

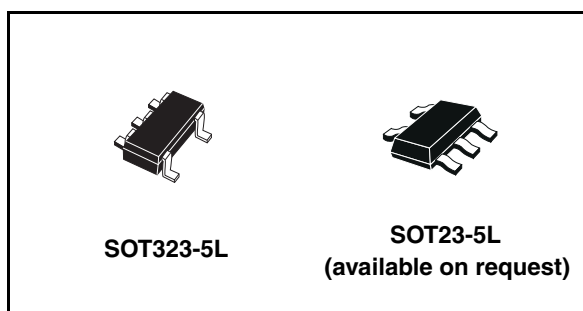
## 50 mA, 3 $\mu$ A supply current low drop linear regulator

### Features

- 2.3 V to 12 V input voltage range
- 50 mA maximum output current
- 3  $\mu$ A quiescent current
- Available in 1.8 V, 2.5 V, 3.3 V, 5.0 V and adjustable
- 200 mV dropout voltage at 25 mA output current
- Internal thermal protection
- Available in SOT323-5L package, and SOT23-5L package (upon request)

### Applications

- Portable/battery powered equipments
- Electronic sensors
- Microcontroller power
- Real time clock backup power



### Description

The STLQ50 is a BiCMOS linear regulator specifically designed for operating in environment with very low power consumption constraints.

Due to the very low quiescent current (3  $\mu$ A) the device is suitable for those application that have very long stand-by time allowing extension of battery life.

The P-MOS pass element allows also a very good drop-out figure (200 mV at 25 mA  $I_O$  and 350 mV at full load) without affecting the consumption characteristics.

Housed in the very small SOT323-5L or SOT23-5L, it fulfils the space saving requirements in battery powered equipments.

**Table 1. Device summary**

| Part number | Order codes     |                               | Output voltage              |
|-------------|-----------------|-------------------------------|-----------------------------|
|             | Packages        |                               |                             |
|             | SOT323-5L (T&R) | SOT23-5L (T&R) <sup>(1)</sup> |                             |
| STLQ50XX18  | STLQ50C18R      | STLQ50M18R                    | Fixed V <sub>O</sub> = 1.8V |
| STLQ50XX25  | STLQ50C25R      | STLQ50M25R                    | Fixed V <sub>O</sub> = 2.5V |
| STLQ50XX33  | STLQ50C33R      | STLQ50M33R                    | Fixed V <sub>O</sub> = 3.3V |
| STLQ50XX50  | STLQ50C50R      | STLQ50M50R                    | Fixed V <sub>O</sub> = 5.0V |
| STLQ50      | STLQ50C-R       | STLQ50M-R                     | Adjustable                  |

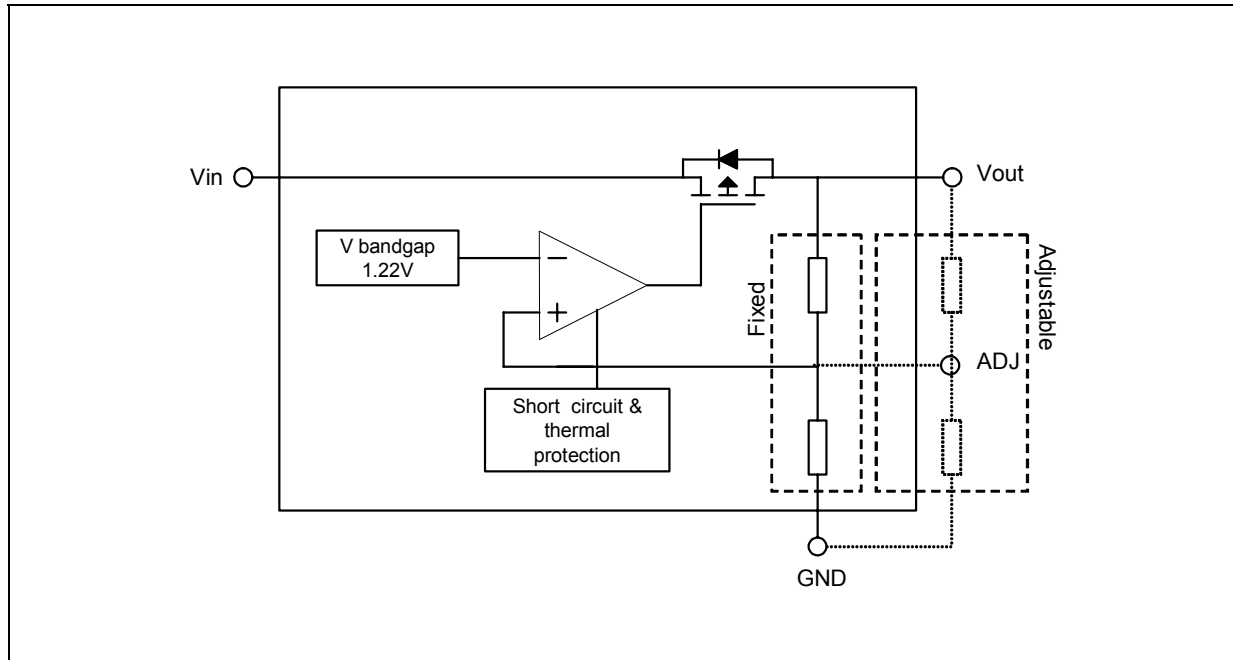
1. Available upon request.

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# 1 Diagram

Figure 1. Block diagram



## 2 Pin configuration

Figure 2. Pin connections (top view)

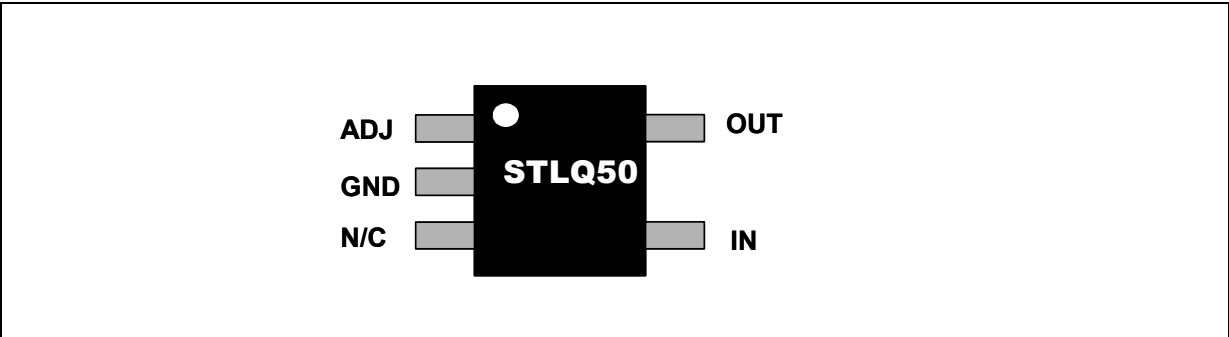


Table 2. Pin description

| Pin n° | Symbol | Note                          |
|--------|--------|-------------------------------|
| 1      | ADJ    | STLQ50: output voltage adjust |
|        | N/C    | STLQ50xx: not connected       |
| 2      | GND    | Ground                        |
| 3      | N/C    | Not connected                 |
| 4      | IN     | Input voltage                 |
| 5      | OUT    | Output voltage                |

### 3 Maximum ratings

**Table 3. Absolute maximum ratings**

| Symbol    | Parameter                   | Value       | Unit |
|-----------|-----------------------------|-------------|------|
| $V_I$     | DC Input voltage            | -0.3 to +14 | V    |
| $V_{FB}$  | FB voltage                  | -0.3 to +7  | V    |
| ESD       | Human body model (all pins) | ±2          | kV   |
| $T_J$     | Junction temperature        | -40 to 150  | °C   |
| $T_{STG}$ | Storage temperature range   | -55 to 150  | °C   |

*Note: Absolute maximum ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied.*

**Table 4. Thermal data**

| Symbol     | Parameter                           | SOT323-5L            | SOT23-5L           | Unit |
|------------|-------------------------------------|----------------------|--------------------|------|
| $R_{thJA}$ | Thermal resistance junction-ambient | 331.4 <sup>(1)</sup> | 191 <sup>(1)</sup> | °C/W |

1. This value is referred to a 4-layer PCB, JEDEC standard test board.

## 4 Electrical characteristics

**Table 5. Electrical characteristics**

( $V_I = V_{O(NOM)} + 1\text{ V}$  or  $V_I = 2.5\text{ V}$  if  $V_O + 1.5\text{ V}$ ;  $T_A = -40\text{ °C}$  to  $125\text{ °C}$ ;  $I_O = 1\text{ mA}$ ; typical values are at  $T_A = 25\text{ °C}$ ,  $C_O = 1\text{ }\mu\text{F}$  unless otherwise specified)

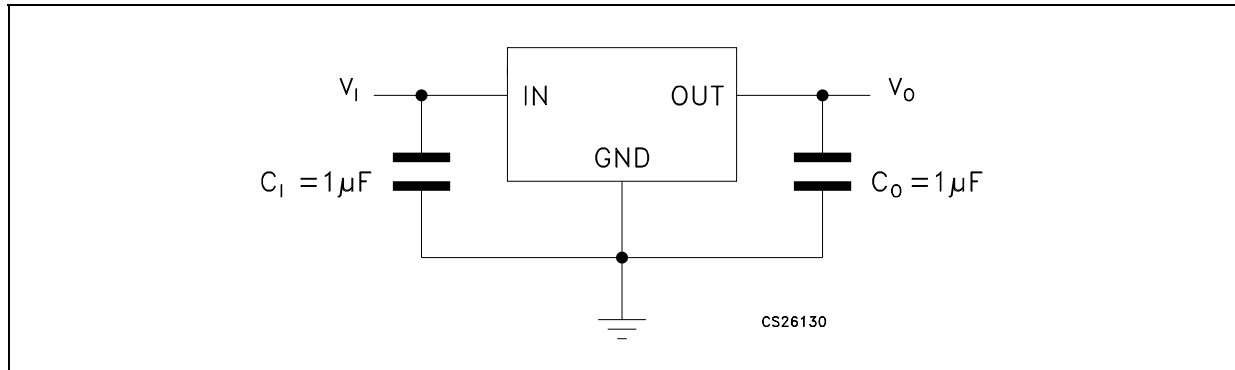
| Symbol                | Parameter                                                         | Test conditions                                                                                                                      | Min.  | Typ. | Max. | Unit                       |
|-----------------------|-------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------|-------|------|------|----------------------------|
| $V_I$                 | Input voltage range                                               | $I_O = 20\text{ mA}$                                                                                                                 | 2.3   |      | 12   | V                          |
|                       |                                                                   | $I_O = 50\text{ mA}$                                                                                                                 | 2.5   |      | 12   |                            |
| $I_Q$                 | Quiescent current (Measured on ground pin, fixed version)         | $V_I = 5\text{ V}$                                                                                                                   |       | 3.5  | 5.0  | $\mu\text{A}$              |
|                       |                                                                   | $V_I = 12\text{ V}$                                                                                                                  |       | 4.1  | 6.0  |                            |
| $V_O$                 | Output voltage range (STLQ50ADJ)                                  |                                                                                                                                      | 1.222 |      | 11   | V                          |
|                       | Accuracy as percentage of nominal voltage at $T_J = 25\text{ °C}$ |                                                                                                                                      | -2    |      | +2   | %                          |
| $V_{\text{DROP-MAX}}$ | Max dropout voltage <sup>(1)</sup>                                | $I_O = 50\text{ mA}$ ;                                                                                                               |       | 0.4  | 0.7  | V                          |
| $\Delta V_O$          | Load regulation                                                   | $1\text{ mA} < I_O < 50\text{ mA}$                                                                                                   |       |      | 0.15 | %/mA                       |
| $\Delta V_O$          | Line regulation                                                   | $V_O = 1.5\text{ V}$ :<br>$V_O + 1\text{ V} < V_I < 12\text{ V}$ ;<br>$V_O = 1.5\text{ V}$ :<br>$2.5\text{ V} < V_I < 12\text{ V}$ ; |       |      | 0.3  | %/V                        |
| SVR                   | Supply voltage rejection                                          | $V_{\text{RIPPLE}} = 0.1\text{ V}$ , $I_O = 20\text{ mA}$<br>$f = 120\text{ Hz}$                                                     |       | 30   |      | dB                         |
| eN                    | Output noise voltage                                              | $B_W$ from 200Hz to 100KHz; $I_O = 10\text{ mA}$                                                                                     |       | 560  |      | $\mu\text{V}_{\text{RMS}}$ |
| Th                    | Thermal protection                                                |                                                                                                                                      |       | 160  |      | $^{\circ}\text{C}$         |
| $I_{\text{OMAX}}$     | Maximum output current <sup>(2)</sup>                             | $V_O = 0\text{ V}$                                                                                                                   |       | 500  |      | mA                         |

1.  $V_I = 2.5\text{ V}$  when  $V_{O(NOM)} \leq 2.1\text{ V}$

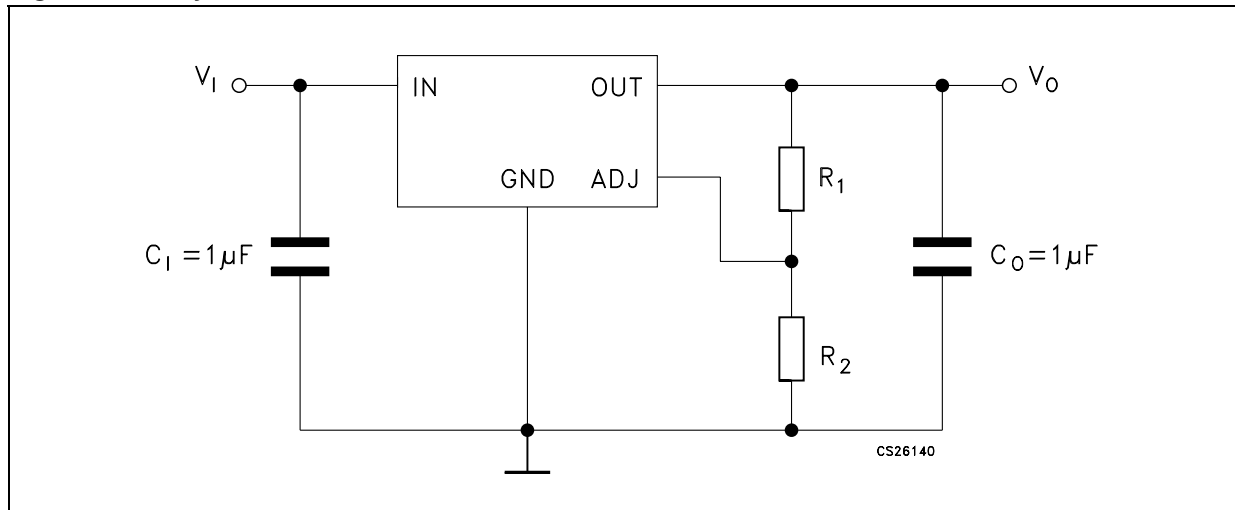
2. The maximum power dissipation must not be exceeded, see application information for details.

## 5 Typical application

**Figure 3. Fixed versions: STLQ5018- STLQ5025- STLQ5033- STLQ5050**



**Figure 4. Adjustable version STLQ50ADJ**



## 6 Typical characteristics

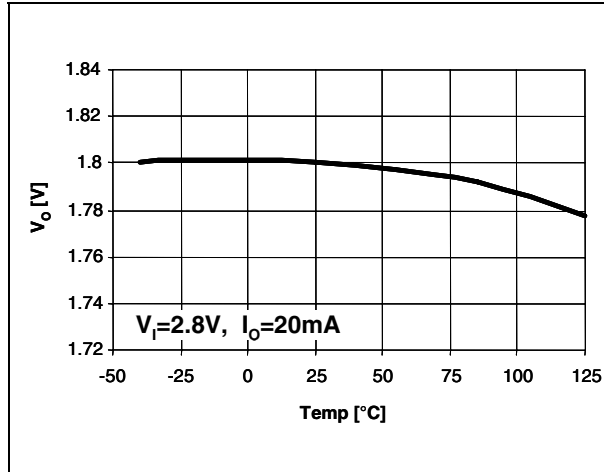
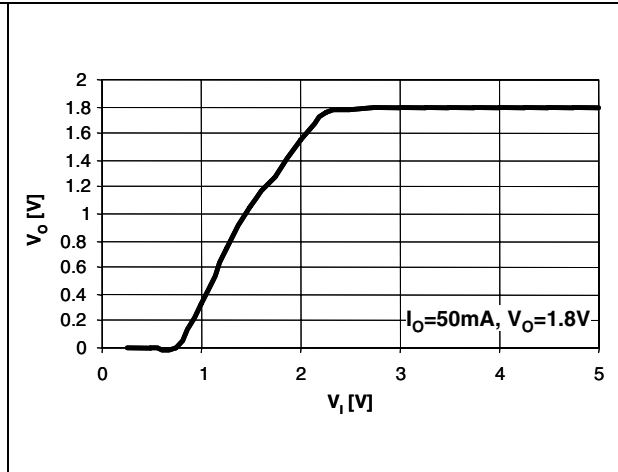
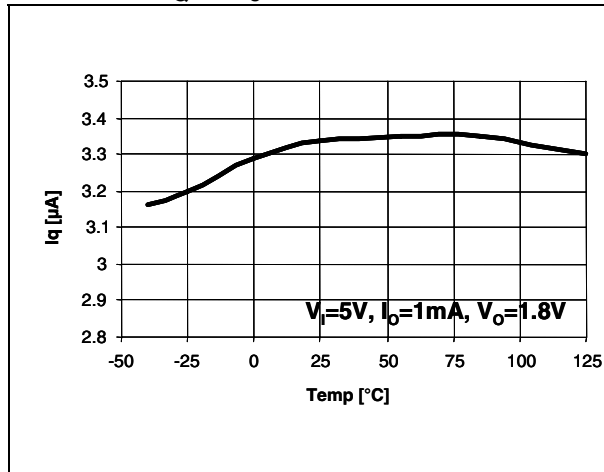
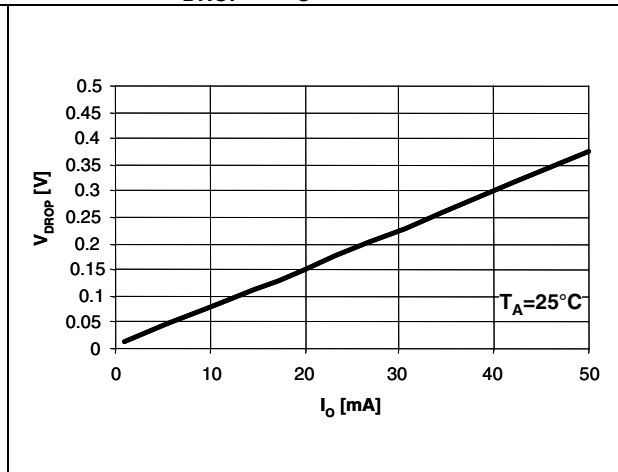
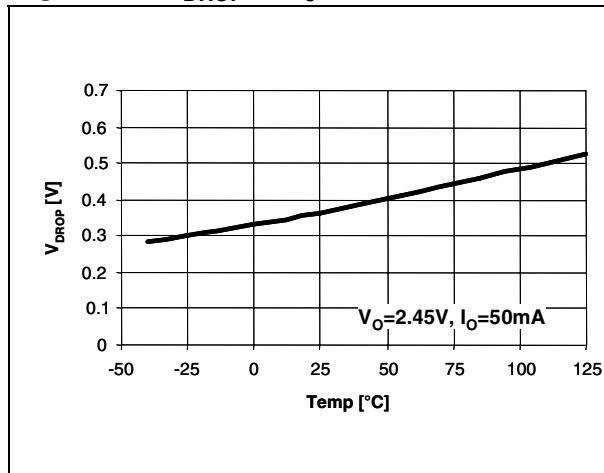
Figure 5.  $V_O$  vs  $T_J$ Figure 6.  $V_O$  vs  $V_I$ Figure 7.  $I_Q$  vs  $T_J$ Figure 8.  $V_{DROP}$  vs  $I_O$ Figure 9.  $V_{DROP}$  vs  $T_J$ 

Figure 10. Stability

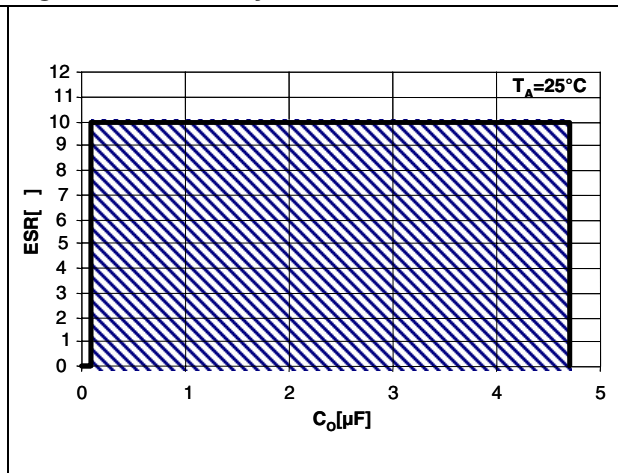


Figure 11. S.V.R. vs Freq.

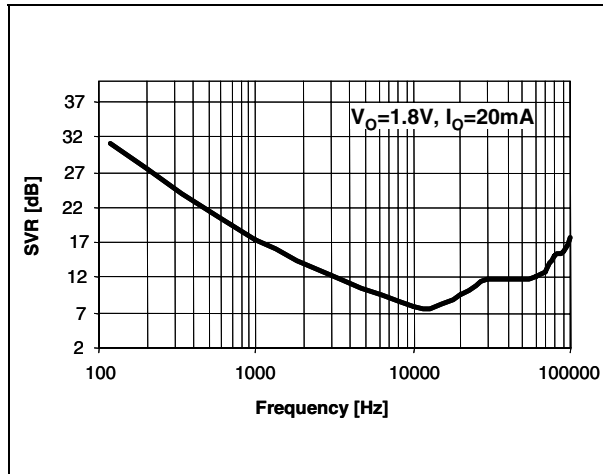
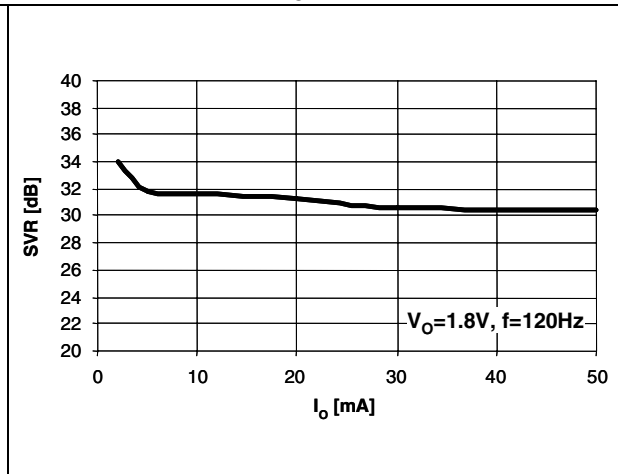
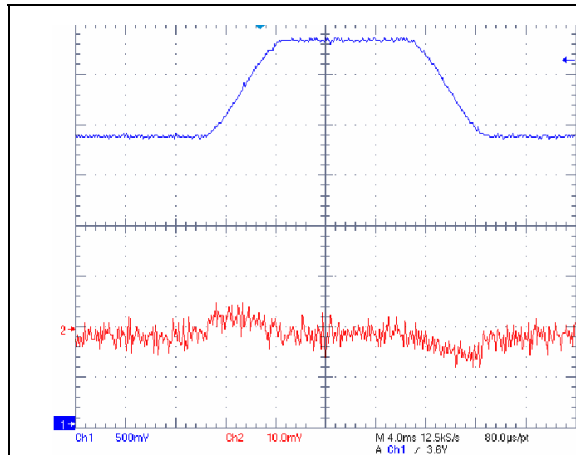
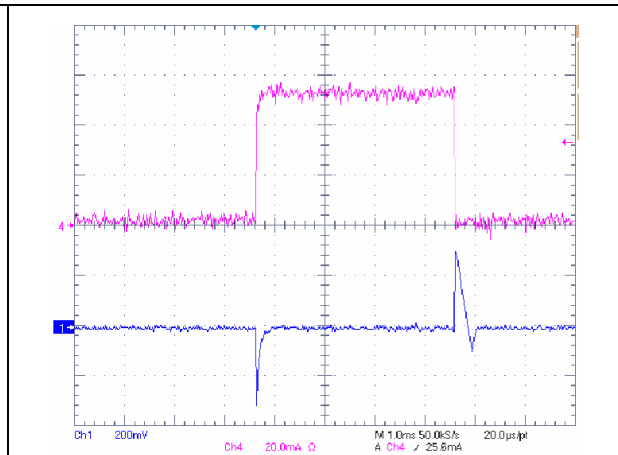
Figure 12. S.V.R. vs  $I_O$ 

Figure 13. Line transient response



$I_O = 50mA$ ;  $C_O = 10\mu F$ ;  $V_I = 2.8V$ ,  $V_I$  rise/fall = 5ms

Figure 14. Load transient response



$C_O = 1\mu F$ ;  $V_O = 1.8V$ ;  $V_I = 2.8V$ , Curr. rise/fall = 1μs

Figure 15. Short circuit current

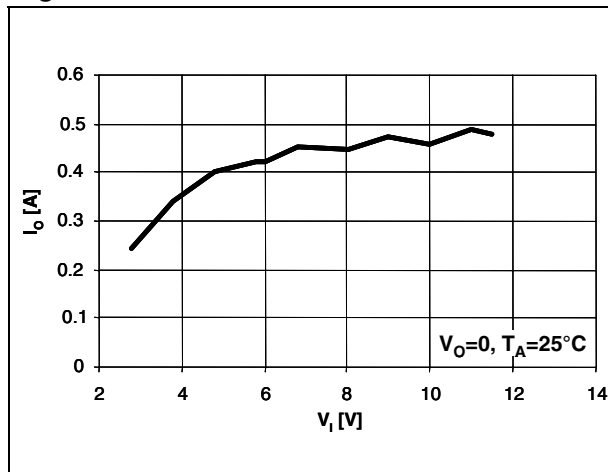
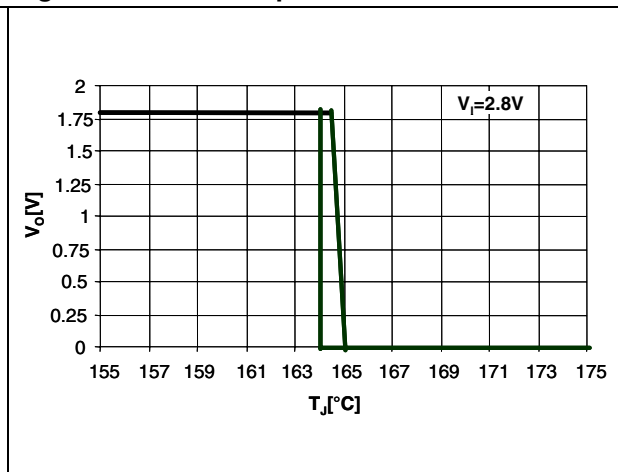


Figure 16. Thermal protection



## 7 Application information

The STLQ50 is a BiCMOS linear regulator specifically designed for operating in environment with very low power consumption constraints. The very low quiescent current of 3  $\mu\text{A}$  is obtained with use of CMOS technology that makes the device suitable for those application that have very long stand-by time. The very low power consumption allows extending the battery life and the tiny packages (SOT323-5L or SOT23-5L) fulfil the space saving requirements of battery powered equipments. Moreover the STLQ50 provides wide input voltage operation from 2.5 V up to 12 V.

The P-MOS pass element allows also a very good drop-out figure: 0.7 V at full load and at 125 °C without affecting the consumption characteristics.

### 7.1 External components

The typical application schematic of STLQ50 is shown in [Figure 1 - Figure 2](#), a 1  $\mu\text{F}$  input and output capacitors placed close to the device are needed in order to provide proper operation. The device is stable with electrolytic and ceramic output capacitors having values higher than 1  $\mu\text{F}$  (see figure typical characteristics for stability details).

In the adjustable version (STLQ50) the output voltage is programmed using an external resistor divider as shown in [Figure 2](#). The output voltage can be adjusted from 1.22 to 11 V and it can be calculated using the following formula:

$$V_O = V_{FB} \times (1 + R_1/R_2)$$

where  $V_{FB}=1.222$  V is the internal reference voltage;

The sum between  $R_1$  and  $R_2$  resistors should be chosen in order to guarantee 1  $\mu\text{A}$  of divider current at least. Lower value resistors will improve the noise performances but the quiescent current will increase. Higher value resistors should be avoided because the ADJ leakage current will influence the voltage set by the resistor divider making the above formula no more valid.

The suggested design procedure is to choose  $R_2 = 1 \text{ M}\Omega$  and then calculate  $R_1$  using the following formula:  $R_1 = (V_O/V_{FB}-1) \times R_2$

### 7.2 Power dissipation

In order to ensure proper operation, the STLQ50 junction temperature should never exceed 125 °C, this limits the maximum power dissipation the regulator can sustain in any application. The maximum power dissipation can be calculated as:

$$P_{D\text{MAX}} = (T_{J\text{MAX}} - T_A)/R_{thJA}$$

where  $T_{J\text{MAX}} = 125$  °C;

$T_A$  is the ambient temperature;

$R_{thJA}$  is the junction to ambient thermal resistance of the package (see [Table 4](#) thermal data).

The power dissipation can be calculated simply as:

$$P_D = (V_I - V_O) \times I_O$$

In every application condition,  $P_D$  must be lower than  $P_{D\text{MAX}}$ .

## 7.3 Protection

The P-MOS pass element has an internal diode with anode connected to  $V_O$  and cathode to  $V_I$ . In case  $V_O > V_I$  the current will flow from output to the input without any limitation. In this case proper limiting network is recommended.

The current limitation is automatically provided by the characteristics of the PMOS pass element (see typical characteristics), so the short circuit current is dependent on the input voltage. When considering the short circuit current take care, in any case, to not exceed the maximum power dissipation sustainable by the device.

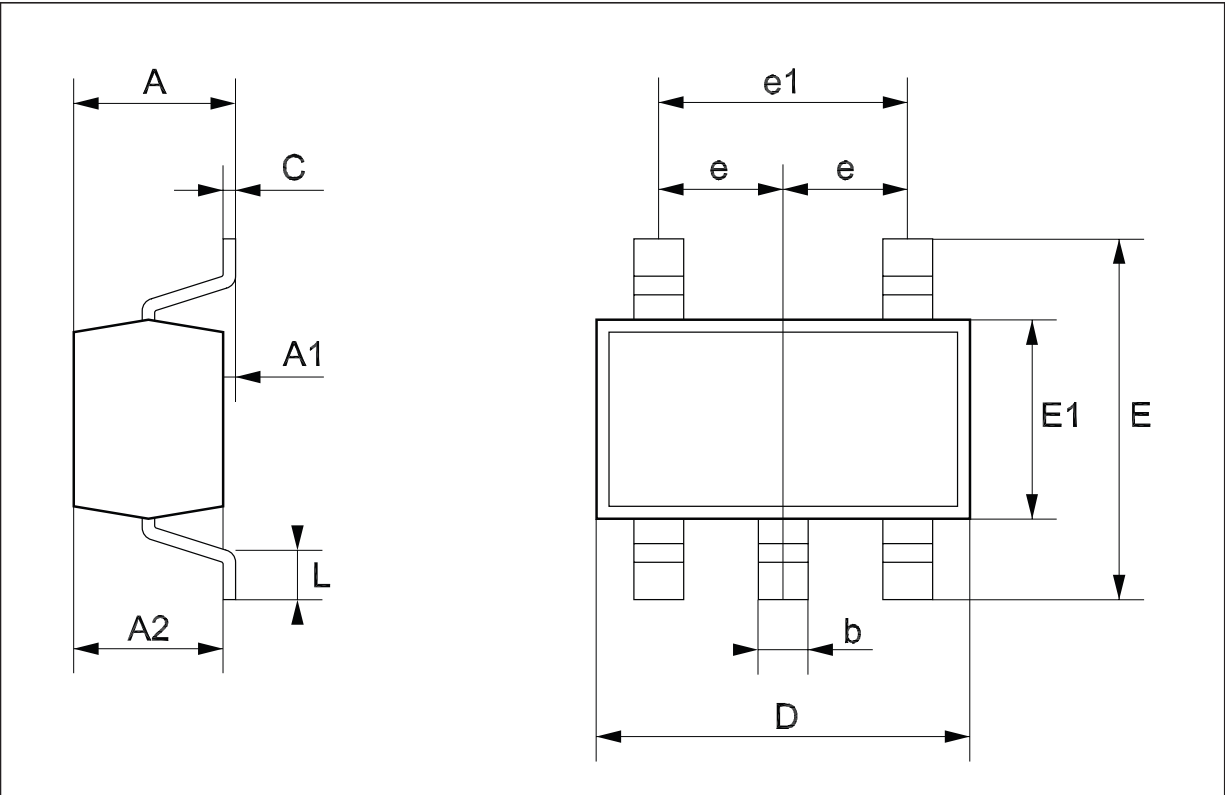
The STLQ50 features an internal thermal protection that linearly reduces the output current when the internal temperature increases, consequently, at a given load, also the output voltage decreases. The action of the thermal protection starts at 125 °C when the output voltage slightly decreases, while close to 163 °C the output voltage drops to 0 V. Since this is a linear control, sudden over current conditions can quickly rise the chip temperature without time for the thermal protection to act, so it cannot be used as a limitation for the output current.

## 8 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).

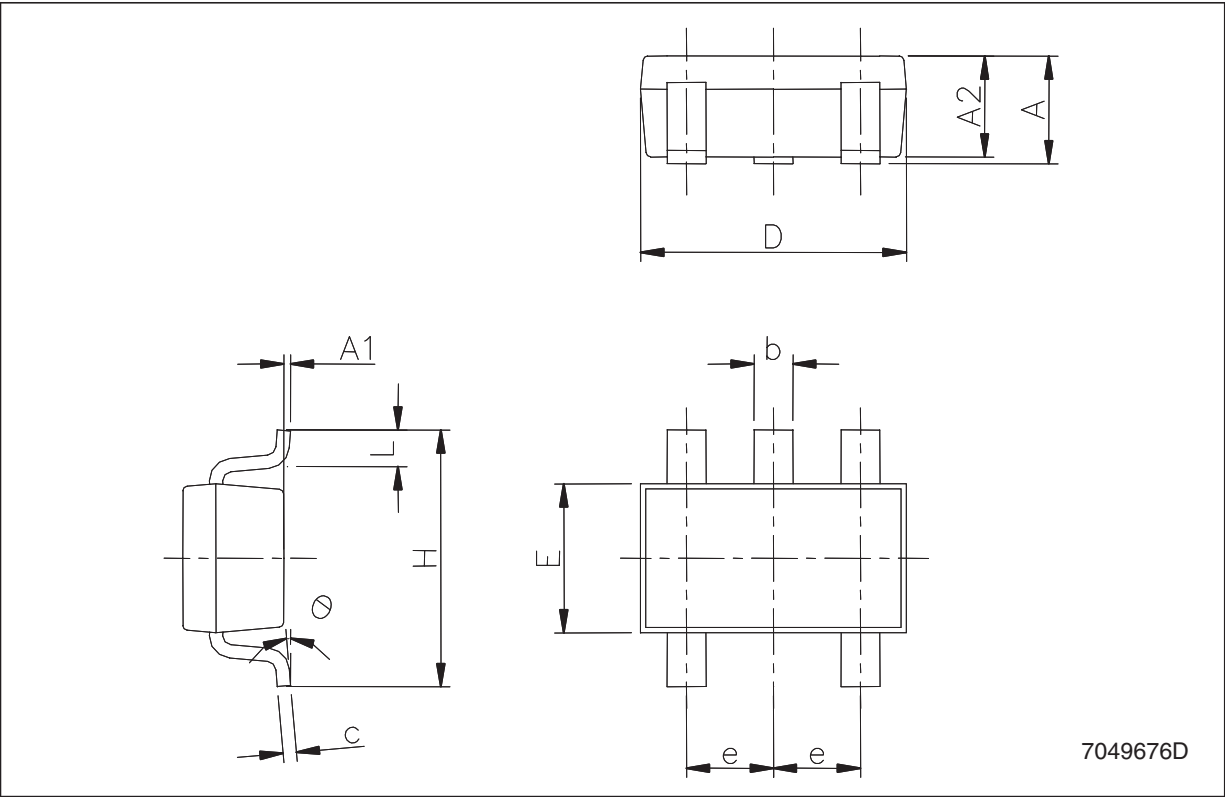
SOT323-5L mechanical data

| Dim. | mm.  |      |      | mils. |      |      |
|------|------|------|------|-------|------|------|
|      | Min. | Typ. | Max. | Min.  | Typ. | Max. |
| A    | 0.80 |      | 1.10 | 31.5  |      | 43.3 |
| A1   | 0.00 |      | 0.10 | 0.0   |      | 3.9  |
| A2   | 0.80 |      | 1.00 | 31.5  |      | 39.4 |
| b    | 0.15 |      | 0.30 | 5.9   |      | 11.8 |
| C    | 0.10 |      | 0.18 | 3.9   |      | 7.1  |
| D    | 1.80 |      | 2.20 | 70.9  |      | 86.6 |
| E    | 1.80 |      | 2.40 | 70.9  |      | 94.5 |
| E1   | 1.15 |      | 1.35 | 45.3  |      | 53.1 |
| e    |      | 0.65 |      |       | 25.6 |      |
| e1   |      | 1.3  |      |       | 51.2 |      |
| L    | 0.10 |      | 0.30 | 3.9   |      | 11.8 |



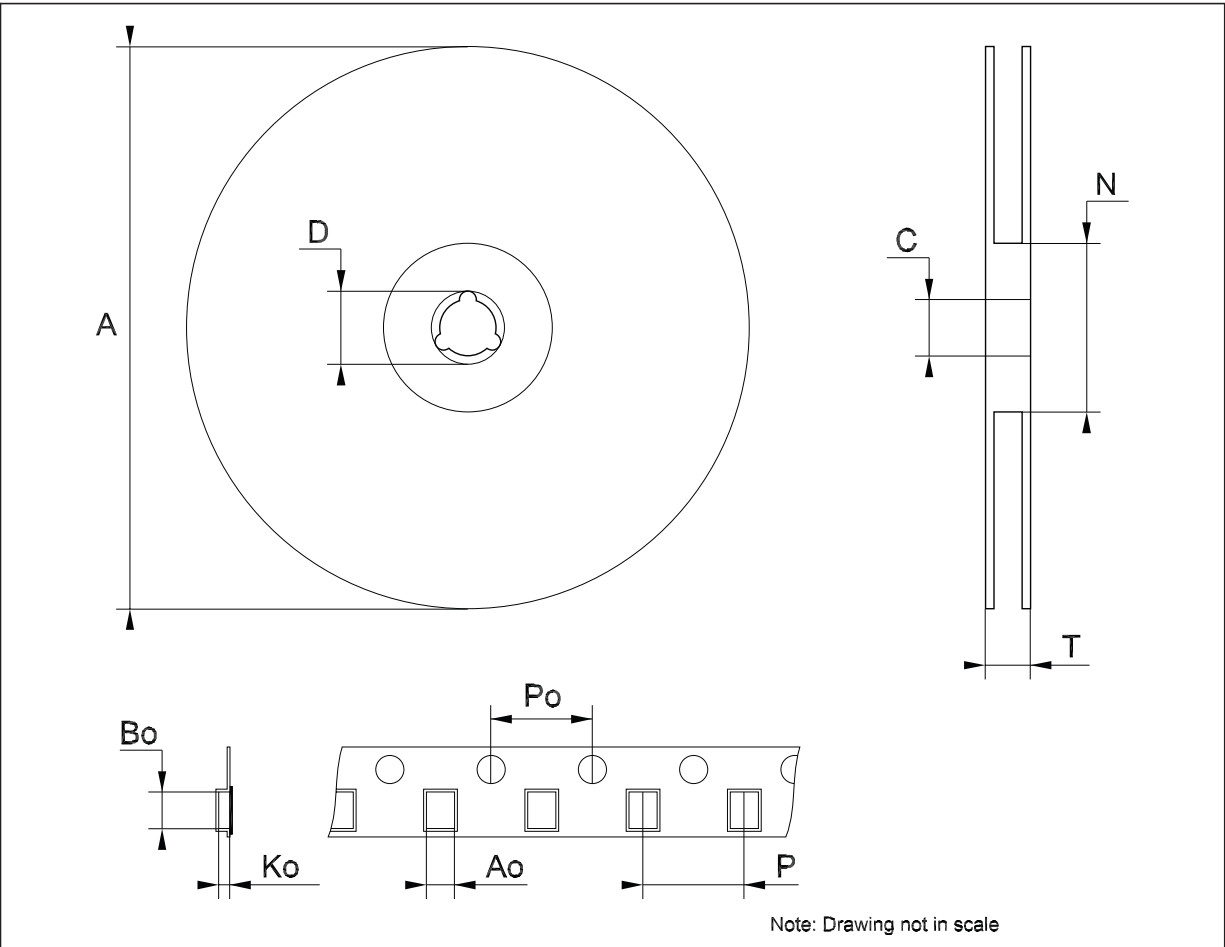
SOT23-5L mechanical data

| 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  |



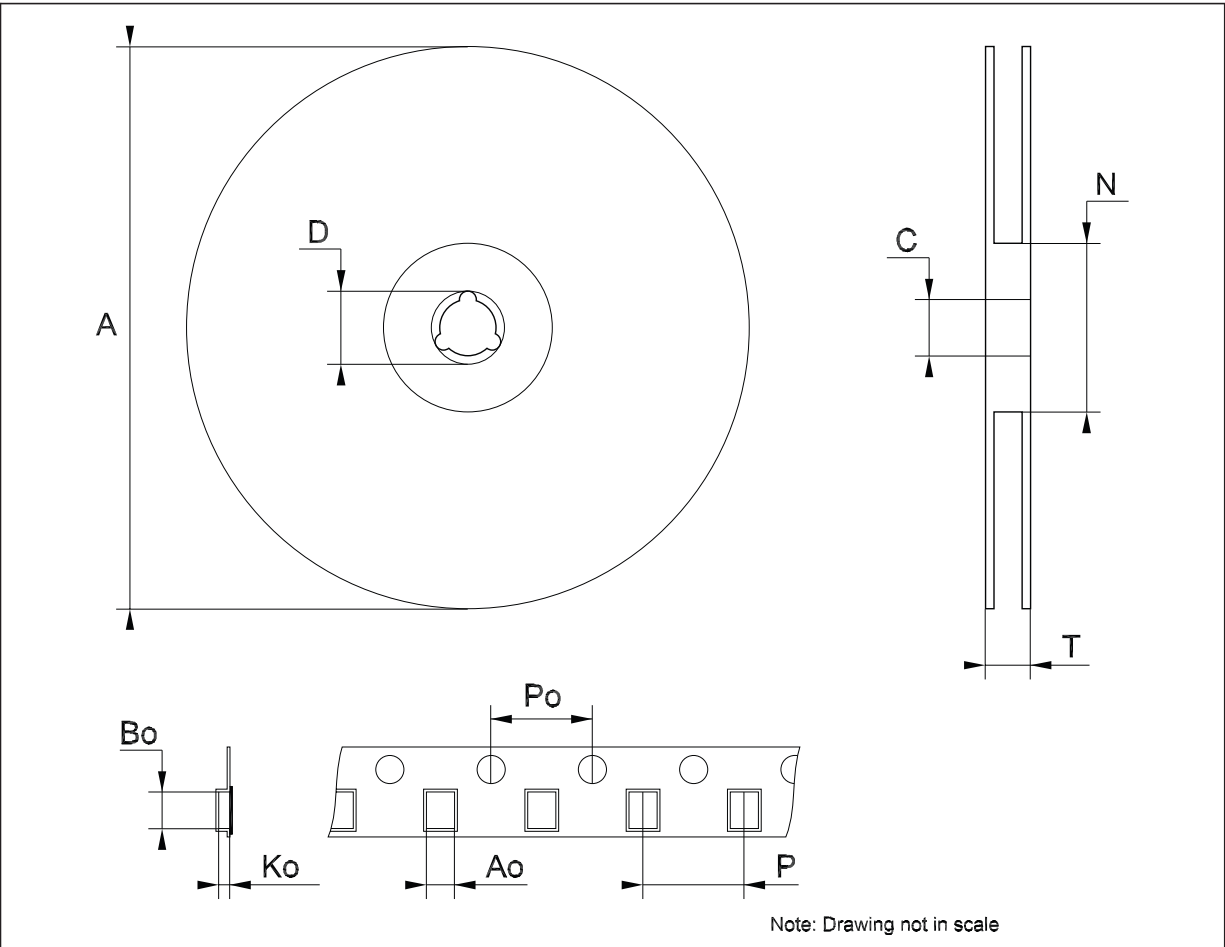
Tape & reel SOT323-xL mechanical data

| Dim. | mm.  |      |      | inch. |       |       |
|------|------|------|------|-------|-------|-------|
|      | Min. | Typ. | Max. | Min.  | Typ.  | Max.  |
| A    | 175  | 180  | 185  | 6.889 | 7.086 | 7.283 |
| C    | 12.8 | 13   | 13.2 | 0.504 | 0.512 | 0.519 |
| D    | 20.2 |      |      | 0.795 |       |       |
| N    | 59.5 | 60   | 60.5 |       | 2.362 |       |
| T    |      |      | 14.4 |       |       | 0.567 |
| Ao   |      | 2.25 |      |       | 0.088 |       |
| Bo   |      | 2.7  |      |       | 0.106 |       |
| Ko   |      | 1.2  |      |       | 0.047 |       |
| Po   | 3.9  | 4    | 4.1  | 0.153 | 0.157 | 0.161 |
| P    | 3.8  | 4    | 4.2  | 0.149 | 0.157 | 0.165 |



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 | 0.058 |
| 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 |



## 9 Revision history

**Table 6. Document revision history**

| Date        | Revision | Changes                             |
|-------------|----------|-------------------------------------|
| 07-Feb-2007 | 1        | Initial release.                    |
| 13-Feb-2007 | 2        | Typo in cover page 350mA ==> 350mV. |
| 06-Jul-2007 | 3        | Added part number.                  |
| 14-Nov-2007 | 4        | Added <a href="#">Table 1</a> .     |

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