



# ST715XX ST715XX25, ST715XX33

## High input voltage - 85 mA LDO linear regulator

### Features

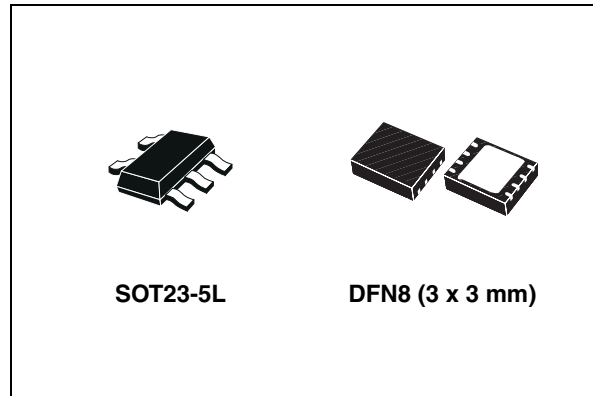
- 2.5 V to 24 V input voltage
- Low dropout voltage (500 mV typ. at 85 mA)
- Very low quiescent current (3.8  $\mu$ A typ. at full load)
- 85 mA guaranteed output current
- Output voltage: fixed or adjustable
- Compatible with ceramic output capacitors from 0.47  $\mu$ F to 10  $\mu$ F
- Internal current 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  $\mu$ 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 <sup>(1)</sup>	7115	ST715PU15R <sup>(1)</sup>	71515	1.5 V
ST715M18R <sup>(1)</sup>	7118	ST715PU18R <sup>(1)</sup>	71518	1.8 V
ST715M25R	7125	ST715PU25R	71525	2.5 V
ST715M28R <sup>(1)</sup>	7128	ST715PU28R <sup>(1)</sup>	71528	2.8 V
ST715M33R	7133	ST715PU33R	71533	3.3 V

1. Available on request.

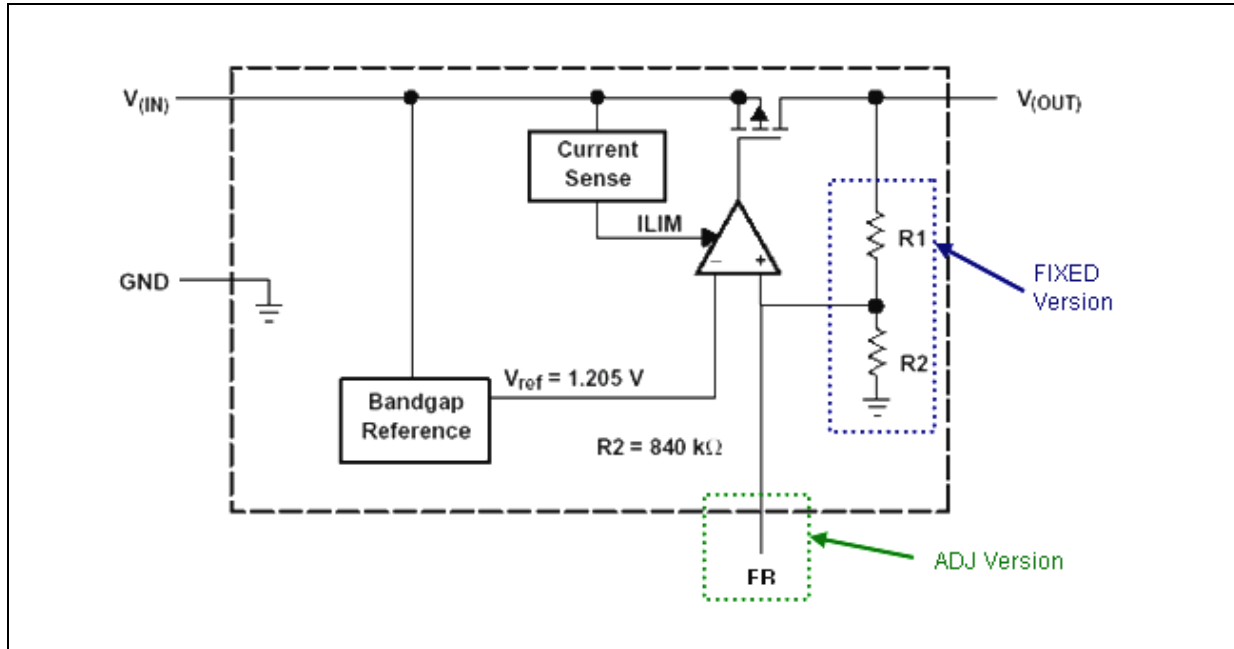
---

# 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>Output voltage selection for adjustable version</b> .....	<b>8</b>
5.1	External capacitor requirements .....	8
5.2	Power dissipation and junction temperature .....	8
<b>6</b>	<b>Typical application</b> .....	<b>10</b>
<b>7</b>	<b>Typical performance characteristics</b> .....	<b>11</b>
<b>8</b>	<b>Package mechanical data</b> .....	<b>13</b>
<b>9</b>	<b>Revision history</b> .....	<b>18</b>

# 1 Diagram

Figure 1. Block diagram



## 2 Pin configuration

Figure 2. Pin connections (top view)

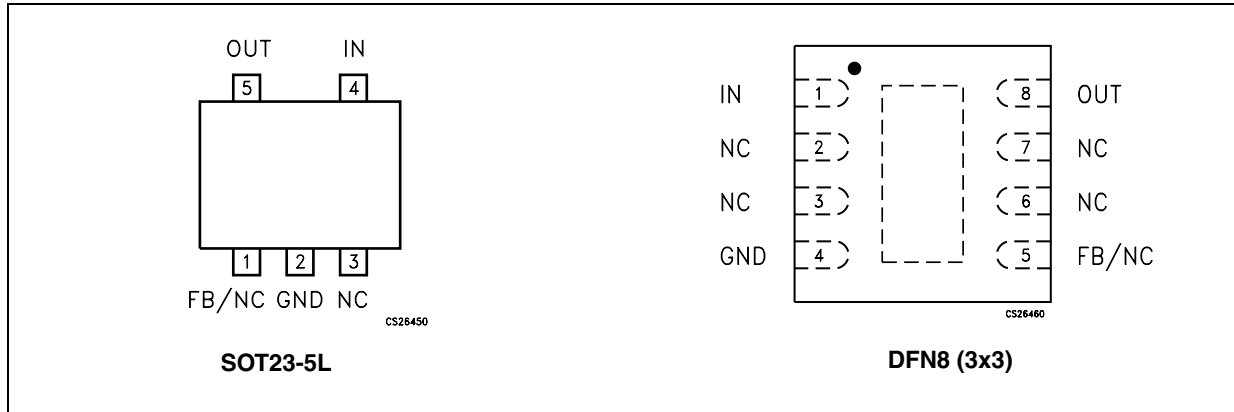


Table 2. Pin description (DFN8 3x3 mm)

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	$\pm 2$	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. <sup>(1)</sup>

**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 <sup>(1)</sup>	$V_{IN}=V_{OUT}+1\text{ to }24\text{V}$ , $I_{OUT} = 1\text{mA to }85\text{mA}$ , $T_J=-40^\circ\text{C to }125^\circ\text{C}$	-4.0		4.0	%
$\Delta V_{OUT}$	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
$\Delta V_{OUT}$	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 <sup>(2)</sup>	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	$\mu\text{V}_{RMS}$
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	$\mu\text{A}$
		$I_{OUT}=0\text{mA to }85\text{mA}$ , $V_{IN}=24\text{V}$ , $T_J=-40^\circ\text{C to }125^\circ\text{C}$			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 <sup>(3)</sup>	$V_{IN} = 4.2\text{V}$ , $C_{OUT}=10\mu\text{F}$ , $I_{OUT}=60\text{mA}$ , $T_J=-40^\circ\text{C to }125^\circ\text{C}$		0.7		ms
$C_{OUT}$	Output capacitor	Capacitance $f = 100\text{kHz}$	0.47			$\mu\text{F}$

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. <sup>(1)</sup>

**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 $24\text{ V}$ , $T_J = -40\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$	0		85	mA	
$V_{OUT}$	$V_{OUT}$ total accuracy <sup>(1)</sup>	$V_{IN} = V_{OUT} + 1$ to $24\text{ V}$ , $I_{OUT} = 0$ to $85\text{ mA}$ , $T_J = -40\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$	-5		+5	%	
$\Delta V_{OUT}$	Line regulation	$V_{IN} = 4.3$ to $24\text{ V}$ , $I_{OUT} = 1\text{ mA}$ , $T_J = -40\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$		0.001	0.004	%/V	
$\Delta V_{OUT}$	Load regulation	$I_{OUT} = 100\text{ }\mu\text{A}$ to $85\text{ mA}$ , $T_J = -40\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$		0.002	0.003	%/mA	
$V_{DROP}$	Drop output voltage <sup>(2)</sup>	$I_{OUT} = 85\text{ mA}$ , $T_J = -40\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$		500	1000	mV	
$e_N$	Output noise voltage <sup>(3)</sup>	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	$\mu\text{V}_{RMS}$	
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 $85\text{ mA}$ , $T_J = -40\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$			3.75	5.5	$\mu\text{A}$
			$V_{IN} = 24\text{ V}$		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 <sup>(4)</sup>	$V_{IN} = 4.2\text{ V}$ , $C_{OUT} = 10\text{ }\mu\text{F}$ , $I_{OUT} = 60\text{ mA}$ , $T_J = -40\text{ }^\circ\text{C}$ to $125\text{ }^\circ\text{C}$		0.7		ms	
$C_{OUT}$	Output capacitor	Capacitance f = 100kHz	0.47			$\mu\text{F}$	

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 $\Omega$  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  $\mu$ 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  $\mu$ 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

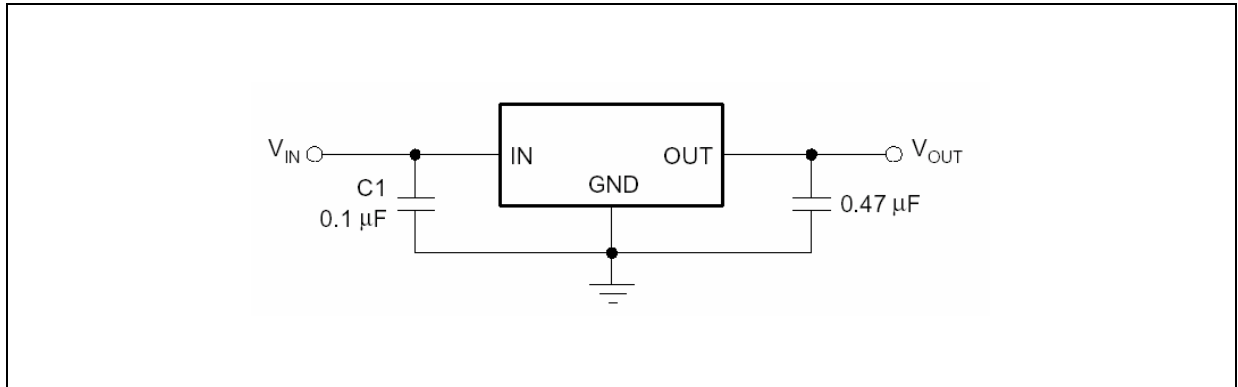
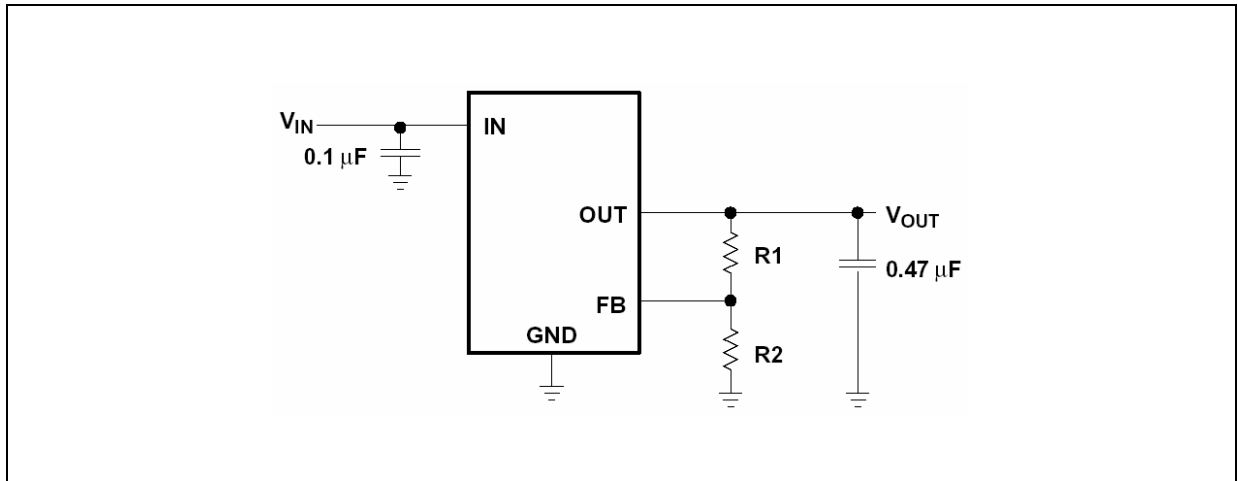


Figure 4. Application circuit for adjustable version



# 7 Typical performance characteristics

Figure 5. Output voltage vs. temperature

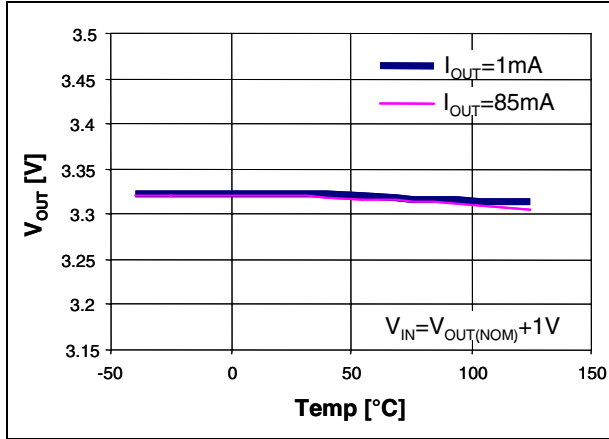


Figure 6. Output voltage vs. input voltage

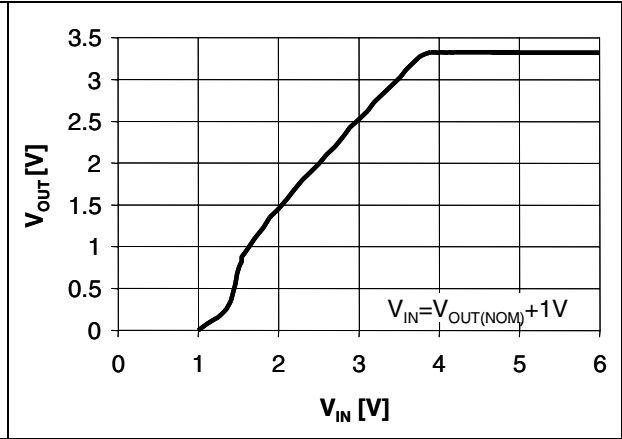


Figure 7. Dropout voltage vs. output current

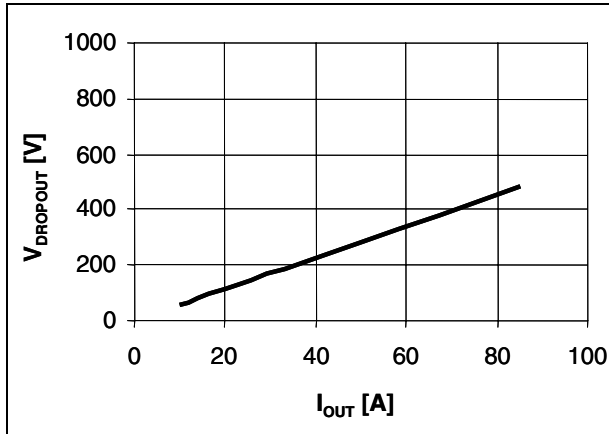


Figure 8. C<sub>OUT</sub> stability region

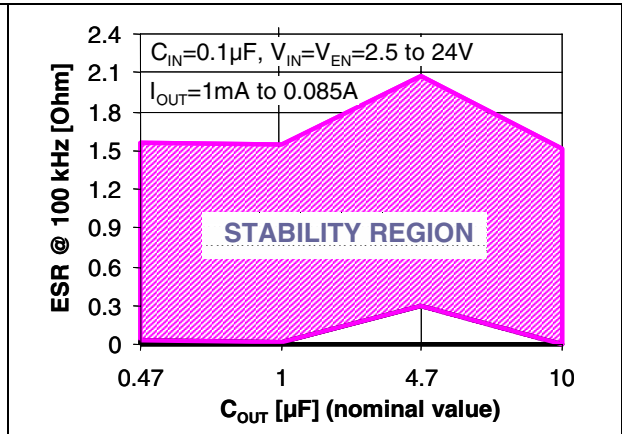


Figure 9. Supply voltage rejection vs. frequency

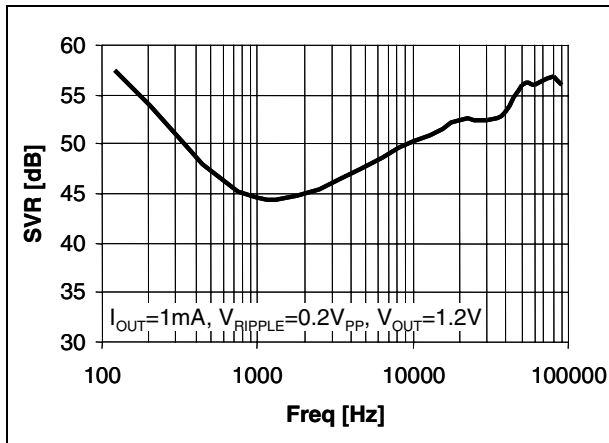


Figure 10. Output noise voltage vs. frequency

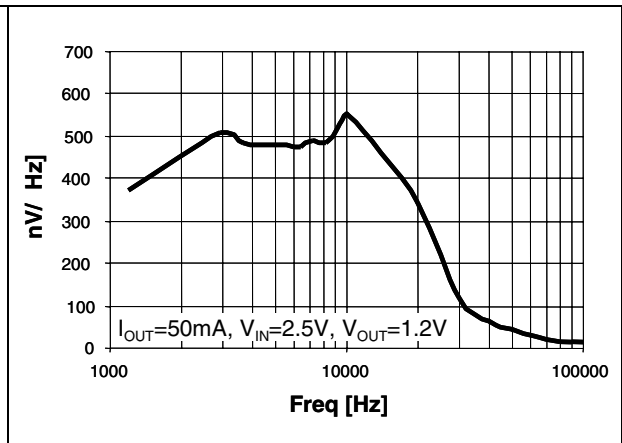


Figure 11. Quiescent current vs. input voltage    Figure 12. Load transient

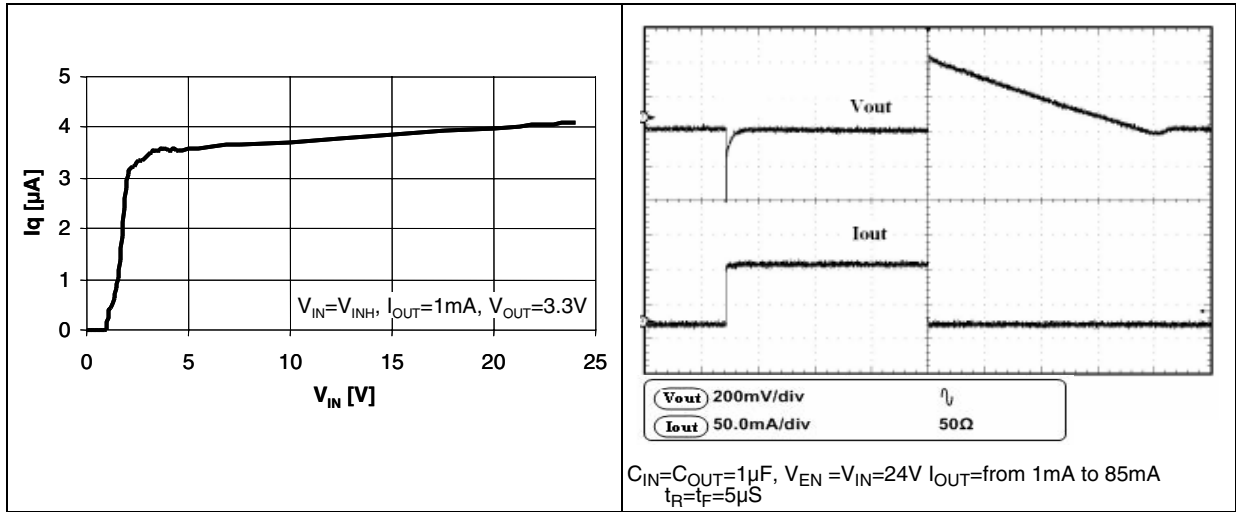


Figure 13. Line transient

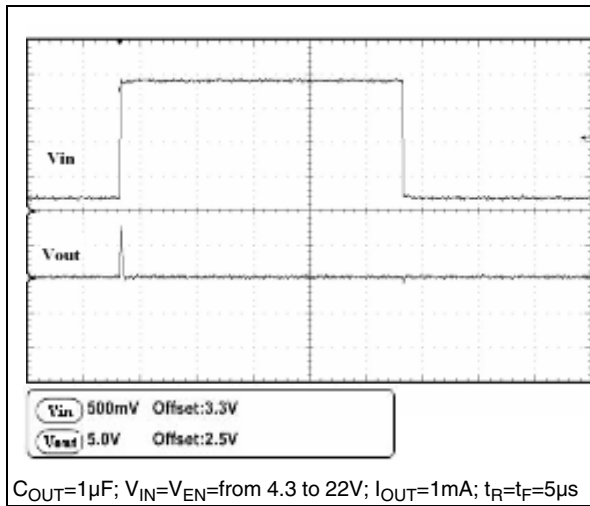
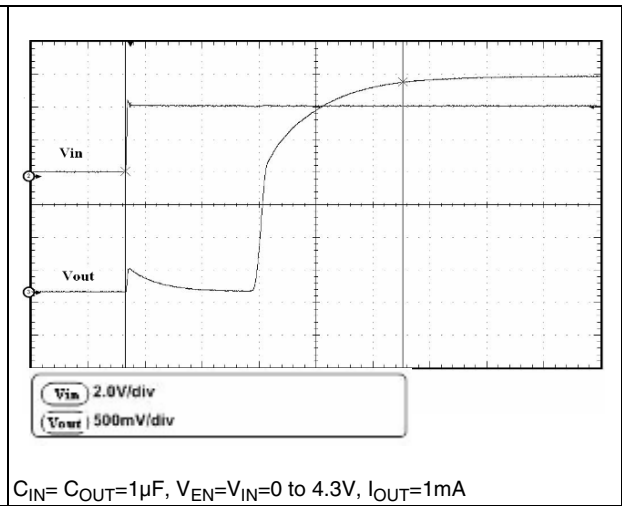


Figure 14. Enable transient

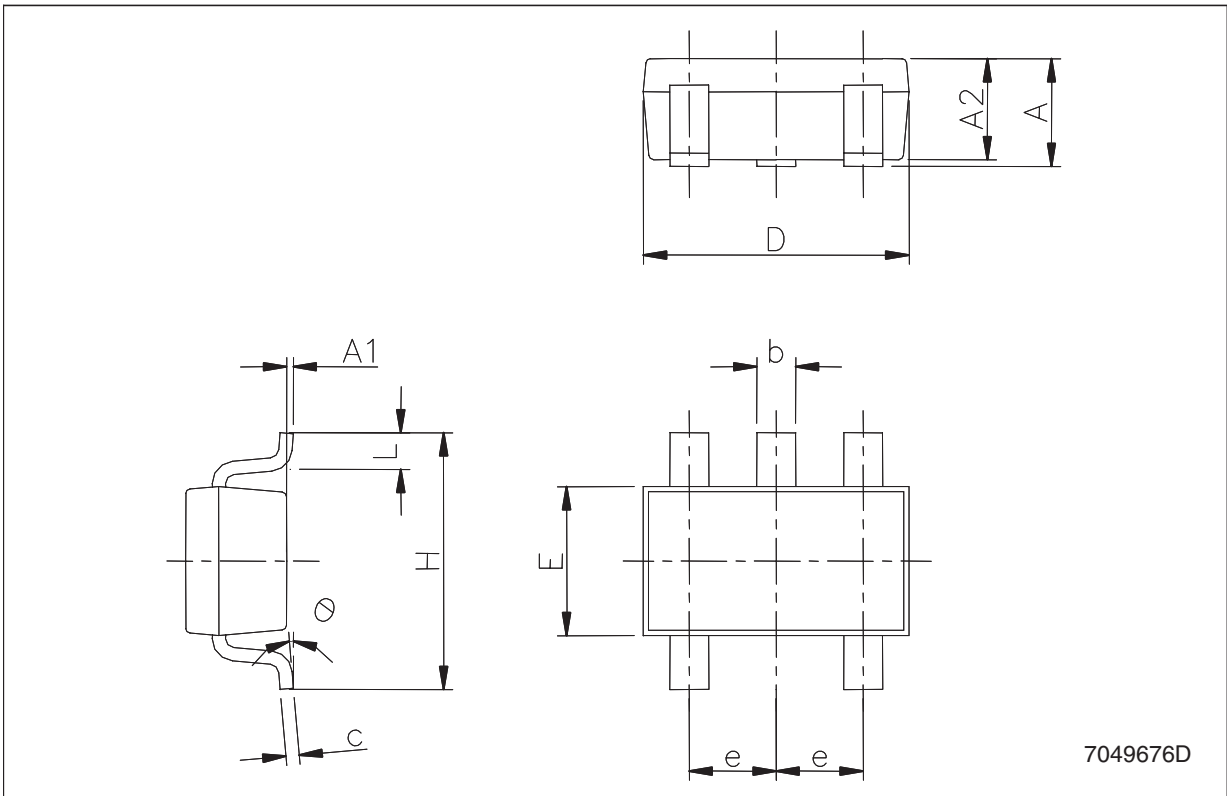


## 8 Package mechanical data

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK<sup>®</sup> is an ST trademark.

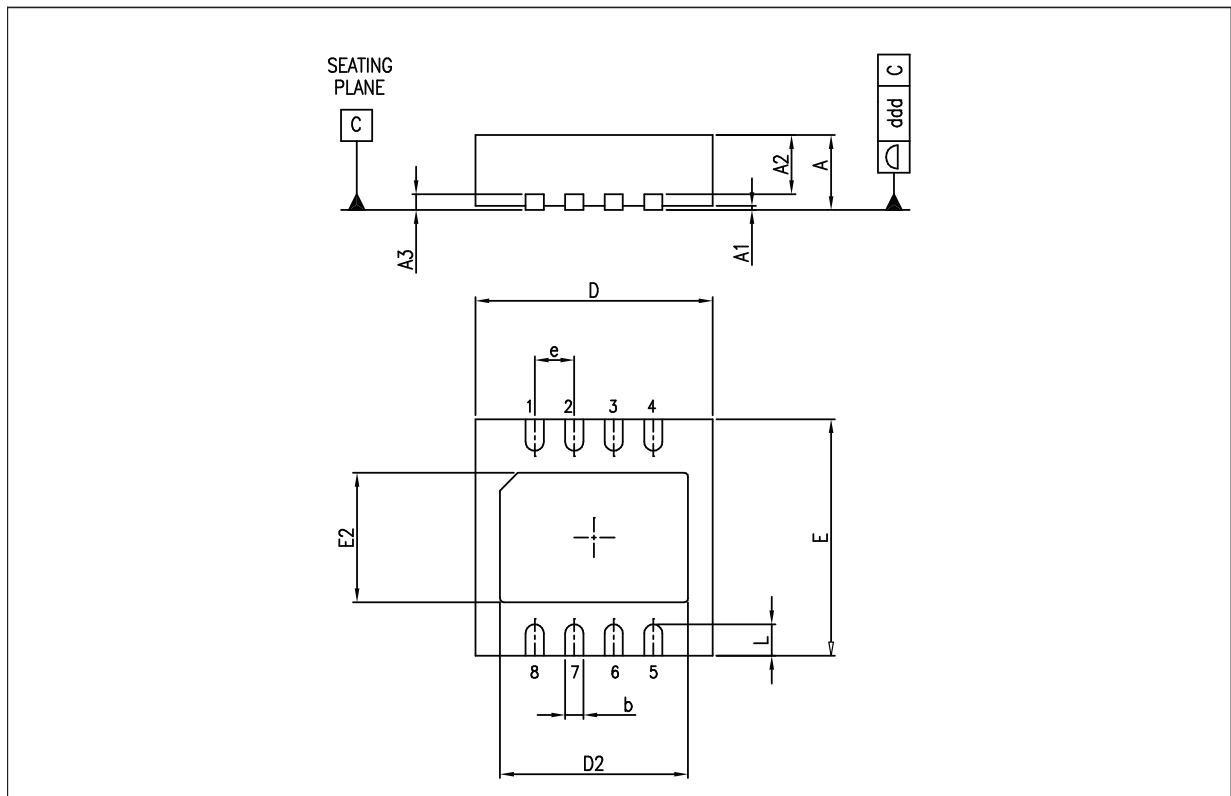
**SOT23-5L mechanical data**

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



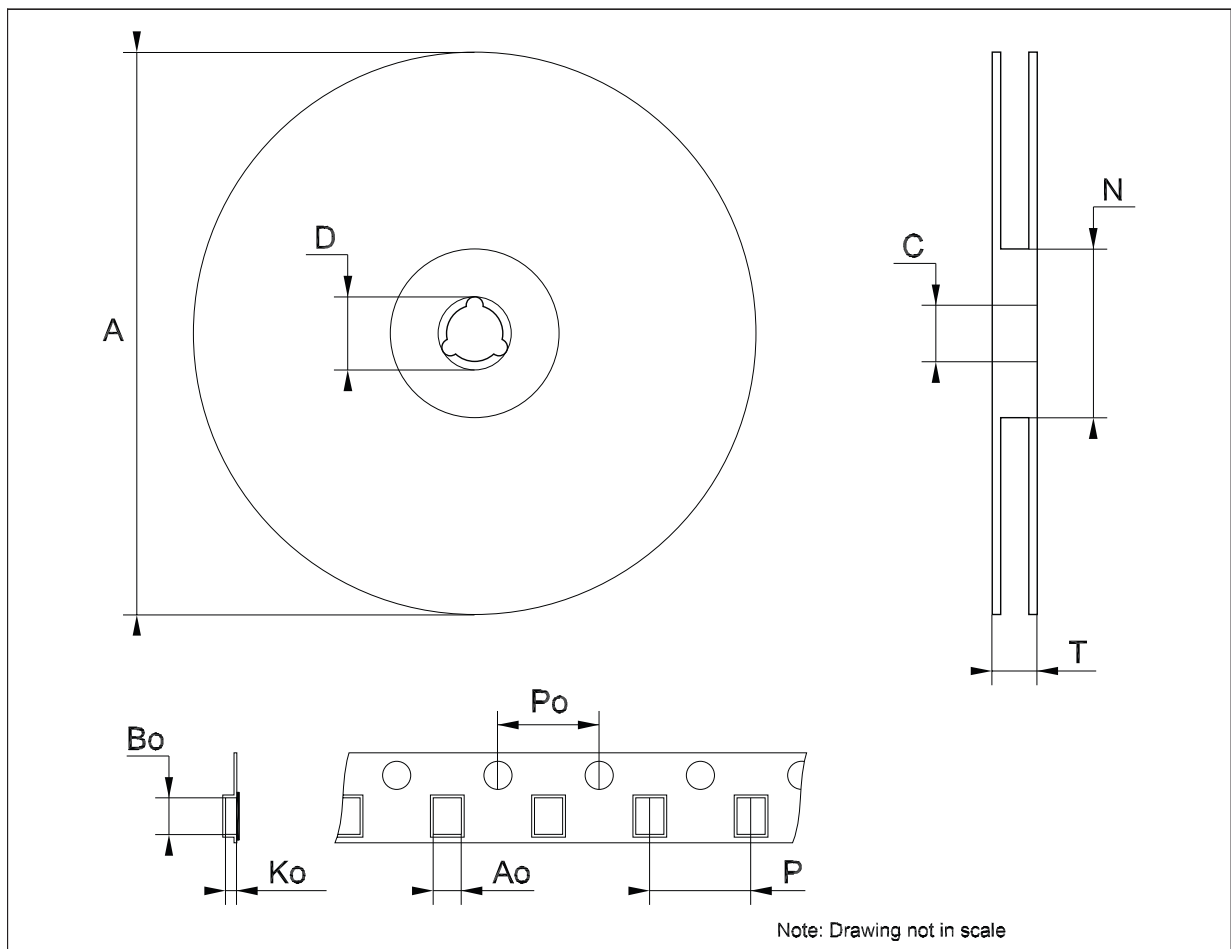
**DFN8 (3x3 mm) mechanical data**

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**

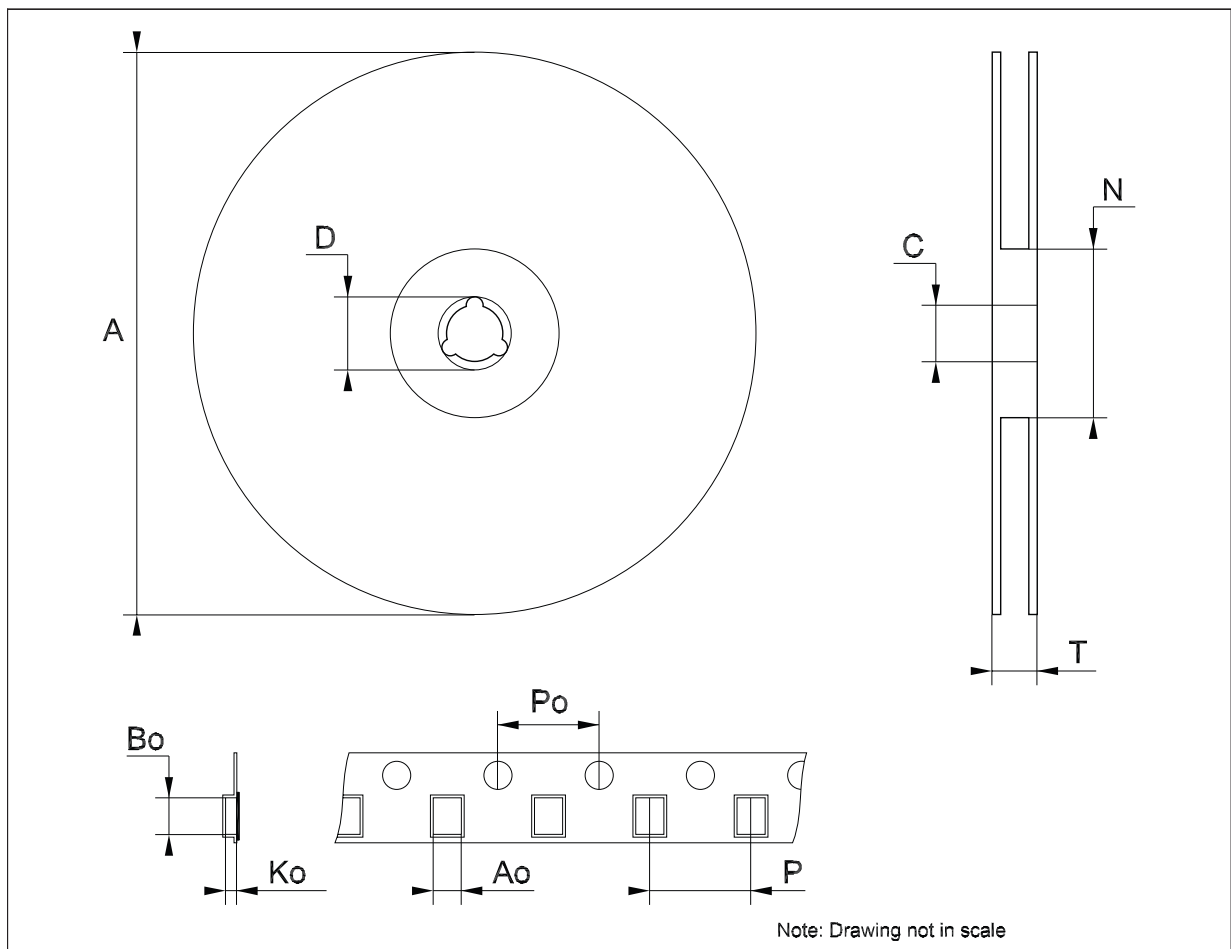
Dim.	mm.			inch.		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			180			7.086
C	12.8	13.0	13.2	0.504	0.512	0.519
D	20.2			0.795		
N	60			2.362		
T			14.4			0.567
Ao	3.13	3.23	3.33	0.123	0.127	0.131
Bo	3.07	3.17	3.27	0.120	0.124	0.128
Ko	1.27	1.37	1.47	0.050	0.054	0.058
Po	3.9	4.0	4.1	0.153	0.157	0.161
P	3.9	4.0	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: <a href="#">Features on page 1</a> .
22-Sep-2008	3	Modified: DFN8 (3x3 mm) mechanical data <a href="#">on page 15</a> .
26-Nov-2008	4	Modified: <a href="#">Section 5 on page 8</a> .
24-Mar-2010	5	Modified: <a href="#">Table 4 on page 5</a> .
20-May-2010	6	Modified: I <sub>Q</sub> max values <a href="#">Table 6 on page 6</a> and <a href="#">Table 7 on page 7</a> .
24-Jun-2010	7	Modified: <a href="#">Table 2</a> and <a href="#">Table 3 on page 4</a> .

**Please Read Carefully:**

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

**UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.**

**UNLESS EXPRESSLY APPROVED IN WRITING BY AN AUTHORIZED ST REPRESENTATIVE, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER'S OWN RISK.**

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2010 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Philippines - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

[www.st.com](http://www.st.com)