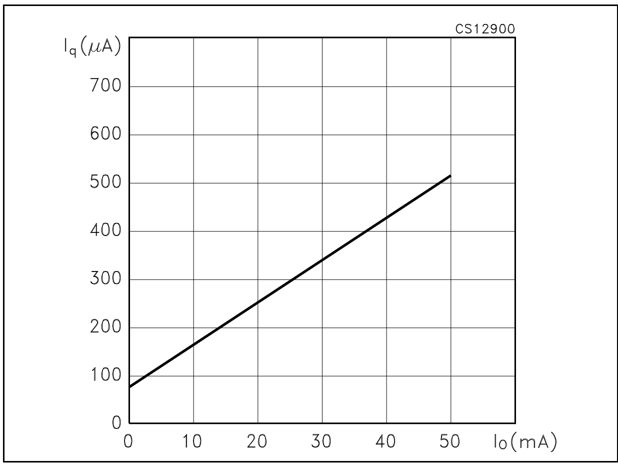


Figure 11. Off mode quiescent current vs temperature

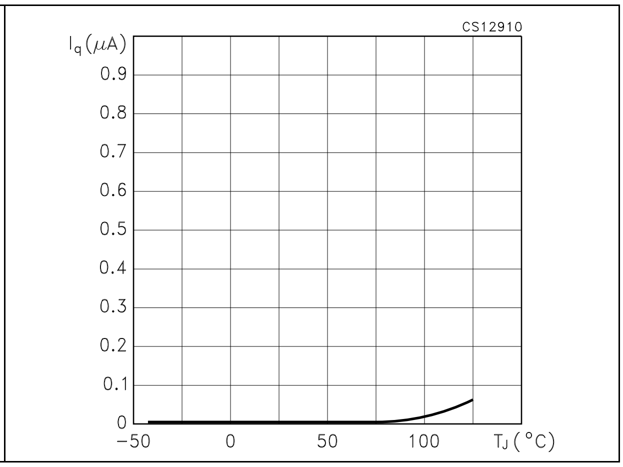


Figure 12. Quiescent current vs input voltage

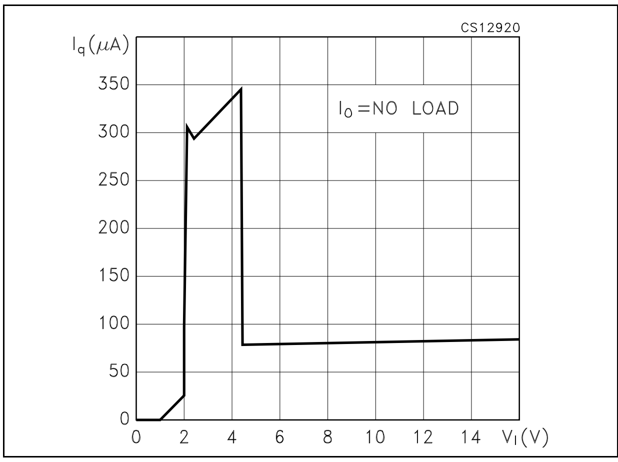
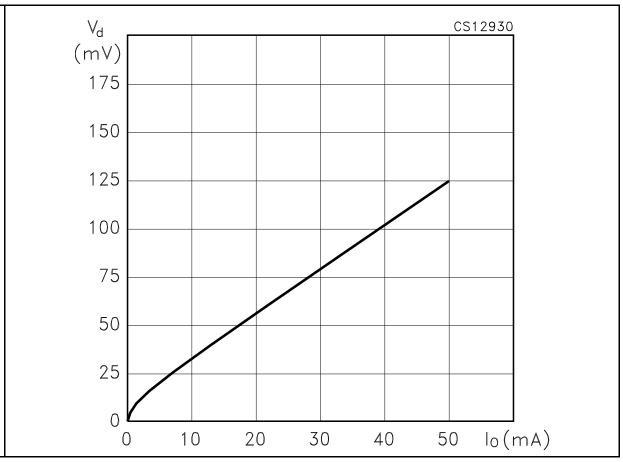


Figure 13. Dropout voltage vs output current



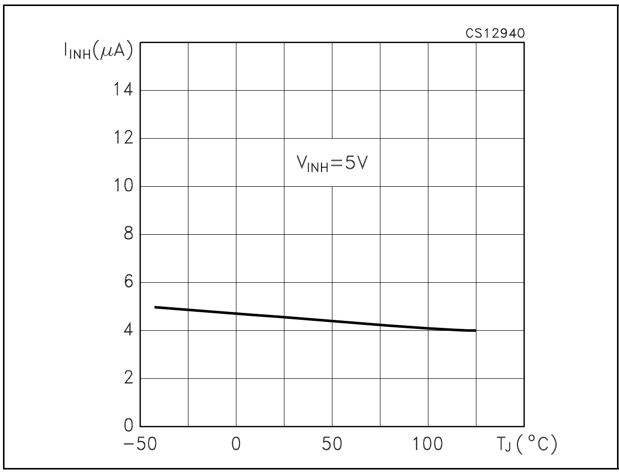


Figure 14. Inhibit input current vs temperature

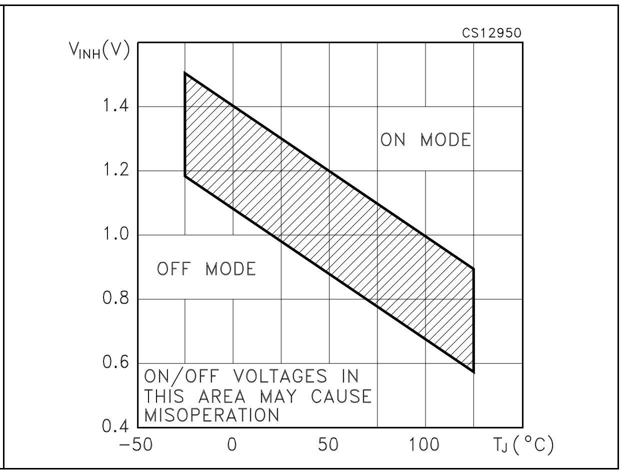


Figure 15. Inhibit voltage vs temperature

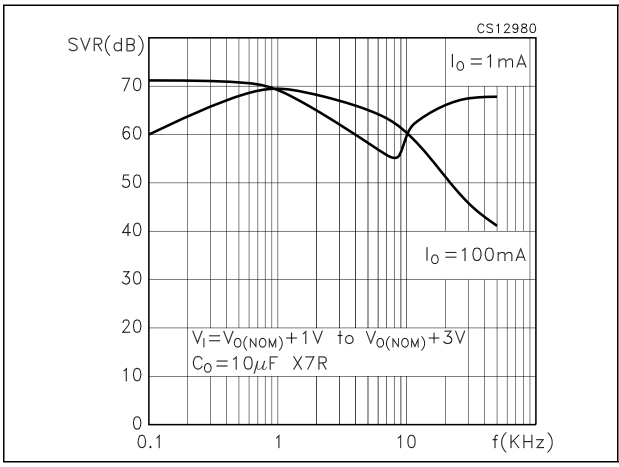


Figure 16. Supply voltage rejection vs frequency

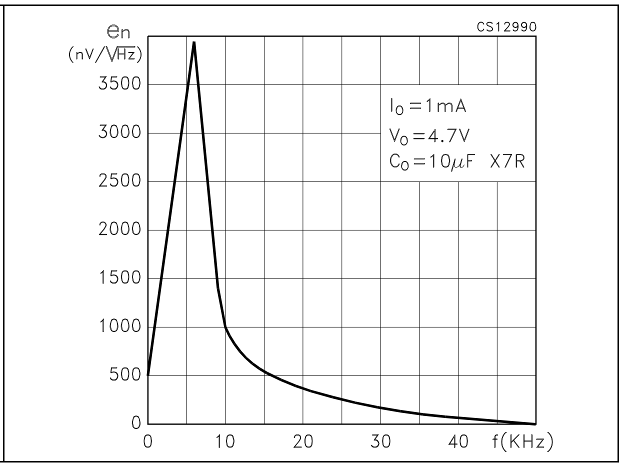


Figure 17. Noise voltage vs frequency

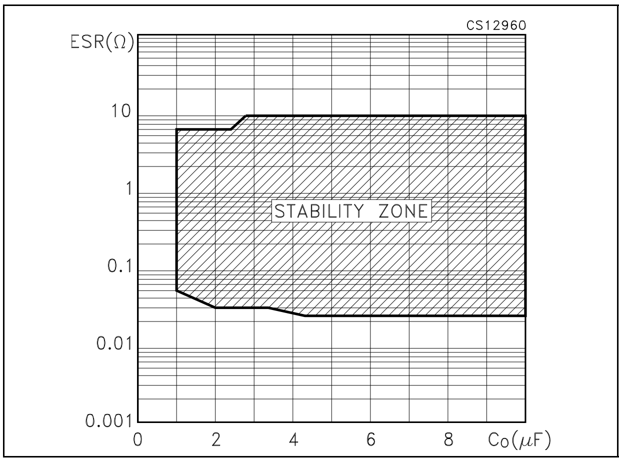


Figure 18. Best case: highest output version

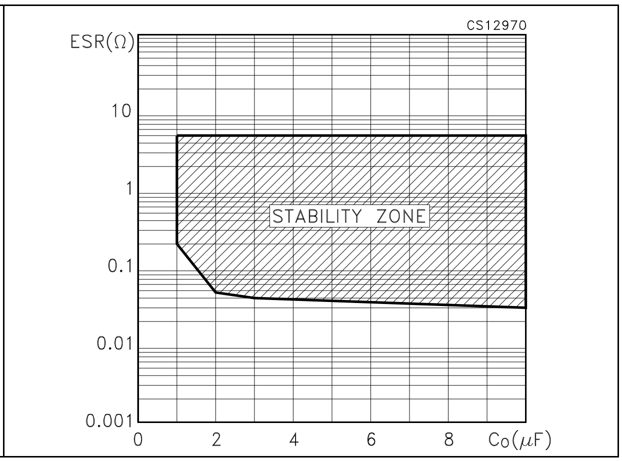
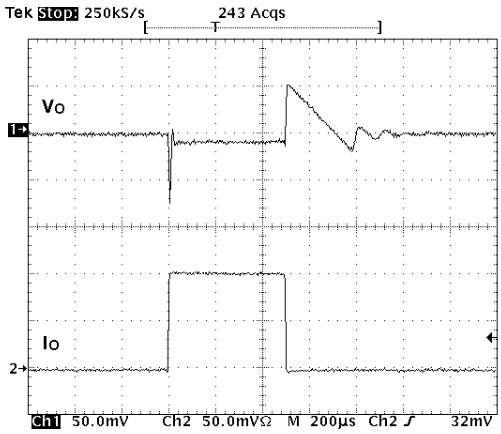


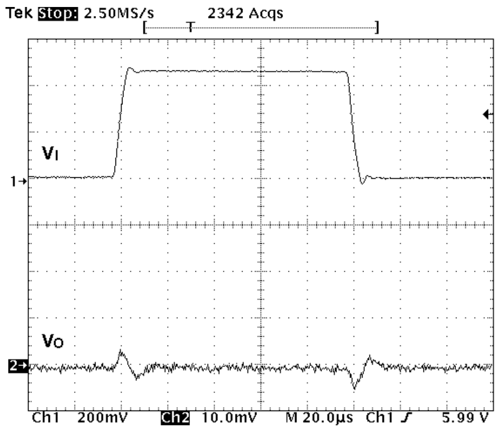
Figure 19. Worst case: lowest output version

Figure 20. Load transient response



V_O = 4.7V, I_O = 1 to 100mA, C_O = 4.7μF (X7R)

Figure 21. Line transient response



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

7 Application notes

7.1 External capacitors

Like any low-dropout regulator, the LD2980 requires external capacitors for regulator stability. This capacitor must be selected to meet the requirements of minimum capacitance and equivalent series resistance (please refer to *Figure 18* and *Figure 19*). We suggest to solder input and output capacitors as close as possible to the relative pins.

7.2 Input capacitor

An input capacitor whose value is 1 μF is required with the LD2980 (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.

7.3 Output capacitor

The LD2980 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 18* and *Figure 19* 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 1 μF for output voltages equal or major than 3.8 V, 2.2 μF for output voltages from 2.85 to 3.3 V, and 3.3 μF 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 *Figure 18* and *Figure 19* to choose the right value according to the used version and keeping in account that the ESR of ceramic capacitors has been measured @ 100 kHz).

7.4 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.

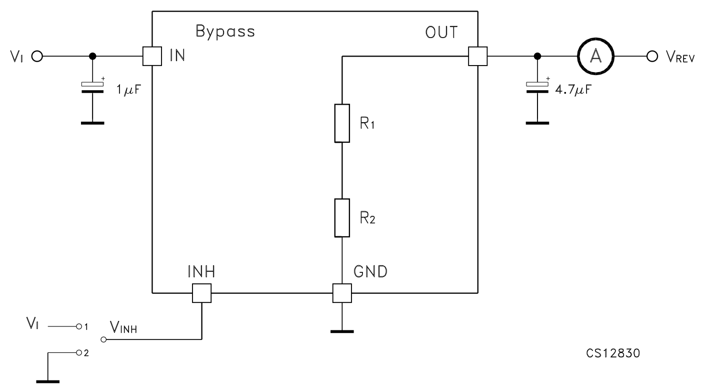
7.5 Inhibit input operation

The inhibit pin can be used to turn OFF the regulator when pulled low, so drastically reducing the current consumption down to less than 1 μA. 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.

7.6 Reverse current

The power transistor used in the LD2980 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 22*, flows to the GND across the two feedback resistors. This current typical value is 160 μA. R_1 and R_2 resistors are implanted type; typical values are, respectively, 42.6 kΩ and 51.150 kΩ.

Figure 22. Reverse current test circuit



8 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.

Table 7. SOT23-5L mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	0.90		1.45
A1	0		0.15
A2	0.90		1.30
b	0.30		0.50
c	2.09		0.20
D		2.95	
E		1.60	
e		0.95	
H		2.80	
L	0.30		0.60
θ	0		8

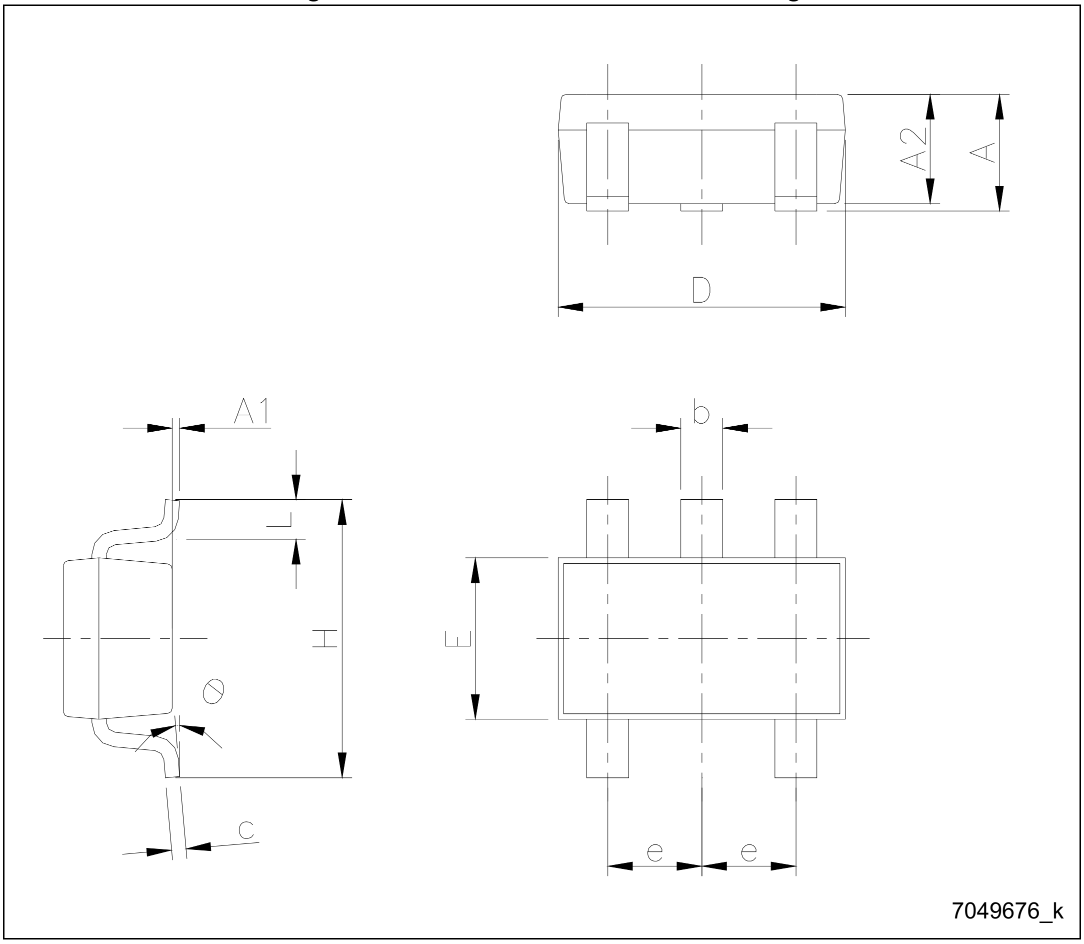


Figure 23. SOT23-5L mechanical drawing

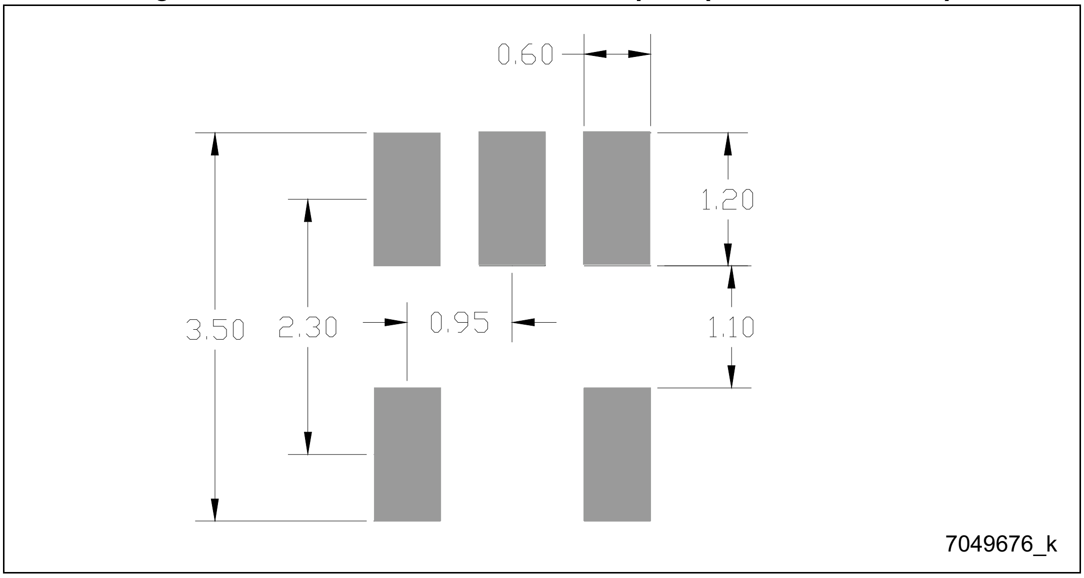


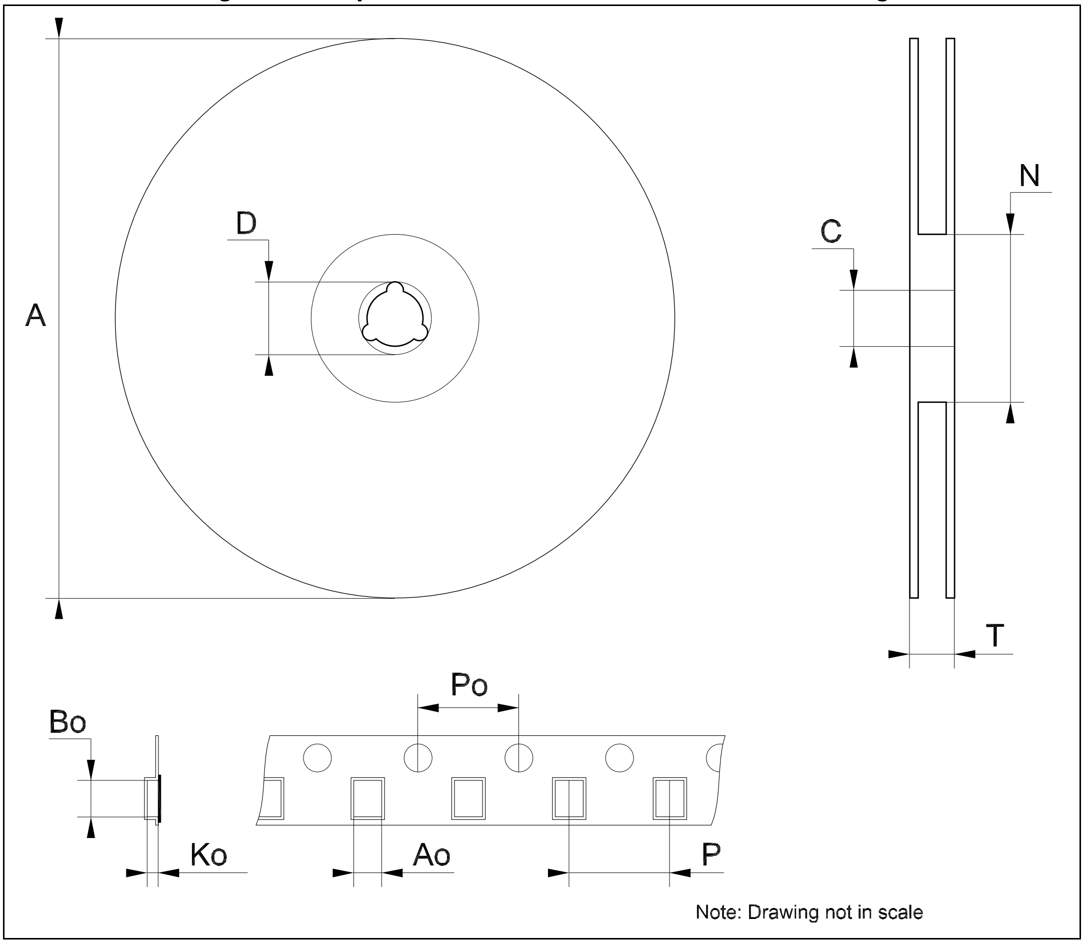
Figure 24. SOT23-5L recommended footprint (dimensions in mm)

9 Packaging mechanical data

Table 8. Tape and reel SOT23-5L mechanical data

Dim.	mm		
	Min.	**Typ.**	**Max.**
A			180
C	12.8	13.0	13.2
D	20.2		
N	60		
T			14.4
Ao	3.13	3.23	3.33
Bo	3.07	3.17	3.27
Ko	1.27	1.37	1.47
Po	3.9	4.0	4.1
P	3.9	4.0	4.1

Figure 25. Tape and reel SOT23-5L mechanical drawing



10 Revision history

Table 9. Document revision history

Date	Revision	Changes
03-Jul-2006	13	Order codes updated and new template.
13-Nov-2006	14	Add part number LD2980ABU18TR.
06-Sep-2007	15	Add *Table 1 on page 1*.
14-Feb-2008	16	Modified: *Table 1 on page 1*.
11-Jul-2008	17	Modified: *Table 1 on page 1*.
06-Nov-2013	18	Document name changed from LD2980ABxx and LD2980Cxx to LD2980. Updated *Table 1: Device summary*, *Table 5: Electrical characteristics for LD2980ABM*, *Table 6: Electrical characteristics for LD2980CM* and *Section 8: Package mechanical data*. Added *Section 9: Packaging mechanical data*. Minor text changes in title, in features and description in cover page.