

## Very low quiescent BiCMOS voltage regulator

### Features

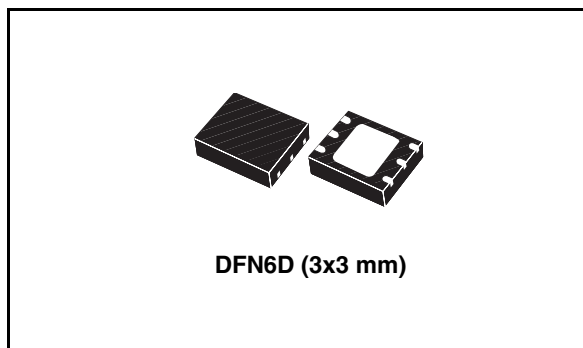
- Fixed output voltage: 1.8 V, 2.5 V, 3.3 V (1.5 V, under customer request)
- Output voltage tolerance:  $\pm 2\%$  at 25 °C
- Output current capability: 1 A minimum
- Very low quiescent current: max 500  $\mu$ A over temperature range
- Typ. dropout 0.7 V (@  $I_O = 1$  A)
- Stable with low ESR ceramic capacitors
- Available with and without the external output voltage sense pin
- Thermal shutdown protection with hysteresis
- Over current protection
- Operating junction temperature range: from 0 to 125 °C

### Description

The ST1L02xx is a low drop linear voltage regulator capable to supply up to 1 A output current.

The output voltage is fixed to 3.3 V, but under customer request, it's possible to have also 1.5 V, 1.8 V and 2.5 V. Thanks to the BiCMOS technology, the quiescent current is well controlled and maintained below 650  $\mu$ A over the whole allowed junction temperature range.

The ST1L02xx is stable with low ESR output ceramic capacitors.



Internal protection circuitry includes thermal protection with hysteresis and over current limiting.

The ST1L02xx is especially suitable for data storage applications such as HDDs, where can be used to supply the read channel and memory chips requiring 3.3 V.

The regulator is available in the small and thin DFN6D (3x3 mm) package.

**Table 1. Device summary**

| Part numbers | Order codes              | Package        |
|--------------|--------------------------|----------------|
| ST1L02XX18   | ST1L02PU18R              | DFN6D (3x3 mm) |
| ST1L02XX25   | ST1L02PU25R              | DFN6D (3x3 mm) |
| ST1L02XX33   | ST1L02PU33R              | DFN6D (3x3 mm) |
| ST1L02XX     | ST1L02PUR <sup>(1)</sup> | DFN6D (3x3 mm) |

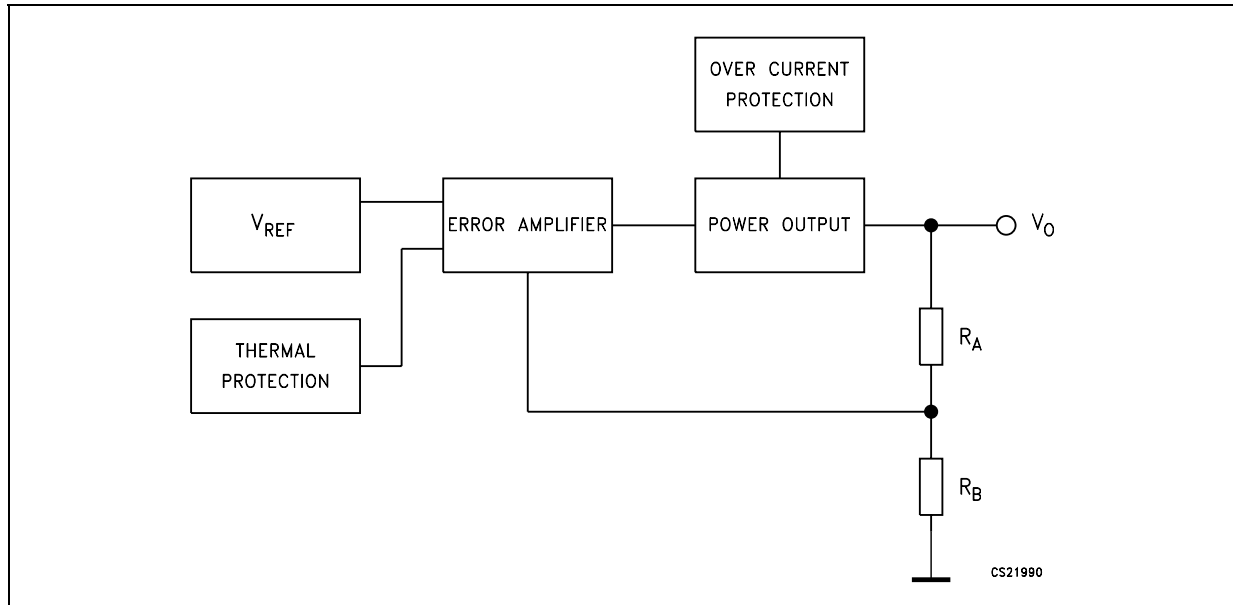
1. Only 3.3 V

## Contents

|          |                                         |           |
|----------|-----------------------------------------|-----------|
| <b>1</b> | <b>Diagram .....</b>                    | <b>3</b>  |
| <b>2</b> | <b>Pin configuration .....</b>          | <b>4</b>  |
| <b>3</b> | <b>Maximum ratings .....</b>            | <b>5</b>  |
| <b>4</b> | <b>Electrical characteristics .....</b> | <b>6</b>  |
| <b>5</b> | <b>Typical application .....</b>        | <b>9</b>  |
| <b>6</b> | <b>Typical characteristics .....</b>    | <b>10</b> |
| <b>7</b> | <b>Package mechanical data .....</b>    | <b>14</b> |
| <b>8</b> | <b>Revision history .....</b>           | <b>18</b> |

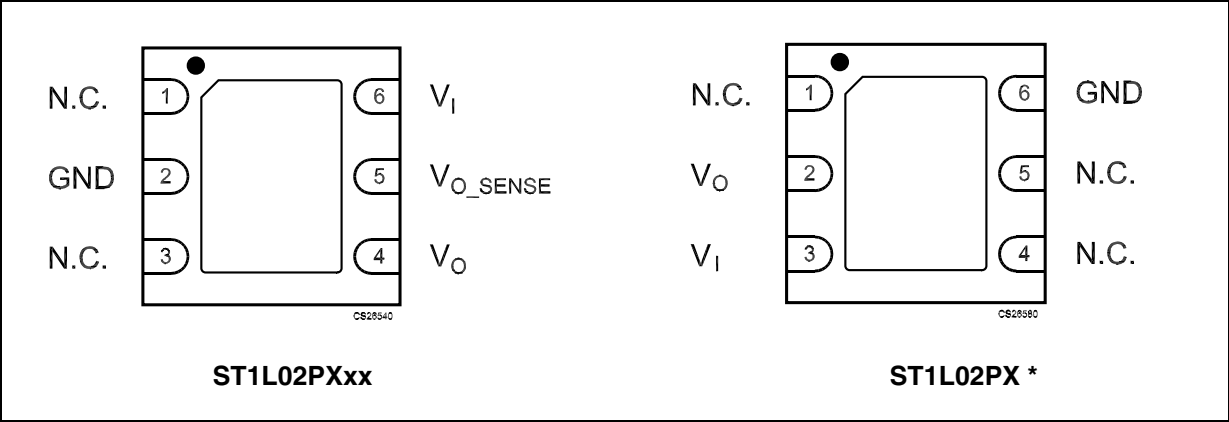
# 1 Diagram

Figure 1. Schematic diagram



## 2 Pin configuration

Figure 2. Pin connections (top through view)



\* Only 3.3 V.

Table 2. Pin description

| Pin n° for ST1L02PXxx | Pin n° for ST1L02PX | Symbol               | Name and function                                                    |
|-----------------------|---------------------|----------------------|----------------------------------------------------------------------|
| 1, 3                  | 1, 4, 5             | N.C.                 | Not connected.                                                       |
| 2                     | 6                   | GND                  | Ground. The exposed metallic pad of the package is connected to GND. |
| 4                     | 2                   | V <sub>O</sub>       | Output voltage pin. Bypass with a 4.7 μF capacitor to GND.           |
| 5                     | -                   | V <sub>O_SENSE</sub> | Sense output voltage pin. Must be connected to pin 4.                |
| 6                     | 3                   | V <sub>I</sub>       | Supply voltage input pin. Bypass with a 4.7 μF capacitor to GND.     |

### 3 Maximum ratings

**Table 3. Absolute maximum ratings**

| Symbol     | Parameter                                | Value              | Unit |
|------------|------------------------------------------|--------------------|------|
| $V_I$      | DC supply voltage                        | 10                 | V    |
| $P_{TOT}$  | Power dissipation                        | internally limited | W    |
| $I_O$      | Output current                           | internally limited | A    |
| $T_{OP}$   | Operating junction temperature range     | 0 to 150           | °C   |
| $T_{STG}$  | Storage temperature range <sup>(1)</sup> | -65 to 150         | °C   |
| $T_{LEAD}$ | Lead temperature (Soldering) 10 Sec.     | 260                | °C   |

1. Storage temperature >125 °C are acceptable only if the regulator is soldered to a PCBA.

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

**Table 4. Thermal data**

| Symbol     | Parameter                           | Value | Unit |
|------------|-------------------------------------|-------|------|
| $R_{thJC}$ | Thermal resistance junction-case    | 10    | °C/W |
| $R_{thJA}$ | Thermal resistance junction-ambient | 55    | °C/W |

## 4 Electrical characteristics

**Table 5. Electrical characteristics for ST1L02XX18**

(refer to the typical application schematic,  $V_I = 4.5\text{ V}$  to  $7\text{ V}$ ,  $I_O = 5\text{ mA}$  to  $1\text{ A}$ ,  $C_I = 4.7\text{ }\mu\text{F}$ ,  $C_O = 4.7\text{ }\mu\text{F}$ ,  $T_J = 0$  to  $125\text{ }^\circ\text{C}$ , unless otherwise specified). Typical values are intended at  $T_J = 25\text{ }^\circ\text{C}$  unless otherwise specified.

| Symbol                    | Parameter                                     | Test                                                                                                                 | Min.  | Typ.  | Max.  | Unit             |
|---------------------------|-----------------------------------------------|----------------------------------------------------------------------------------------------------------------------|-------|-------|-------|------------------|
| $V_O$                     | Output voltage                                | $V_I = 4.75\text{ V}$ to $5.25\text{ V}$ , $T = 25^\circ\text{C}$                                                    | 1.764 | 1.8   | 1.836 | V                |
| $V_O$                     | Output voltage                                | $V_I = 4.75\text{ V}$ to $5.25\text{ V}$                                                                             | 1.746 | 1.8   | 1.854 | V                |
| $\Delta V_O$              | Line regulation                               | $V_I = 4.75\text{ V}$ to $5.25\text{ V}$                                                                             |       |       | 15    | mV               |
| $\Delta V_O$              | Load regulation                               | $V_I = 4.75\text{ V}$ , $I_O = 10\text{ mA}$ to $1\text{ A}$                                                         |       |       | 10    | mV               |
| $I_S$                     | Output current limit                          | $V_I = 5.5\text{ V}$                                                                                                 | 1.0   |       |       | A                |
| $I_{O\text{MIN}}$         | Minimum output current for regulation         |                                                                                                                      |       |       | 2     | mA               |
| $V_d$                     | Dropout voltage <sup>(1)</sup>                | $I_O = 0.8\text{ A}$                                                                                                 |       |       | 1.6   | V                |
|                           |                                               | $I_O = 1\text{ A}$                                                                                                   |       |       | 1.6   | V                |
| $I_Q$                     | Quiescent current                             | $V_I = 5\text{ V}$ , $I_O = 2\text{ mA}$ to $1\text{ A}$ , $T = 25^\circ\text{C}$                                    |       |       | 500   | $\mu\text{A}$    |
| $I_Q$                     | Quiescent current                             | $V_I = 7\text{ V}$ , $I_O = 2\text{ mA}$ to $1\text{ A}$                                                             |       |       | 650   | $\mu\text{A}$    |
| SVR                       | Supply voltage rejection <sup>(2)</sup>       | $V_I = 5 \pm 0.5\text{ V}$ , $I_O = 5\text{ mA}$ , $f = 120\text{ Hz}$                                               | 50    | 75    |       | dB               |
| eN                        | RMS Output noise <sup>(2)</sup>               | $B = 10\text{ Hz}$ to $10\text{ kHz}$ , $V_I = 5\text{ V}$ , $I_O = 5\text{ mA}$                                     |       | 0.003 |       | % $V_O$          |
| $\Delta V_O / \Delta I_O$ | Load transient (rising) <sup>(3)</sup>        | $V_I = 5\text{ V}$ , any $200\text{ mA}$ step from $100\text{ mA}$ to $1\text{ A}$ , $t_R \geq 1\text{ }\mu\text{s}$ |       |       | 5     | % $V_O$          |
| $\Delta V_O / \Delta I_O$ | Load transient (falling) <sup>(3)</sup>       | $V_I = 5\text{ V}$ , $I_O = 1\text{ A}$ to $10\text{ mA}$ , $t_F \geq 1\text{ }\mu\text{s}$                          |       |       | 3.6   | V                |
| $\Delta V_O / \Delta V_I$ | Start-up transient <sup>(3)</sup>             | $V_I = 0\text{ V}$ to $5\text{ V}$ , $I_O = 10\text{ mA}$ to $1\text{ A}$ , $t_R \geq 1\text{ }\mu\text{s}$          |       |       | 3.5   | V                |
| $\Delta V_O / \Delta I_O$ | Short circuit removal response <sup>(3)</sup> | $V_I = 5\text{ V}$ , $I_O = \text{short}$ to $10\text{ mA}$                                                          |       |       | 3.5   | V                |
| $T_{SH}$                  | Thermal shutdown trip point <sup>(3)</sup>    | $V_I = 5\text{ V}$                                                                                                   |       | 165   |       | $^\circ\text{C}$ |

1. See minimum start-up voltage,  $V_I = 3.3\text{ V}$ .

2. Guaranteed by design. Not tested in production.

3.  $C_I = 10\text{ }\mu\text{F}$ ,  $C_O = 10\text{ }\mu\text{F}$ , all X7R ceramic capacitors.

**Table 6. Electrical characteristics for ST1L02XX25**

(refer to the typical application schematic,  $V_I = 4.5\text{ V}$  to  $7\text{ V}$ ,  $I_O = 5\text{ mA}$  to  $1\text{ A}$ ,  $C_I = 4.7\text{ }\mu\text{F}$ ,  $C_O = 4.7\text{ }\mu\text{F}$ ,  $T_J = 0$  to  $125\text{ }^\circ\text{C}$ , unless otherwise specified). Typical values are intended at  $T_J = 25\text{ }^\circ\text{C}$  unless otherwise specified.

| Symbol                  | Parameter                                     | Test                                                                                                                 | Min.   | Typ.  | Max.   | Unit             |
|-------------------------|-----------------------------------------------|----------------------------------------------------------------------------------------------------------------------|--------|-------|--------|------------------|
| $V_O$                   | Output voltage                                | $V_I = 4.75\text{ V}$ to $5.25\text{ V}$ , $T = 25^\circ\text{C}$                                                    | 2.45   | 2.5   | 2.55   | V                |
| $V_O$                   | Output voltage                                | $V_I = 4.75\text{ V}$ to $5.25\text{ V}$                                                                             | 2.4375 | 2.5   | 2.5625 | V                |
| $\Delta V_O$            | Line regulation                               | $V_I = 4.75\text{ V}$ to $5.25\text{ V}$                                                                             |        |       | 15     | mV               |
| $\Delta V_O$            | Load regulation                               | $V_I = 4.75\text{ V}$ , $I_O = 10\text{ mA}$ to $1\text{ A}$                                                         |        |       | 10     | mV               |
| $I_S$                   | Output current limit                          | $V_I = 5.5\text{ V}$                                                                                                 | 1.0    |       |        | A                |
| $I_{O\text{MIN}}$       | Minimum output current for regulation         |                                                                                                                      |        |       | 2      | mA               |
| $V_d$                   | Dropout voltage <sup>(1)</sup>                | $I_O = 0.8\text{ A}$                                                                                                 |        | 0.6   | 1.0    | V                |
|                         |                                               | $I_O = 1\text{ A}$                                                                                                   |        | 0.7   | 1.1    | V                |
| $I_Q$                   | Quiescent current                             | $V_I = 5\text{ V}$ , $I_O = 2\text{ mA}$ to $1\text{ A}$ , $T = 25^\circ\text{C}$                                    |        |       | 500    | $\mu\text{A}$    |
| $I_Q$                   | Quiescent current                             | $V_I = 7\text{ V}$ , $I_O = 2\text{ mA}$ to $1\text{ A}$                                                             |        |       | 650    | $\mu\text{A}$    |
| SVR                     | Supply voltage rejection <sup>(2)</sup>       | $V_I = 5 \pm 0.5\text{ V}$ , $I_O = 5\text{ mA}$ , $f = 120\text{ Hz}$                                               | 50     | 75    |        | dB               |
| eN                      | RMS Output noise <sup>(2)</sup>               | $B = 10\text{ Hz}$ to $10\text{ kHz}$ , $V_I = 5\text{ V}$ , $I_O = 5\text{ mA}$                                     |        | 0.003 |        | % $V_O$          |
| $\Delta V_O/\Delta I_O$ | Load transient (rising) <sup>(3)</sup>        | $V_I = 5\text{ V}$ , any $200\text{ mA}$ step from $100\text{ mA}$ to $1\text{ A}$ , $t_R \geq 1\text{ }\mu\text{s}$ |        |       | 5      | % $V_O$          |
| $\Delta V_O/\Delta I_O$ | Load transient (falling) <sup>(3)</sup>       | $V_I = 5\text{ V}$ , $I_O = 1\text{ A}$ to $10\text{ mA}$ , $t_F \geq 1\text{ }\mu\text{s}$                          |        |       | 3.6    | V                |
| $\Delta V_O/\Delta V_I$ | Start-up transient <sup>(3)</sup>             | $V_I = 0\text{ V}$ to $5\text{ V}$ , $I_O = 10\text{ mA}$ to $1\text{ A}$ , $t_R \geq 1\text{ }\mu\text{s}$          |        |       | 3.5    | V                |
| $\Delta V_O/\Delta I_O$ | Short circuit removal response <sup>(3)</sup> | $V_I = 5\text{ V}$ , $I_O = \text{short}$ to $10\text{ mA}$                                                          |        |       | 3.5    | V                |
| $T_{SH}$                | Thermal shutdown trip point <sup>(2)</sup>    | $V_I = 5\text{ V}$                                                                                                   |        | 165   |        | $^\circ\text{C}$ |

1. See minimum start-up voltage,  $V_I = 3.2\text{ V}$ .

2. Guaranteed by design. Not tested in production

3.  $C_I = 10\text{ }\mu\text{F}$ ,  $C_O = 10\text{ }\mu\text{F}$ , all X7R ceramic capacitors.

**Table 7. Electrical characteristics for ST1L02XX33**

(refer to the typical application schematic,  $V_I = 4.5\text{V}$  to  $7\text{V}$ ,  $I_O = 5\text{mA}$  to  $1\text{A}$ ,  $C_I = 4.7\mu\text{F}$ ,  $C_O = 4.7\mu\text{F}$ ,  $T_J = 0$  to  $125^\circ\text{C}$ , unless otherwise specified). Typical values are intended at  $T_J = 25^\circ\text{C}$  unless otherwise specified.

| Symbol                  | Parameter                                     | Test                                                                                              | Min.   | Typ.  | Max.   | Unit             |
|-------------------------|-----------------------------------------------|---------------------------------------------------------------------------------------------------|--------|-------|--------|------------------|
| $V_O$                   | Output voltage                                | $V_I = 4.75\text{ V to } 5.25\text{ V}$ , $T = 25^\circ\text{C}$                                  | 3.234  | 3.3   | 3.366  | V                |
| $V_O$                   | Output voltage                                | $V_I = 4.75\text{ V to } 5.25\text{ V}$                                                           | 3.2175 | 3.3   | 3.3825 | V                |
| $\Delta V_O$            | Line regulation                               | $V_I = 4.75\text{ V to } 5.25\text{ V}$                                                           |        |       | 15     | mV               |
| $\Delta V_O$            | Load regulation                               | $V_I = 4.75\text{ V}$ , $I_O = 10\text{ mA to } 1\text{ A}$                                       |        |       | 10     | mV               |
| $I_S$                   | Output current limit                          | $V_I = 5.5\text{ V}$                                                                              | 1.0    |       |        | A                |
| $I_{O\text{MIN}}$       | Minimum output current for regulation         |                                                                                                   |        |       | 2      | mA               |
| $V_d$                   | Dropout voltage                               | $I_O = 0.8\text{ A}$                                                                              |        | 0.6   | 1.0    | V                |
|                         |                                               | $I_O = 1\text{ A}$                                                                                |        | 0.7   | 1.1    | V                |
| $I_Q$                   | Quiescent current                             | $V_I = 5\text{ V}$ , $I_O = 2\text{ mA to } 1\text{ A}$ , $T = 25^\circ\text{C}$                  |        |       | 500    | $\mu\text{A}$    |
| $I_Q$                   | Quiescent current                             | $V_I = 7\text{ V}$ , $I_O = 2\text{ mA to } 1\text{ A}$                                           |        |       | 650    | $\mu\text{A}$    |
| SVR                     | Supply voltage rejection <sup>(2)</sup>       | $V_I = 5 \pm 0.5\text{V}$ , $I_O = 5\text{ mA}$ , $f = 120\text{ Hz}$                             | 50     | 75    |        | dB               |
| eN                      | RMS Output noise <sup>(2)</sup>               | $B = 10\text{ Hz to } 10\text{ kHz}$ , $V_I = 5\text{ V}$ , $I_O = 5\text{ mA}$                   |        | 0.003 |        | % $V_O$          |
| $\Delta V_O/\Delta I_O$ | Load transient (rising) <sup>(1)</sup>        | $V_I = 5\text{ V}$ , any 200 mA step from 100 mA to 1 A, $t_R \geq 1\mu\text{s}$                  |        |       | 5      | % $V_O$          |
| $\Delta V_O/\Delta I_O$ | Load transient (falling) <sup>(1)</sup>       | $V_I = 5\text{ V}$ , $I_O = 1\text{ A to } 10\text{ mA}$ , $t_F \geq 1\mu\text{s}$                |        |       | 3.6    | V                |
| $\Delta V_O/\Delta V_I$ | Start-up transient <sup>(1)</sup>             | $V_I = 0\text{ V to } 5\text{ V}$ , $I_O = 10\text{ mA to } 1\text{ A}$ , $t_R \geq 1\mu\text{s}$ |        |       | 3.5    | V                |
| $\Delta V_O/\Delta I_O$ | Short circuit removal response <sup>(1)</sup> | $V_I = 5\text{ V}$ , $I_O = \text{short to } 10\text{ mA}$                                        |        |       | 3.5    | V                |
| $T_{SH}$                | Thermal shutdown trip point <sup>(2)</sup>    | $V_I = 5\text{ V}$                                                                                |        | 165   |        | $^\circ\text{C}$ |

1.  $C_I = 10\mu\text{F}$ ,  $C_O = 10\mu\text{F}$ , all X7R ceramic capacitors.

2. Guaranteed by design. Not tested in production.

## 5 Typical application

Figure 3. Application schematic for ST1L02PM

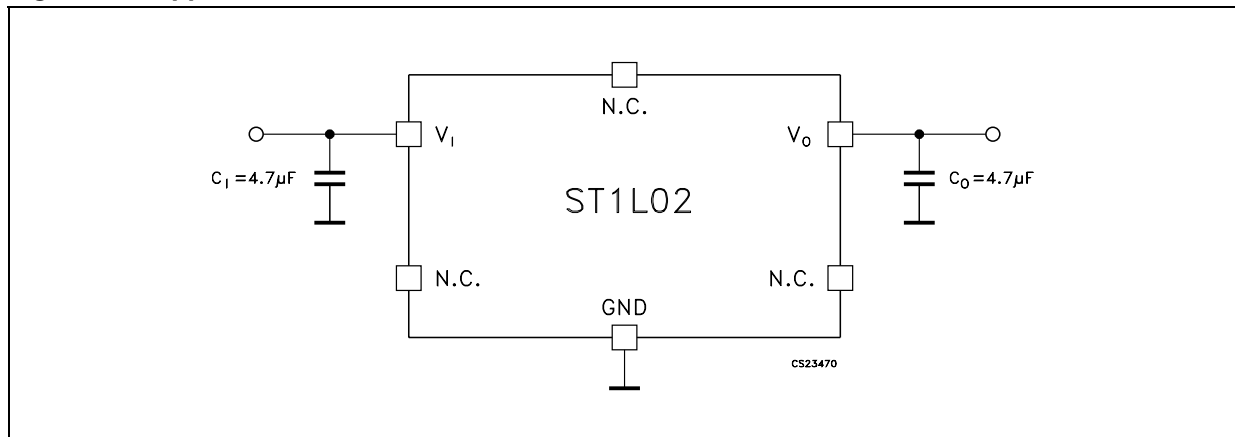
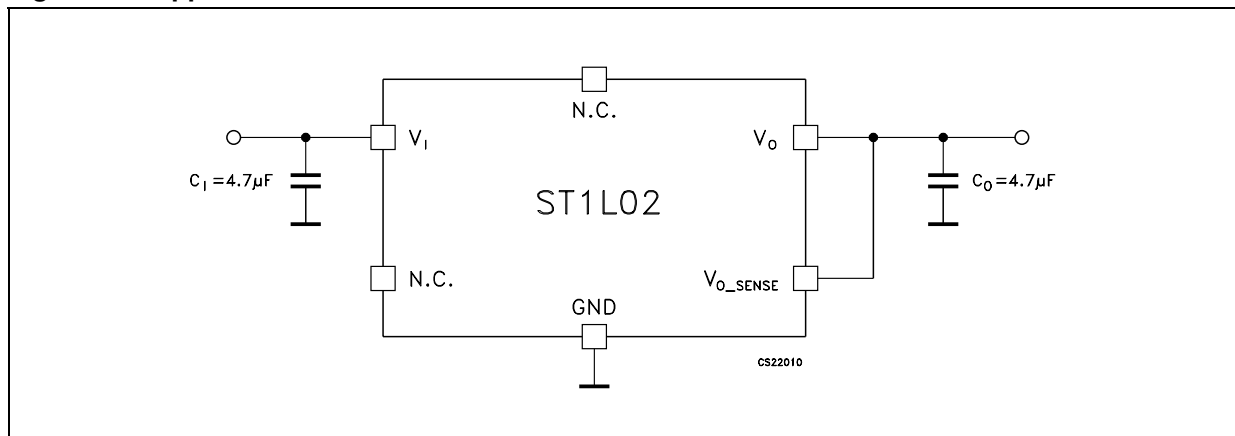


Figure 4. Application schematic for ST1L02PMxx



**Note:** The regulator is designed to be stable with either tantalum and ceramic capacitors on the input and the output. The expected values of the input and output ceramic capacitors are from  $1\mu\text{F}$  to  $22\mu\text{F}$  with  $4.7\mu\text{F}$  typical. The input capacitor must be connected within 0.5 inches of the  $V_I$  terminal. The output capacitor must also be connected within 0.5 inches of output pin. There is no upper limit to the value of the input capacitor.

## 6 Typical characteristics

Figure 5. Output voltage vs temperature

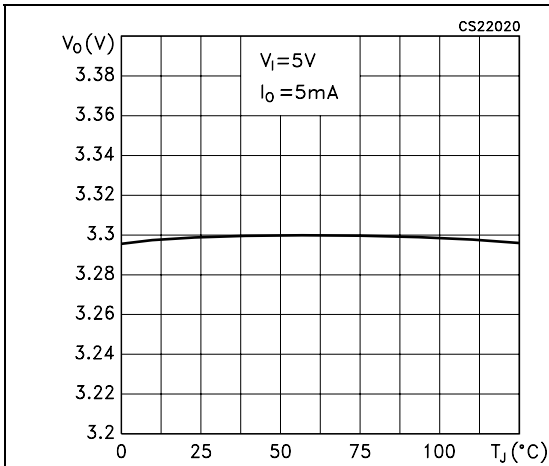


Figure 6. Line regulation vs temperature

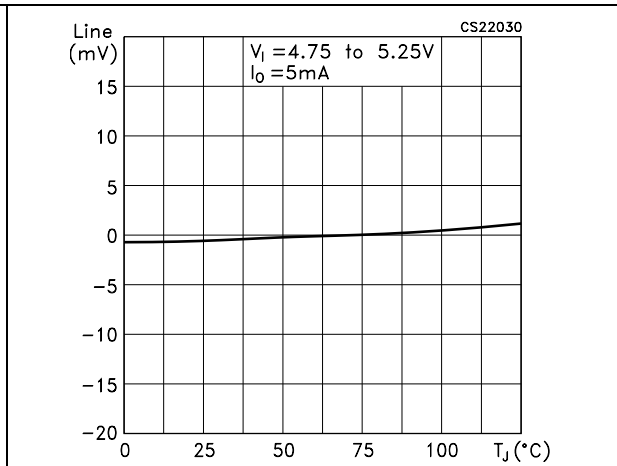


Figure 7. Line regulation vs temperature

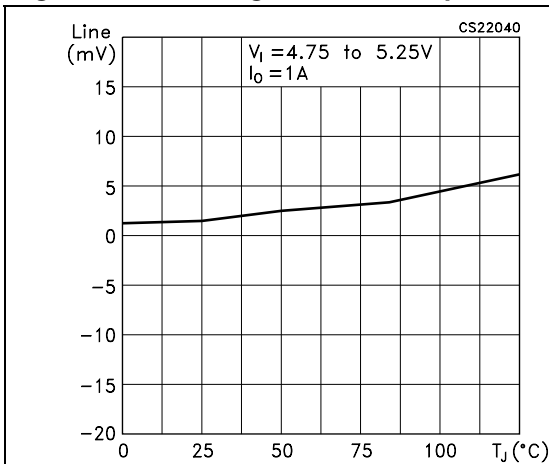


Figure 8. Load regulation vs temperature

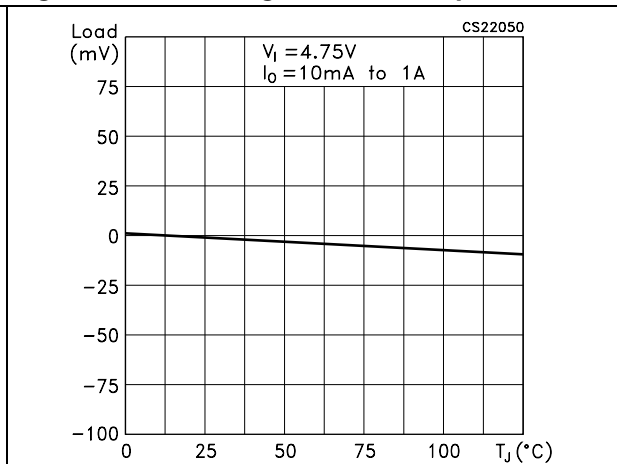


Figure 9. Dropout voltage vs temperature

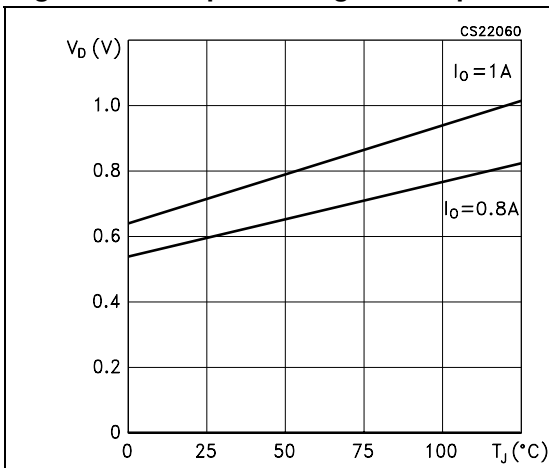


Figure 10. Quiescent current vs temperature

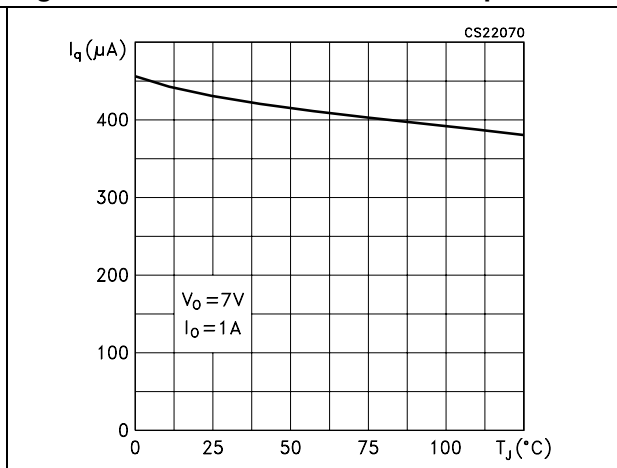


Figure 11. Quiescent current vs temperature

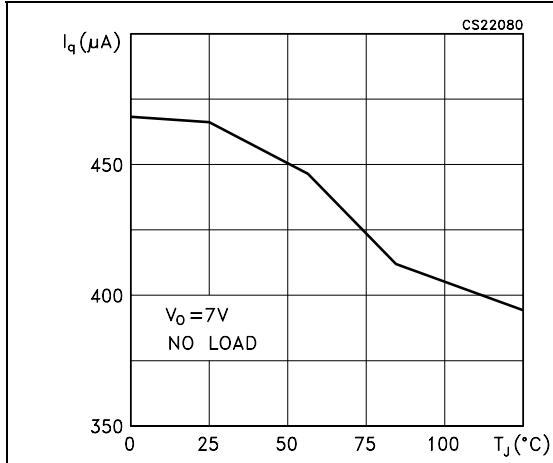


Figure 12. Quiescent current vs temperature

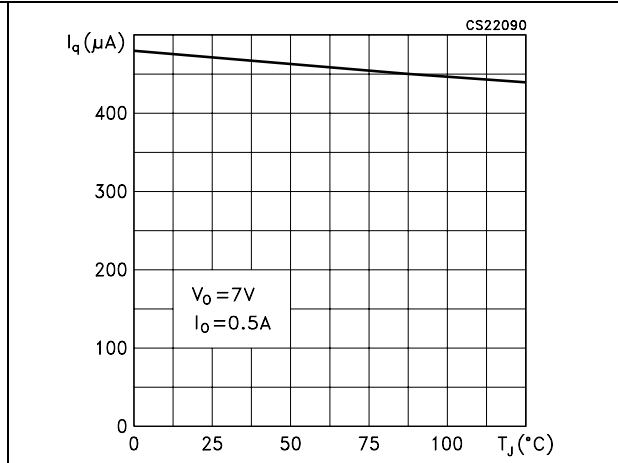


Figure 13. Quiescent current vs temperature

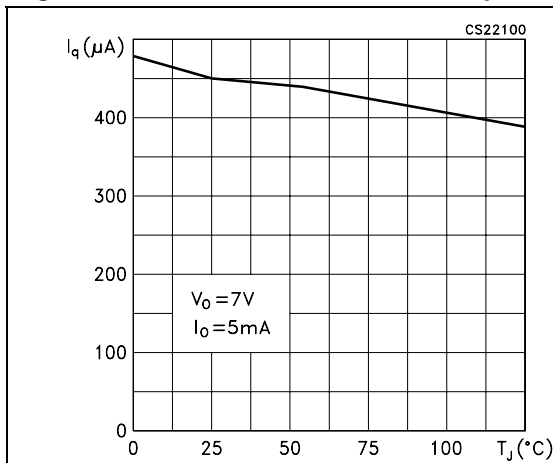


Figure 14. Quiescent current vs output current

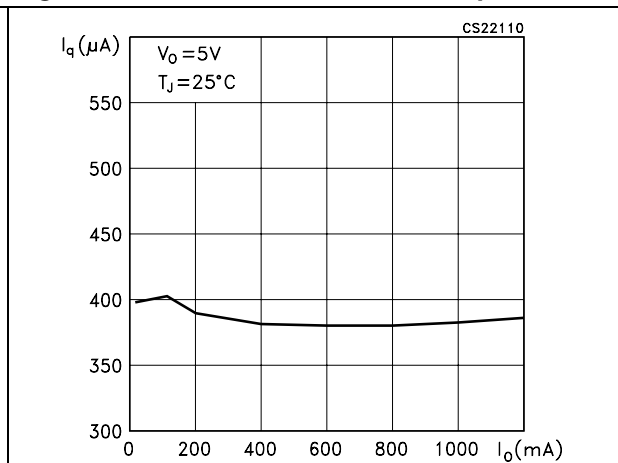


Figure 15. Supply voltage rejection vs temperature

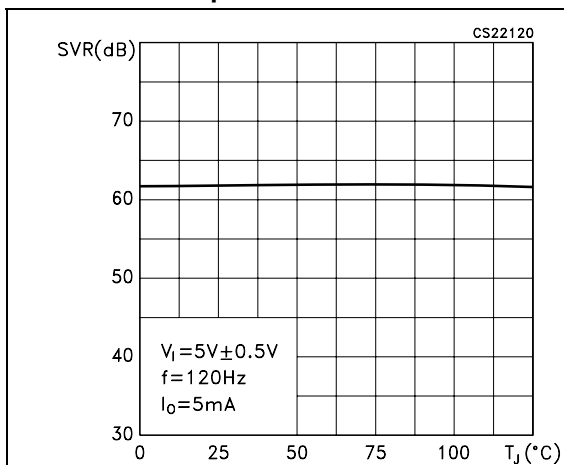


Figure 16. Supply voltage rejection vs frequency

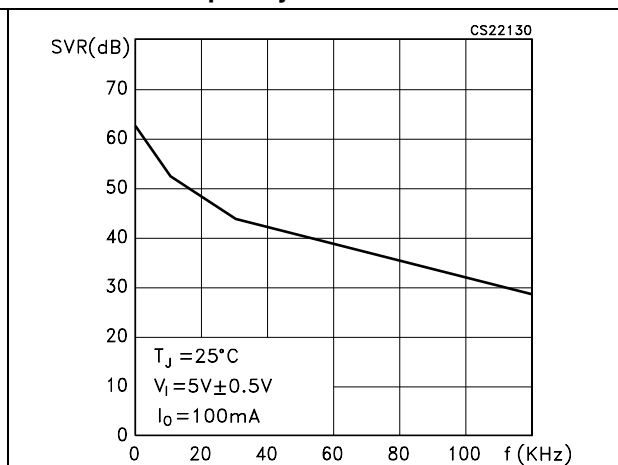


Figure 17. Output noise vs frequency

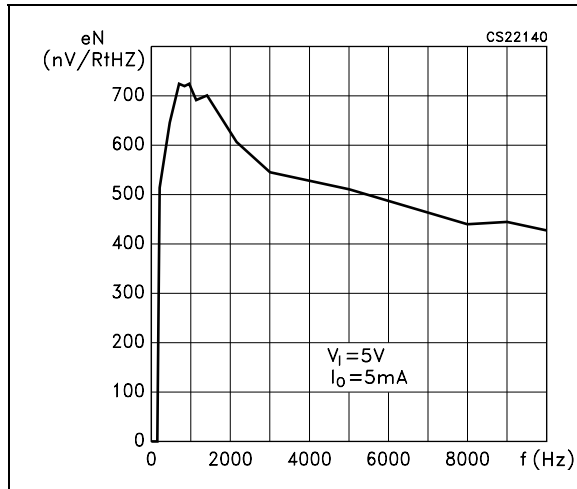
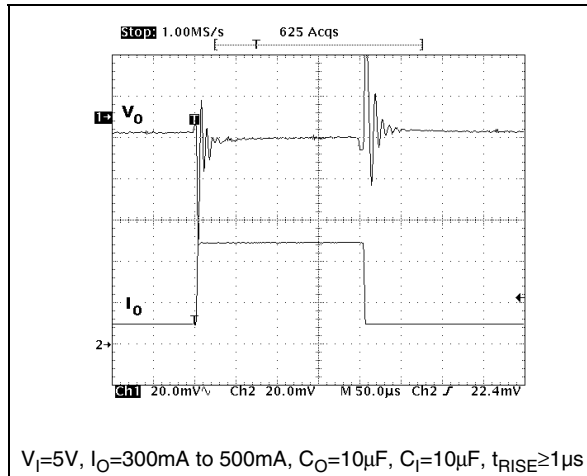
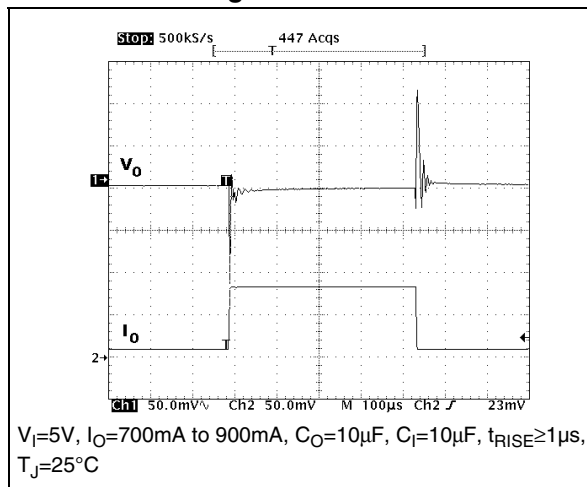
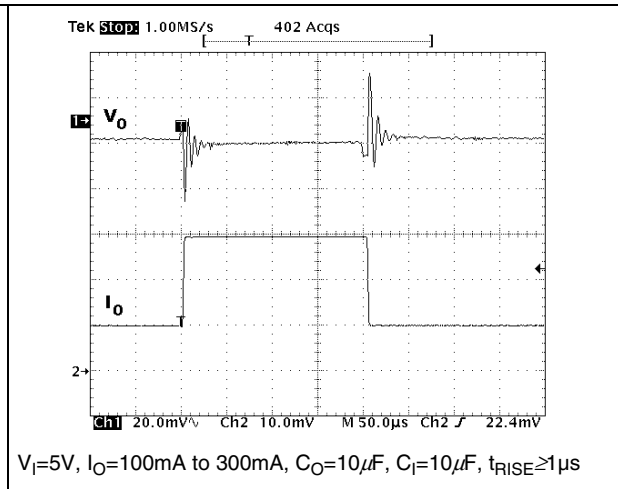
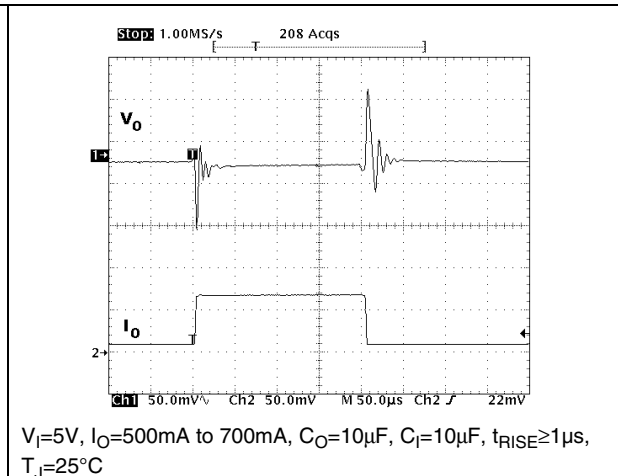
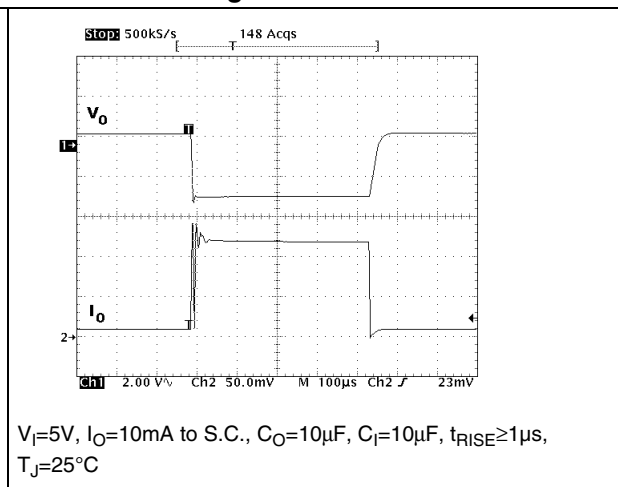
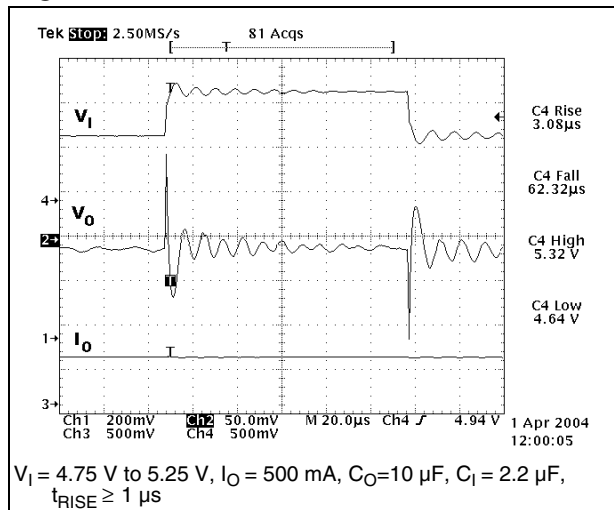
Figure 19. Change of  $V_O$  with step load changeFigure 21. Change of  $V_O$  with step load changeFigure 18. Change of  $V_O$  with step load changeFigure 20. Change of  $V_O$  with step load changeFigure 22. Change of  $V_O$  with step load change

Figure 23. Line transient

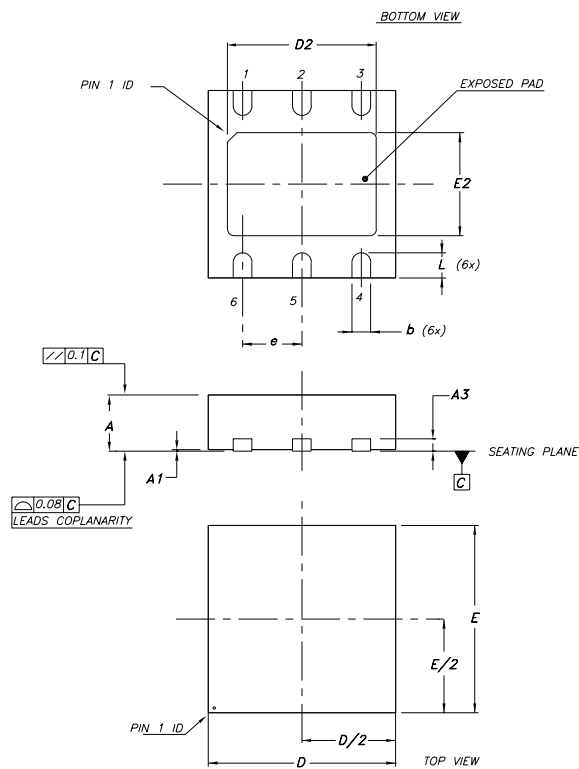


## 7 Package mechanical data

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).

## DFN6D (3x3 mm) mechanical data

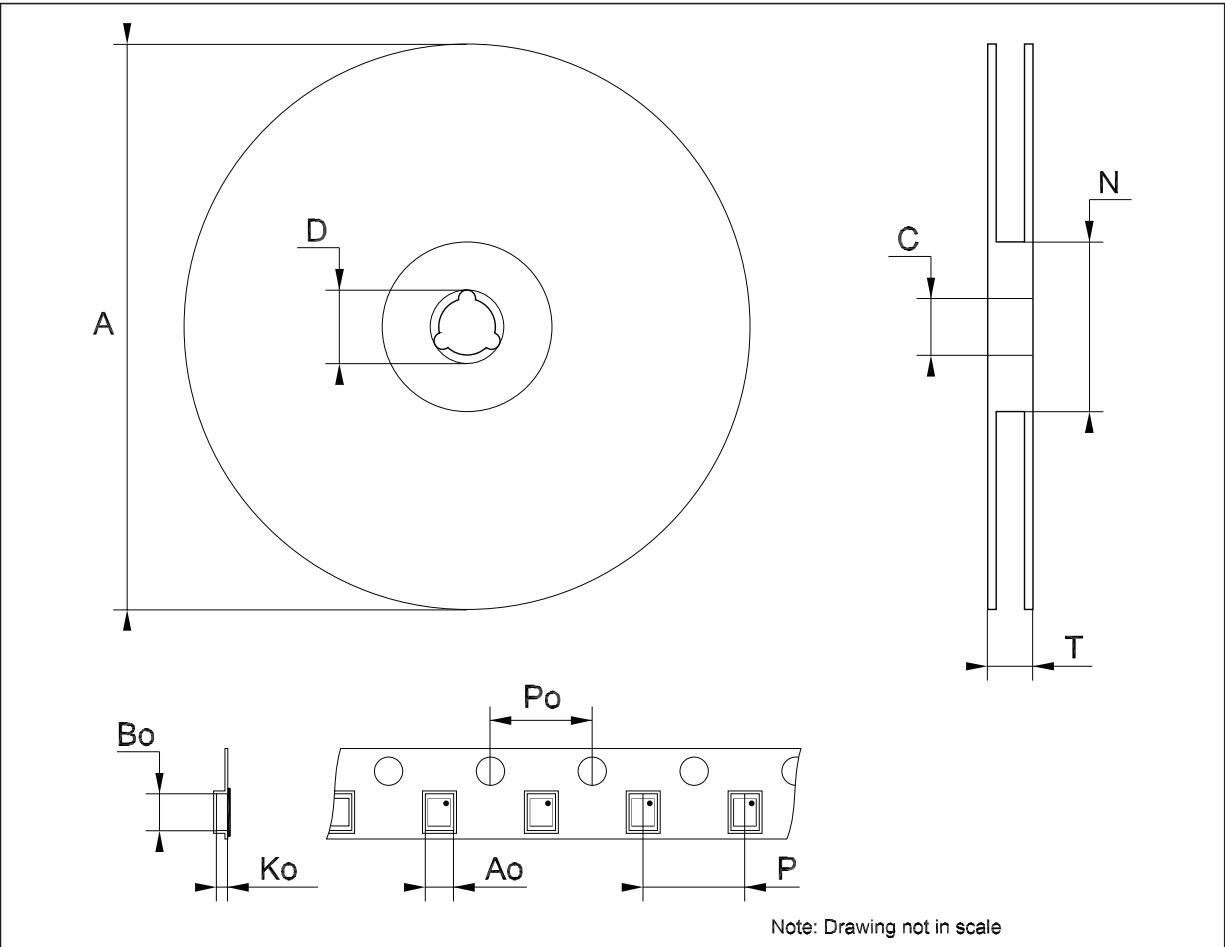
| Dim. | mm.  |      |      | inch. |       |       |
|------|------|------|------|-------|-------|-------|
|      | Min. | Typ. | Max. | Min.  | Typ.  | Max.  |
| A    | 0.80 |      | 1.00 | 0.031 |       | 0.039 |
| A1   | 0    | 0.02 | 0.05 | 0     | 0.001 | 0.002 |
| A3   |      | 0.20 |      |       | 0.008 |       |
| b    | 0.23 |      | 0.45 | 0.009 |       | 0.018 |
| D    | 2.90 | 3.00 | 3.10 | 0.114 | 0.118 | 0.122 |
| D2   | 2.23 |      | 2.50 | 0.088 |       | 0.098 |
| E    | 2.90 | 3.00 | 3.10 | 0.114 | 0.118 | 0.122 |
| E2   | 1.50 |      | 1.75 | 0.059 |       | 0.069 |
| e    |      | 0.95 |      |       | 0.037 |       |
| L    | 0.30 | 0.40 | 0.50 | 0.012 | 0.016 | 0.020 |

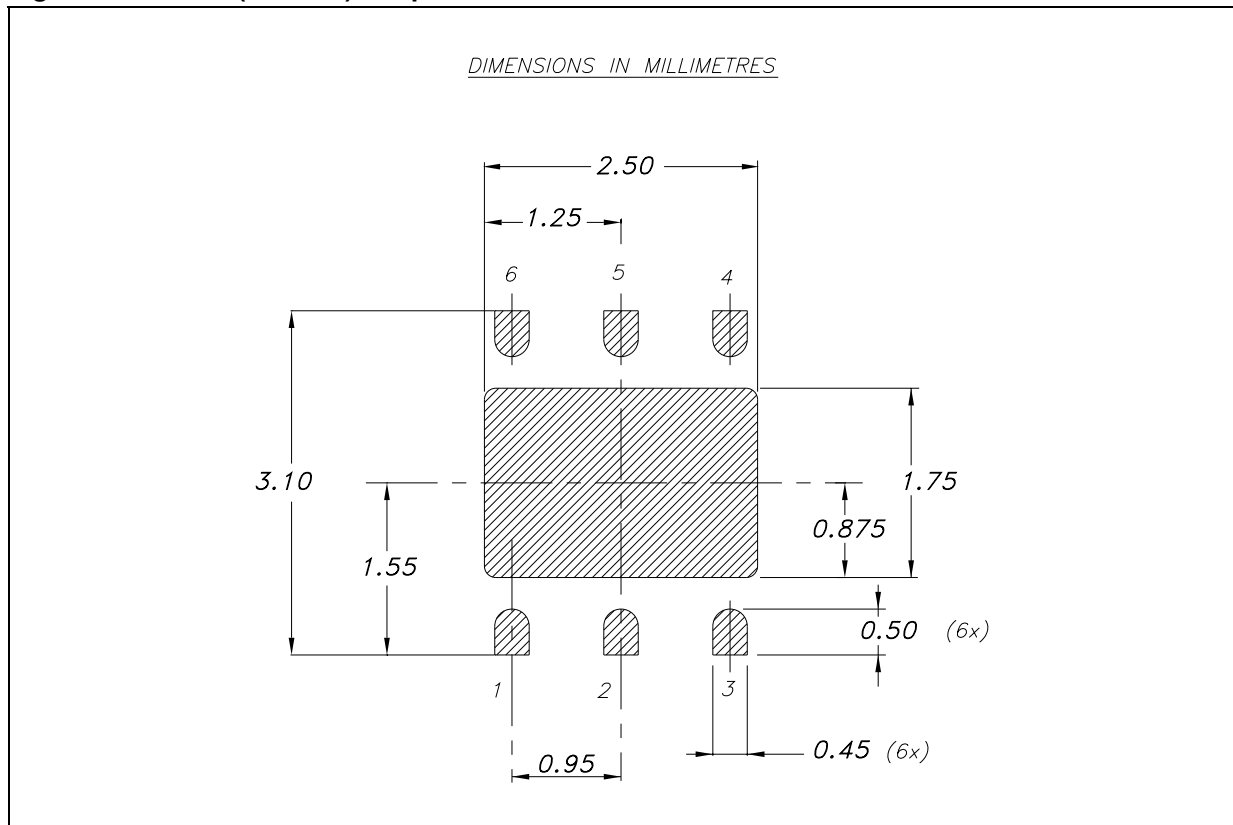


7946637B

Tape & Reel QFNxx/DFNxx (3x3) 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    |      |      | 18.4 |       |       | 0.724  |
| Ao   |      | 3.3  |      |       | 0.130 |        |
| Bo   |      | 3.3  |      |       | 0.130 |        |
| Ko   |      | 1.1  |      |       | 0.043 |        |
| Po   |      | 4    |      |       | 0.157 |        |
| P    |      | 8    |      |       | 0.315 |        |



**Figure 24. DFN6 (3x3 mm) footprint recommended data**

## 8 Revision history

**Table 8. Document revision history**

| Date        | Revision | Changes                                                           |
|-------------|----------|-------------------------------------------------------------------|
| 25-Feb-2005 | 1        | First release.                                                    |
| 10-Jan-2006 | 2        | Add new order codes and tables of the electrical characteristics. |
| 16-May-2006 | 3        | General feature has been updated and add note 3 in table 6.       |
| 05-Jul-2006 | 4        | Updated mechanical data DFN6 (3x3).                               |
| 22-Feb-2007 | 5        | Add note in <a href="#">Figure 2</a> and in order codes.          |
| 03-Apr-2007 | 6        | Add order codes and mechanical data DFN6D.                        |
| 05-Sep-2007 | 7        | Add <a href="#">Table 1</a> in cover page.                        |
| 12-Mar-2008 | 8        | Removed: mechanical data DFN6.                                    |

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