



ST715XX ST715XX25, ST715XX33

High input voltage - 85 mA LDO linear regulator

Features

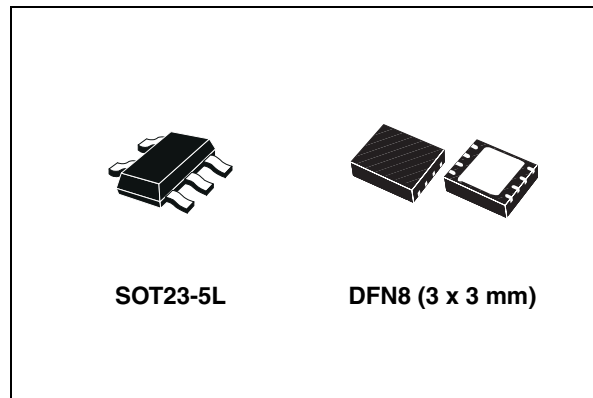
- 2.5 V to 24 V input voltage
- Low dropout voltage (500 mV typ. at 85 mA)
- Very low quiescent current (3.8 μ A typ. at full load)
- 85 mA guaranteed output current
- Output voltage: fixed or adjustable
- Compatible with ceramic output capacitors from 0.47 μ F to 10 μ F
- Internal current limit
- Package DFN8 (3 x 3 mm), SOT23-5L
- Temperature range: -40 °C to 125 °C

Applications

- Mobile phones
- Personal digital assistant (PDAs)
- Cordless phones and similar battery powered systems

Description

The ST715xx is a high voltage, ultra low quiescent low drop linear regulator capable of providing an output current in excess of 85 mA.



The device operates over an input voltage range spanning from 2.5 V to 24 V, and is also stable with output ceramic capacitors. Fault condition protection includes short-circuit current limitation. The ultra low quiescent current of 3.8 μ A at full load makes it highly suitable for low power applications and battery powered systems. The wide input voltage range makes the ST715xx an ideal solution for low power industrial applications also. The ST715xx is available in the DFN8 (3 x 3 mm) 8 leads or the SOT23-5.

Table 1. Device summary

| Order codes | | | | Output voltage |
|--------------------------|---------|---------------------------|---------|----------------|
| SOT23-5L | Marking | DFN8 (3 x 3 mm) | Marking | |
| ST715MR | 71AD | ST715PUR | 715AD | ADJ |
| ST715M15R ⁽¹⁾ | 7115 | ST715PU15R ⁽¹⁾ | 71515 | 1.5 V |
| ST715M18R ⁽¹⁾ | 7118 | ST715PU18R ⁽¹⁾ | 71518 | 1.8 V |
| ST715M25R | 7125 | ST715PU25R | 71525 | 2.5 V |
| ST715M28R ⁽¹⁾ | 7128 | ST715PU28R ⁽¹⁾ | 71528 | 2.8 V |
| ST715M33R | 7133 | ST715PU33R | 71533 | 3.3 V |

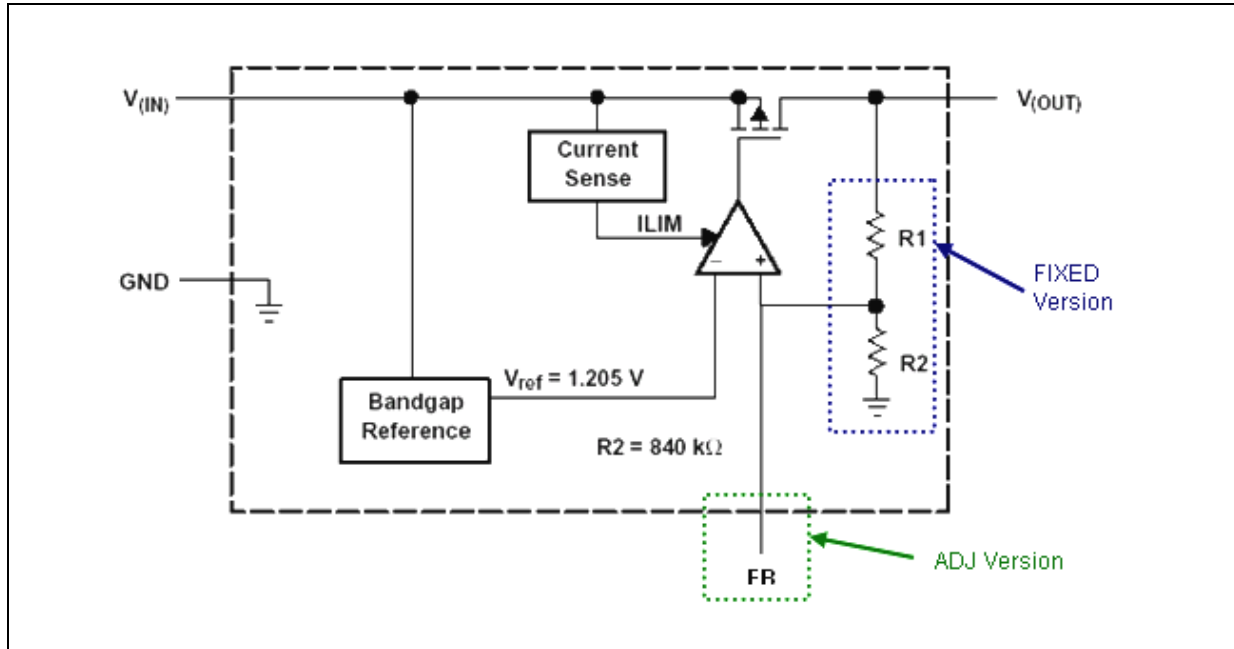
1. Available on request.

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1 Diagram

Figure 1. Block diagram



2 Pin configuration

Figure 2. Pin connections (top view)

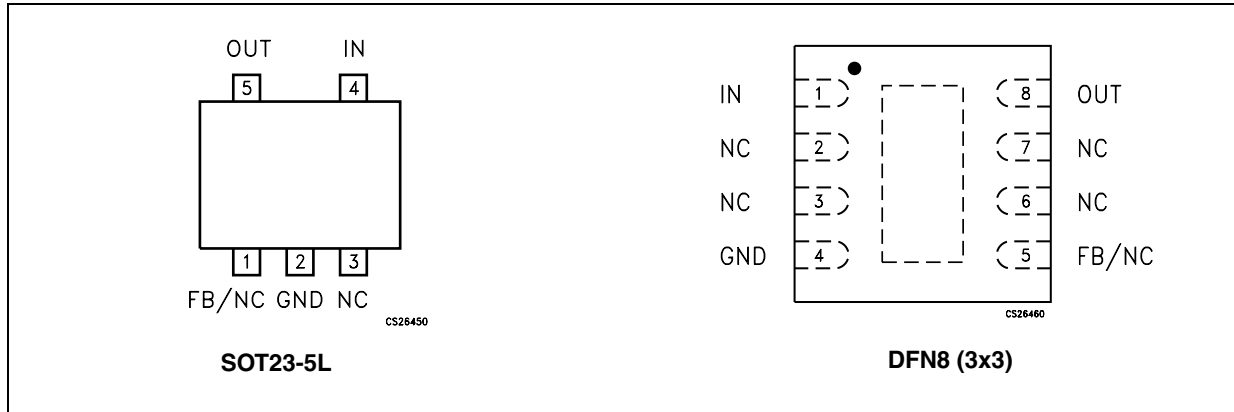


Table 2. Pin description (DFN8 3x3 mm)

| Symbol | Pin for fixed | Pin for adjustable | Name and function |
|--------|-------------------------|----------------------|--------------------------|
| IN | 1 | 1 | Input voltage of the LDO |
| NC | 2, 3, 5, 6, 7, Exp. pad | 2, 3, 6, 7, Exp. pad | Not internally connected |
| GND | 4 | 4 | Common ground |
| FB | - | 5 | Feedback pin |
| OUT | 8 | 8 | Output voltage |

Table 3. Pin description (SOT23-5L)

| Symbol | Pin for fixed | Pin for adjustable | Name and function |
|--------|---------------|--------------------|--------------------------|
| IN | 4 | 4 | Input voltage of the LDO |
| NC | 1, 3 | 3 | Not internally connected |
| GND | 2 | 2 | Common ground |
| FB | | 1 | Feedback pin |
| OUT | 5 | 5 | Output voltage |

3 Maximum ratings

Table 4. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|-----------|--------------------------------------|--|--------------------|
| V_{IN} | DC input voltage | from -0.3 to 26 | V |
| V_{OUT} | DC output voltage | From -0.3 to $V_{IN}+0.3$ | V |
| ADJ | Adjust pin | 4 | V |
| I_{OUT} | Continuous output current | According to package power dissipation | A |
| V_{ESD} | ESD ratings | ± 2 | kV |
| P_D | Power dissipation DFN package | 5 | W |
| | Power dissipation SOT23-5 package | 1 | |
| T_{STG} | Storage temperature range | -65 to 150 | $^{\circ}\text{C}$ |
| T_{OP} | Operating junction temperature range | -40 to 125 | $^{\circ}\text{C}$ |

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

Table 5. Thermal data

| Symbol | Parameter | SOT23-5L | DFN8 | Unit |
|------------|-------------------------------------|----------|------|-----------------------------|
| R_{thJA} | Thermal resistance junction-ambient | 255 | 52 | $^{\circ}\text{C}/\text{W}$ |

4 Electrical characteristics

$T_J = 25\text{ }^\circ\text{C}$, $V_{IN} = V_{OUT(NOM)} + 1\text{ V}$, $C_{IN} = 0.1\text{ }\mu\text{F}$, $C_{OUT} = 1\text{ }\mu\text{F}$, $I_{OUT} = 1\text{ mA}$, unless otherwise specified. ⁽¹⁾

Table 6. Electrical characteristics - adjustable version

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|------------------|-------------------------------------|--|------|-------|-------|---------------------|
| V_{IN} | Operating input voltage | $I_{OUT} = 85\text{mA}$ | 2.5 | | 24 | V |
| V_{OUT} | Output voltage range | | 1.2 | | | V |
| I_{OUT} | Output current | $V_{IN}=2.5\text{ to }6\text{V}$, $T_J=-40^\circ\text{C to }125^\circ\text{C}$ | | | 85 | mA |
| V_{FB} | Feedback voltage | | | 1.2 | | V |
| | V_{FB} accuracy ⁽¹⁾ | $V_{IN}=V_{OUT}+1\text{ to }24\text{V}$, $I_{OUT} = 1\text{mA to }85\text{mA}$, $T_J=-40^\circ\text{C to }125^\circ\text{C}$ | -4.0 | | 4.0 | % |
| ΔV_{OUT} | Line regulation | $V_{IN}=V_{OUT}+1\text{ to }24\text{V}$, $I_{OUT}=1\text{mA}$, $T_J=-40^\circ\text{C to }125^\circ\text{C}$ | | 0.001 | 0.004 | %/V |
| ΔV_{OUT} | Load regulation | $I_{OUT} = 1\text{mA to }85\text{mA}$, $T_J=-40^\circ\text{C to }125^\circ\text{C}$ | | 0.002 | 0.004 | %/mA |
| e_N | Output noise voltage ⁽²⁾ | 200Hz to 100kHz, $I_{OUT} = 50\text{mA}$, $C_{OUT}=10\mu\text{F}$, $T_J=-40^\circ\text{C to }125^\circ\text{C}$, $V_{OUT}=1.2\text{V}$ | | | 95 | μV_{RMS} |
| SVR | Supply voltage rejection | $V_{IN}=V_{OUTNOM}+1\text{V}+/-V_{RIPPLE}$, $V_{RIPPLE}=0.2\text{V}$, $I_{OUT} = 1\text{mA}$, $C_{OUT}=10\mu\text{F}$ $T_J=-40^\circ\text{C to }125^\circ\text{C}$ | | 45 | | dB |
| | | $f=1\text{kHz}$ | | | | |
| I_Q | Quiescent current | $I_{OUT}=0\text{mA to }85\text{mA}$, $T_J=-40^\circ\text{C to }125^\circ\text{C}$ | | | 5.5 | μA |
| | | $I_{OUT}=0\text{mA to }85\text{mA}$, $V_{IN}=24\text{V}$, $T_J=-40^\circ\text{C to }125^\circ\text{C}$ | | | 6.5 | |
| I_{SC} | Short circuit current | $V_{OUT}=0$, $T_J=-40^\circ\text{C to }125^\circ\text{C}$, $V_{IN}=3.8\text{V}$ | 120 | | | mA |
| T_{ON} | Turn on time ⁽³⁾ | $V_{IN} = 4.2\text{V}$, $C_{OUT}=10\mu\text{F}$, $I_{OUT}=60\text{mA}$, $T_J=-40^\circ\text{C to }125^\circ\text{C}$ | | 0.7 | | ms |
| C_{OUT} | Output capacitor | Capacitance $f = 100\text{kHz}$ | 0.47 | | | μF |

1. For $V_{OUT(NOM)} < 2\text{ V}$, $V_{IN} = 2.5\text{ V}$.

2. Guaranteed by design.

3. Turn-on time is time measured between the input just exceeding 90% of its final value and the output voltage just reaching 95 % of its nominal value.

$T_J = 25\text{ }^\circ\text{C}$, $V_{IN} = V_{OUT(NOM)} + 1\text{ V}$, $C_{IN} = 0.1\text{ }\mu\text{F}$, $C_{OUT} = 1\text{ }\mu\text{F}$, $I_{OUT} = 1\text{ mA}$, $V_{OUT} = 3.3\text{ V}$ unless otherwise specified. ⁽¹⁾

Table 7. Electrical characteristics - fixed version

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit | |
|------------------|---|---|------------------------|-------------------------|-------|---------------------|---------------|
| V_{IN} | Operating input voltage | $I_{OUT} = 85\text{ mA}$, $T_J = -40\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$ | | $V_{OUT} + V_{DROPTYP}$ | 24 | V | |
| I_{OUT} | Output current | $V_{IN} = 4.3$ to 24 V , $T_J = -40\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$ | 0 | | 85 | mA | |
| V_{OUT} | V_{OUT} total accuracy ⁽¹⁾ | $V_{IN} = V_{OUT} + 1$ to 24 V , $I_{OUT} = 0$ to 85 mA , $T_J = -40\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$ | -5 | | +5 | % | |
| ΔV_{OUT} | Line regulation | $V_{IN} = 4.3$ to 24 V , $I_{OUT} = 1\text{ mA}$, $T_J = -40\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$ | | 0.001 | 0.004 | %/V | |
| ΔV_{OUT} | Load regulation | $I_{OUT} = 100\text{ }\mu\text{A}$ to 85 mA , $T_J = -40\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$ | | 0.002 | 0.003 | %/mA | |
| V_{DROP} | Drop output voltage ⁽²⁾ | $I_{OUT} = 85\text{ mA}$, $T_J = -40\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$ | | 500 | 1000 | mV | |
| e_N | Output noise voltage ⁽³⁾ | 200Hz to 100kHz, $I_{OUT} = 50\text{ mA}$, $C_{OUT} = 10\text{ }\mu\text{F}$, $T_J = -40\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$ | | | 210 | μV_{RMS} | |
| SVR | Supply voltage rejection | $V_{IN} = V_{OUT(NOM)} + 1\text{ V} \pm V_{RIPPLE}$, $V_{RIPPLE} = 0.2\text{ V}$, $I_{OUT} = 1\text{ mA}$, $C_{OUT} = 10\text{ }\mu\text{F}$ | f=1kHz | | 38 | dB | |
| | | $T_J = -40\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$ | f=100kHz | | 57 | | |
| I_Q | Quiescent current | $I_{OUT} = 0\text{ mA}$ to 85 mA , $T_J = -40\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$ | | | 3.75 | 5.5 | μA |
| | | | $V_{IN} = 24\text{ V}$ | | 4.15 | 6.5 | |
| I_{SC} | Short circuit current | $V_{OUT} = 0$, $T_J = -40\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$ $V_{IN} = 3.8\text{ V}$ | 120 | | | mA | |
| T_{ON} | Turn on time ⁽⁴⁾ | $V_{IN} = 4.2\text{ V}$, $C_{OUT} = 10\text{ }\mu\text{F}$, $I_{OUT} = 60\text{ mA}$, $T_J = -40\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$ | | 0.7 | | ms | |
| C_{OUT} | Output capacitor | Capacitance f = 100kHz | 0.47 | | | μF | |

1. For $V_{OUT(NOM)} < 2\text{ V}$, $V_{IN} = 2.5\text{ V}$.

2. Dropout voltage is the input-to-output voltage difference at which the output voltage is 100 mV below its nominal value. This specification does not apply for output voltages below 2 V.

3. Guaranteed by design.

4. Turn-on time is time measured between the input just exceeding 90 % of its final value and the output voltage just reaching 95% of its nominal value.

5 Output voltage selection for adjustable version

The ST715xx features an adjustable output voltage using two external resistors connected as a voltage divider to the FB pin as shown in the typical application circuit [Figure 4](#). The output voltage is set using the following equation:

Equation 1

$$V_{OUT} = V_{FB} (1 + R_1/R_2)$$

where typically $V_{FB} = 1.2$ V. Choose $R_2 \geq 5$ k Ω in order to optimize quiescent current, accuracy, and high-frequency power-supply rejection. To simplify resistor selection use the following equation:

Equation 2

$$R_1 = R_2 \times (V_{OUT}/V_{FB} - 1)$$

5.1 External capacitor requirements

A 0.1 μ F or larger input bypass capacitor, connected between IN and GND and located close to the device, is recommended to improve transient response and noise rejection of the power supply as a whole. A higher-value input capacitor may be necessary if large, fast-rise-time load transients will be present in the application and if the device is located several inches away from the power source.

The ST715xx requires an output capacitor connected between OUT and GND to stabilize the internal control loop. Any capacitor (including ceramic and tantalum) with a value higher than 0.47 μ F will properly stabilize this loop.

5.2 Power dissipation and junction temperature

To ensure reliable operation, worst-case junction temperature should not exceed 125 °C. This restriction limits the power dissipation the regulator can handle in any given application. To ensure that the junction temperature is within acceptable limits, calculate the maximum allowable dissipation, $P_{D(max)}$, and the actual dissipation, P_D , which must be less than or equal to $P_{D(max)}$.

The maximum power dissipation limit is determined using the following equation:

Equation 3

$$P_{D(max)} = (T_{JMAX} - T_A) / R_{thJA}$$

where:

T_{JMAX} is the maximum allowable junction temperature.

R_{thJA} is the thermal resistance junction-to-ambient for the package.

T_A is the ambient temperature.

The regulator dissipation is calculated using the following equation:

Equation 4

$$P_D = (V_{IN} - V_{OUT}) \times I_{OUT}$$

Power dissipation resulting from quiescent current is negligible.

The ST715xx features internal current limiting. During normal operation, it limits output current to approximately 350 mA. When current limiting engages, the output voltage scales back linearly until the overcurrent condition ends. Take care not to exceed the power dissipation ratings of the package.

6 Typical application

Figure 3. Application circuit for fixed version

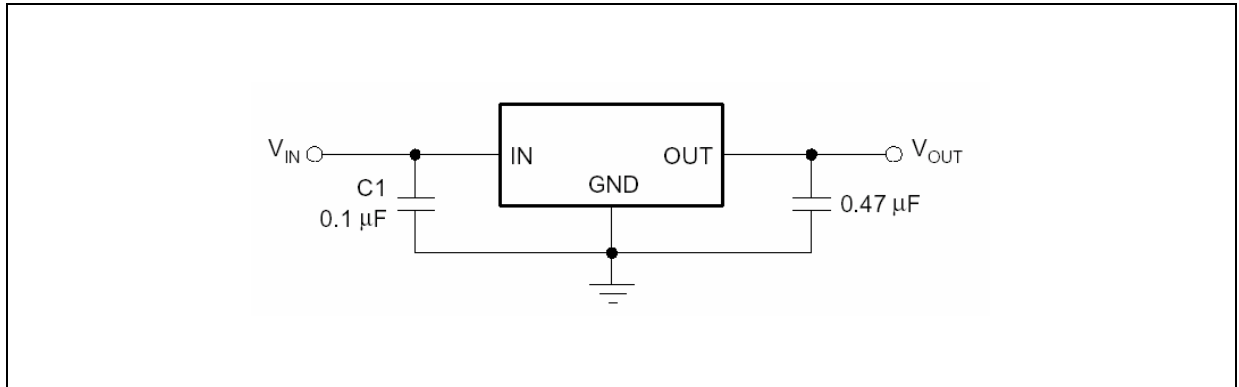
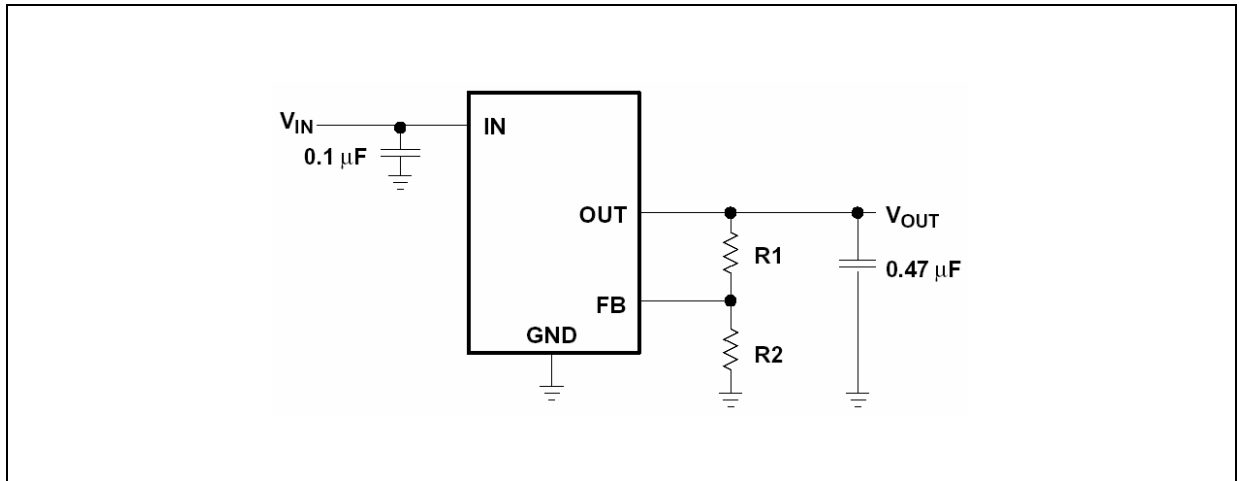


Figure 4. Application circuit for adjustable version



7 Typical performance characteristics

Figure 5. Output voltage vs. temperature

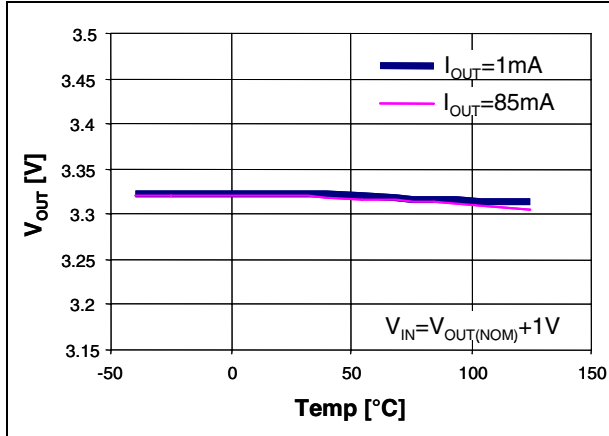


Figure 6. Output voltage vs. input voltage

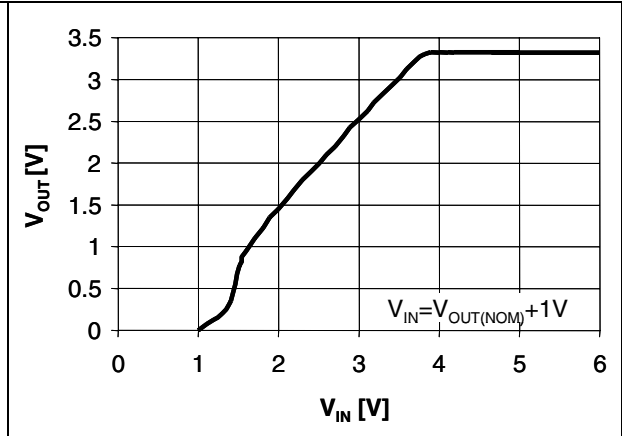


Figure 7. Dropout voltage vs. output current

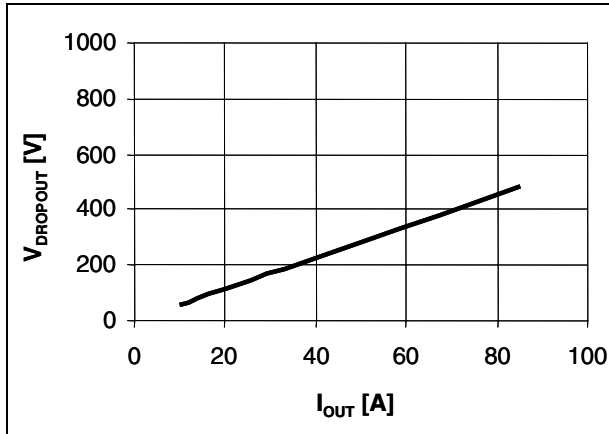


Figure 8. C_{OUT} stability region

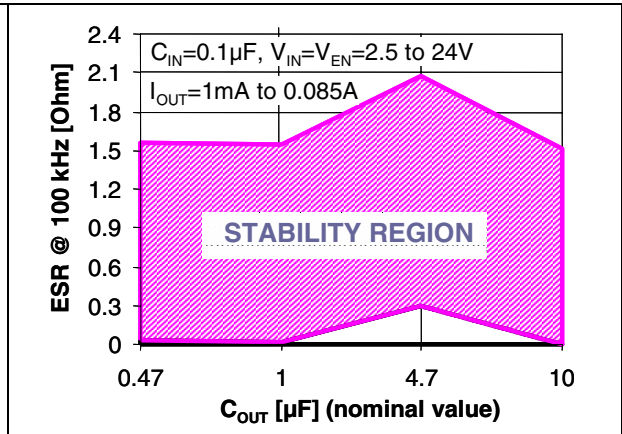


Figure 9. Supply voltage rejection vs. frequency

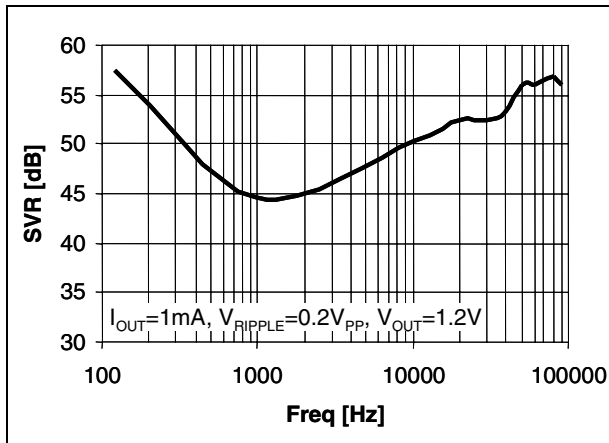


Figure 10. Output noise voltage vs. frequency

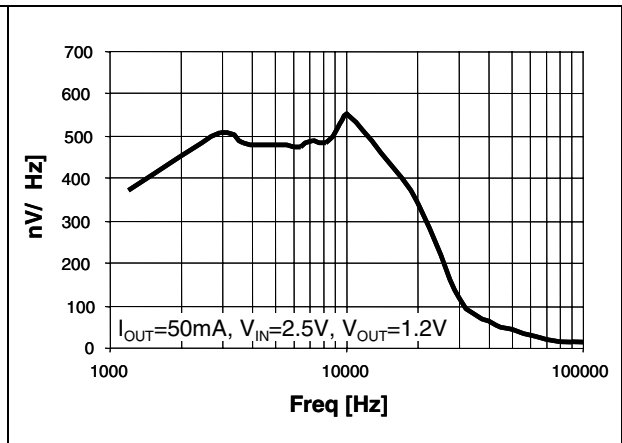


Figure 11. Quiescent current vs. input voltage Figure 12. Load transient

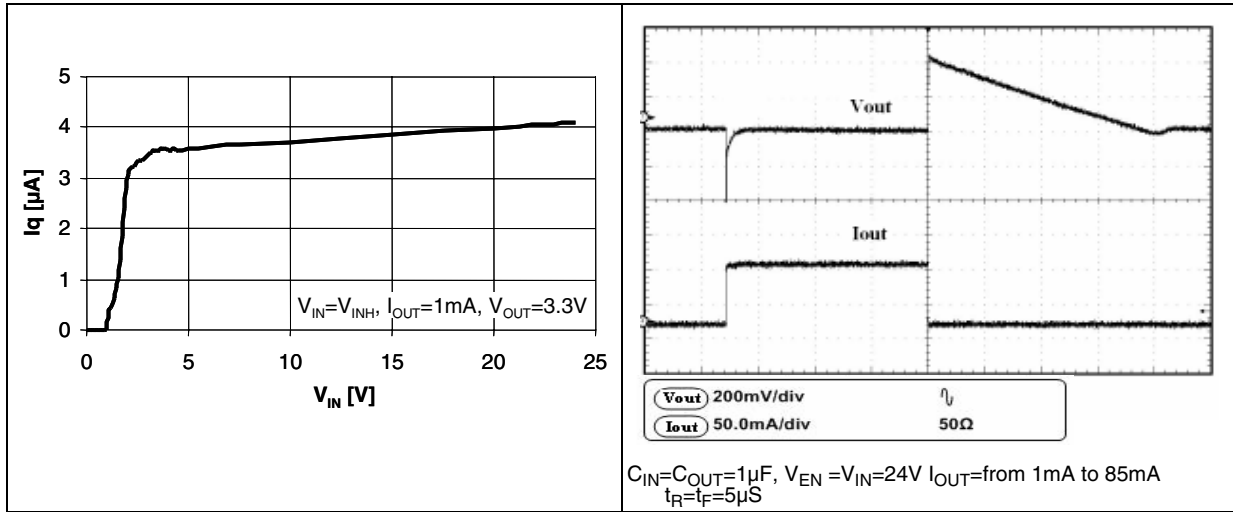


Figure 13. Line transient

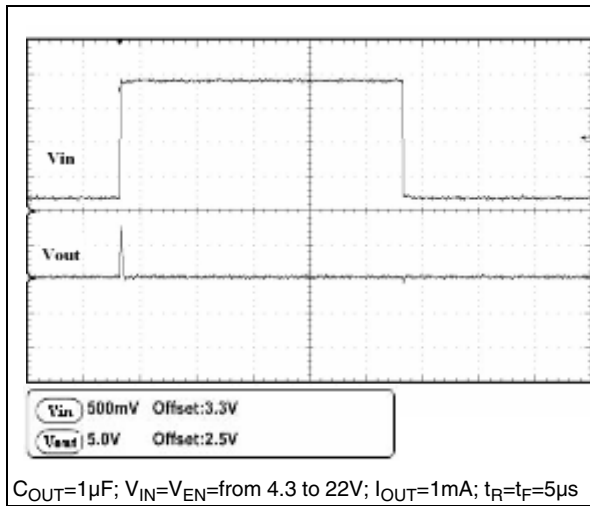
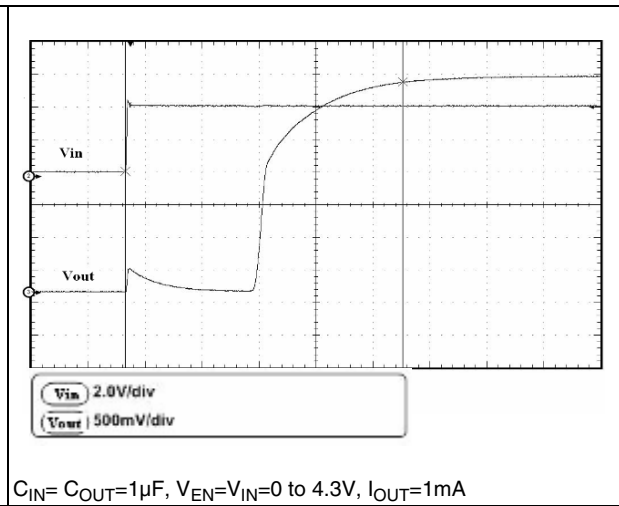


Figure 14. Enable transient

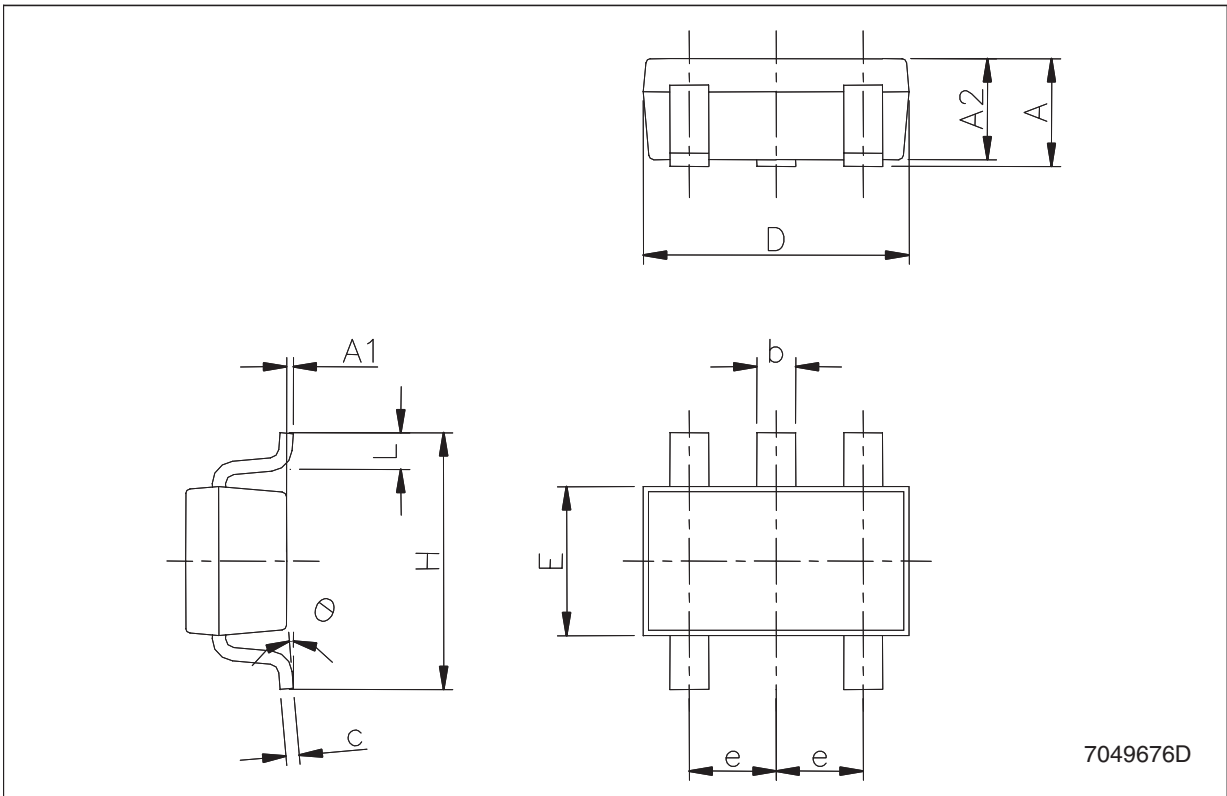


8 Package mechanical data

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.

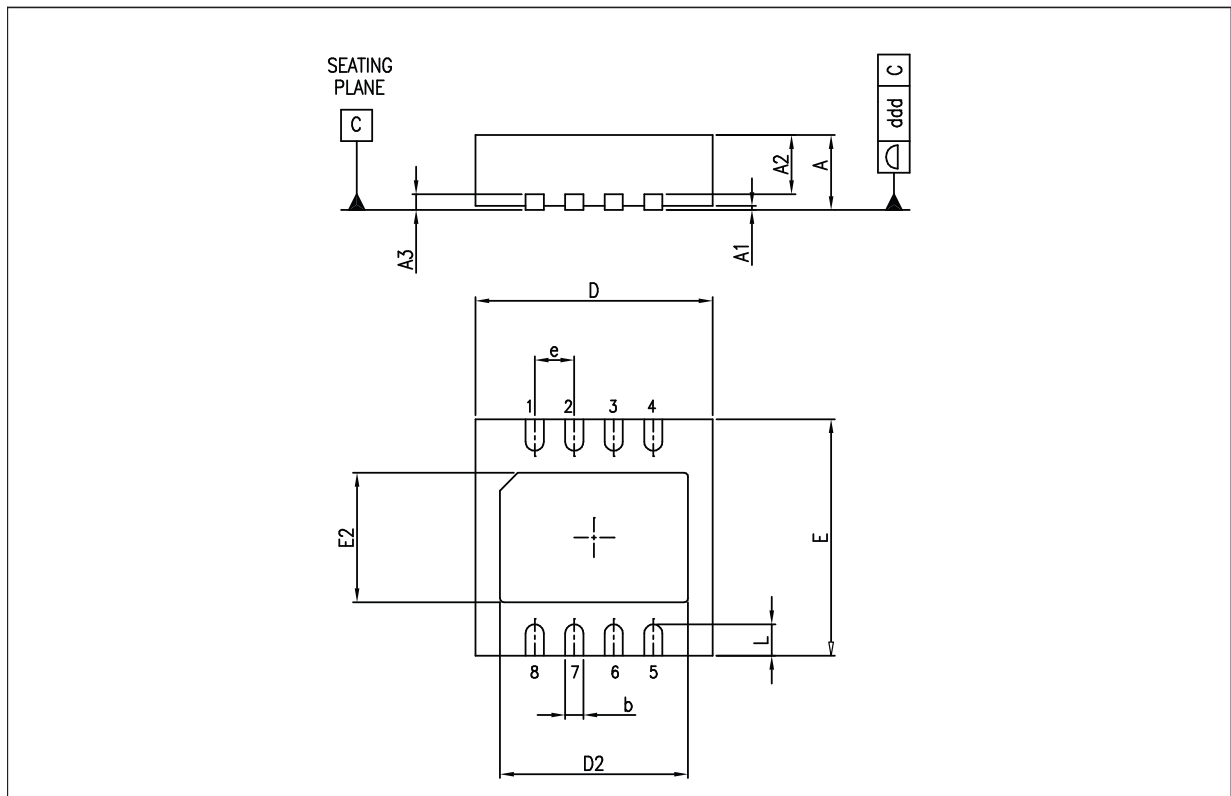
SOT23-5L mechanical data

| 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 |



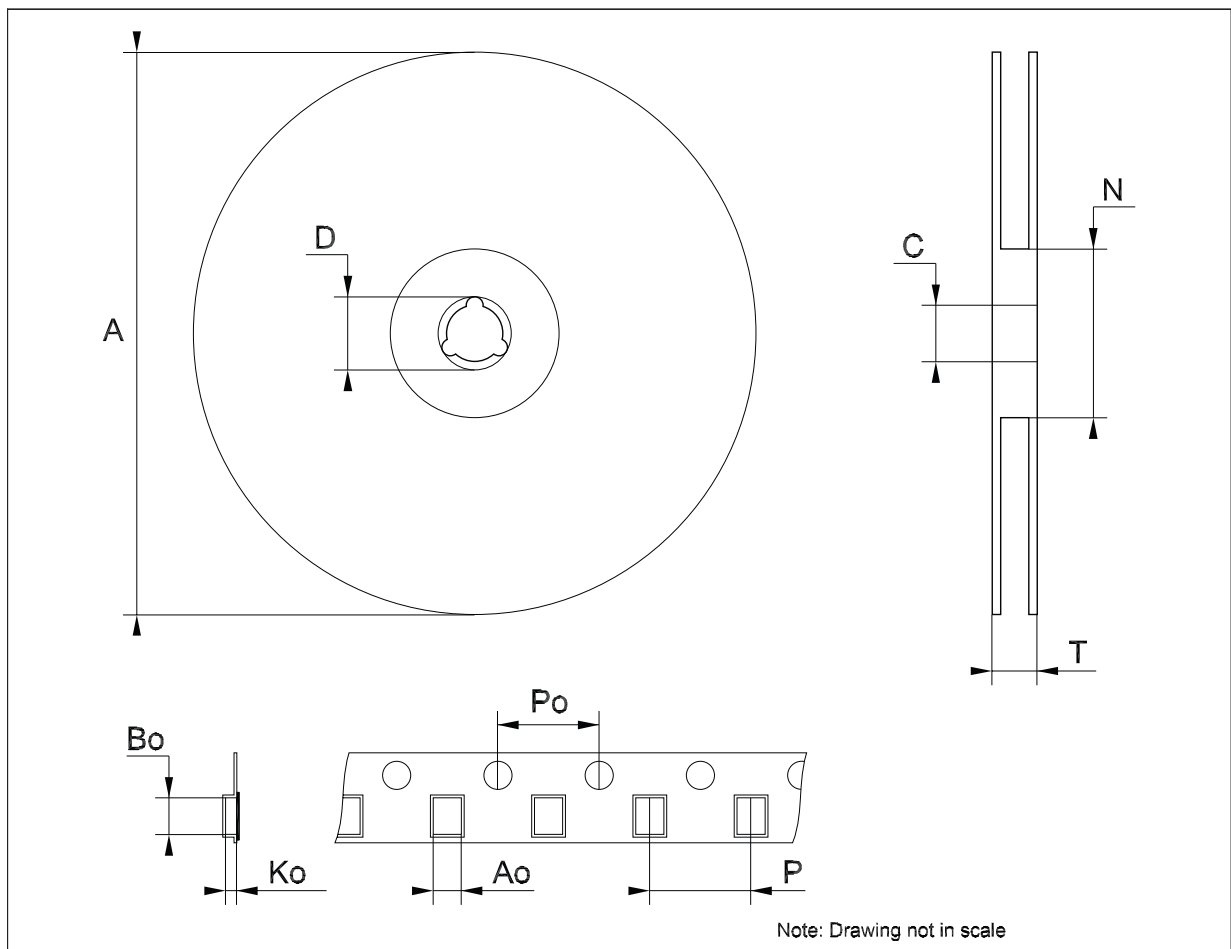
DFN8 (3x3 mm) mechanical data

| Dim. | mm. | | | mils. | | |
|------|-------|-------|-------|-------|-------|------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | 0.80 | 0.90 | 1.00 | 31.5 | 35.4 | 39.4 |
| A1 | | 0.02 | 0.05 | | 0.8 | 2.0 |
| A3 | | 0.20 | | | 7.9 | |
| b | 0.25 | 0.30 | 0.35 | 9.8 | 11.8 | 13.8 |
| D | 2.85 | 3.00 | 3.15 | 112.2 | 118.1 | 124 |
| D2 | 1.603 | 1.753 | 1.853 | 63.1 | 69 | 73 |
| E | 2.85 | 3.00 | 3.15 | 112.2 | 118.1 | 124 |
| E2 | 1.345 | 1.495 | 1.595 | 53 | 58.9 | 62.8 |
| e | | 0.65 | | | 25.6 | |
| L | 0.30 | 0.40 | 0.50 | 11.8 | 15.7 | 19.7 |



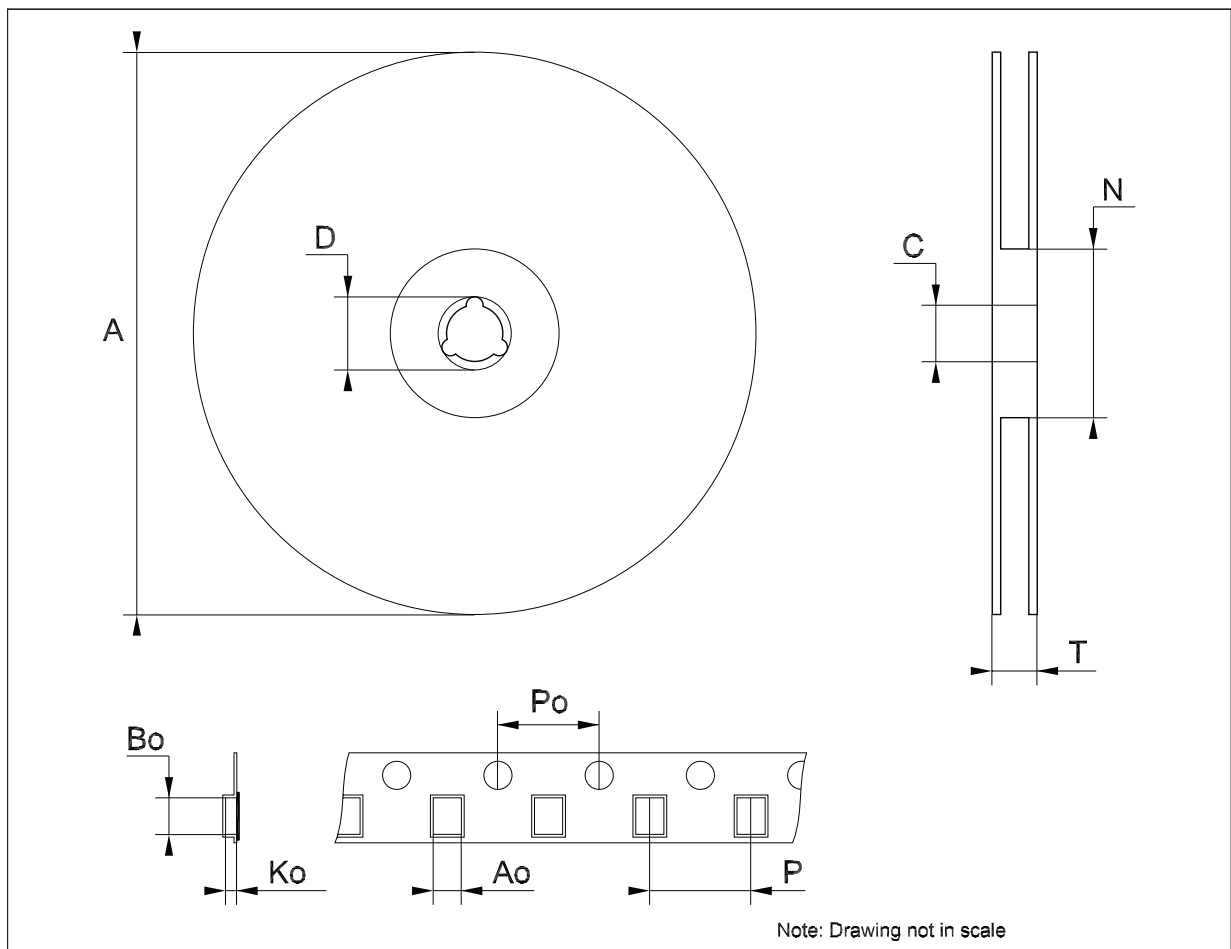
Tape & reel SOT23-xL mechanical data

| 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 |



Tape & reel QFNxx/DFNxx (3x3) mechanical data

| Dim. | mm. | | | inch. | | |
|------|------|------|------|-------|-------|-------|
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 180 | | | 7.087 |
| C | 12.8 | | 13.2 | 0.504 | | 0.519 |
| D | 20.2 | | | 0.795 | | |
| N | 60 | | | 2.362 | | |
| T | | | 14.4 | | | 0.567 |
| Ao | | 3.3 | | | 0.130 | |
| Bo | | 3.3 | | | 0.130 | |
| Ko | | 1.1 | | | 0.043 | |
| Po | | 4 | | | 0.157 | |
| P | | 8 | | | 0.315 | |



9 Revision history

Table 8. Document revision history

| Date | Revision | Changes |
|-------------|----------|--|
| 08-Feb-2008 | 1 | Initial release. |
| 19-Feb-2008 | 2 | Modified: <i>Features on page 1.</i> |
| 22-Sep-2008 | 3 | Modified: DFN8 (3x3 mm) mechanical data <i>on page 15.</i> |
| 26-Nov-2008 | 4 | Modified: <i>Section 5 on page 8.</i> |
| 24-Mar-2010 | 5 | Modified: <i>Table 4 on page 5.</i> |
| 20-May-2010 | 6 | Modified: I _Q max values <i>Table 6 on page 6</i> and <i>Table 7 on page 7.</i> |
| 24-Jun-2010 | 7 | Modified: <i>Table 2</i> and <i>Table 3 on page 4.</i> |

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