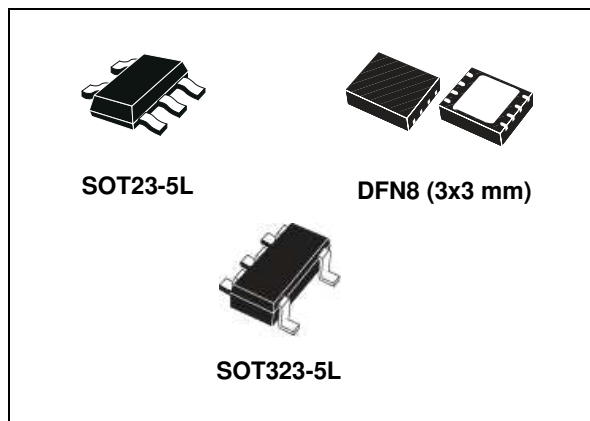


High input voltage, 85 mA LDO linear regulator

Datasheet - production data



Applications

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

Description

The ST715 is a high voltage, ultra-low quiescent current and low drop linear regulator capable of providing an output current in excess of 85 mA.

The device operates over an input voltage range from 2.5 V to 24 V, and it is 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 ST715 an ideal solution for low power industrial applications. The ST715 is available in SOT23-5, SOT323-5L or DFN8 (3x3 mm) 8 leads.

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 voltages available on request: from 1.2 V to 5.0 V with 100 mV step and adjustable from 1.2 V to 15 V
- Compatible with ceramic output capacitors from 0.47 μ F to 10 μ F
- Internal current limit
- Packages: SOT23-5L, SOT323-5L and DFN8 (3x3 mm)
- Temperature range: from -40 °C to 125 °C

Table 1. Device summary

Order codes						Output voltage
SOT23-5L	Marking	SOT323-5L	Marking	DFN8 (3x3 mm)	Marking	
ST715MR	71AD	ST715CR	7AD	ST715PUR	715AD	ADJ
ST715M25R	7125			ST715PU25R	71525	2.5 V
ST715M33R	7133	ST715C33R	733	ST715PU33R	71533	3.3 V
		ST715C50R	750			5.0 V

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1 Diagram

Figure 1. Block diagram (fixed version)

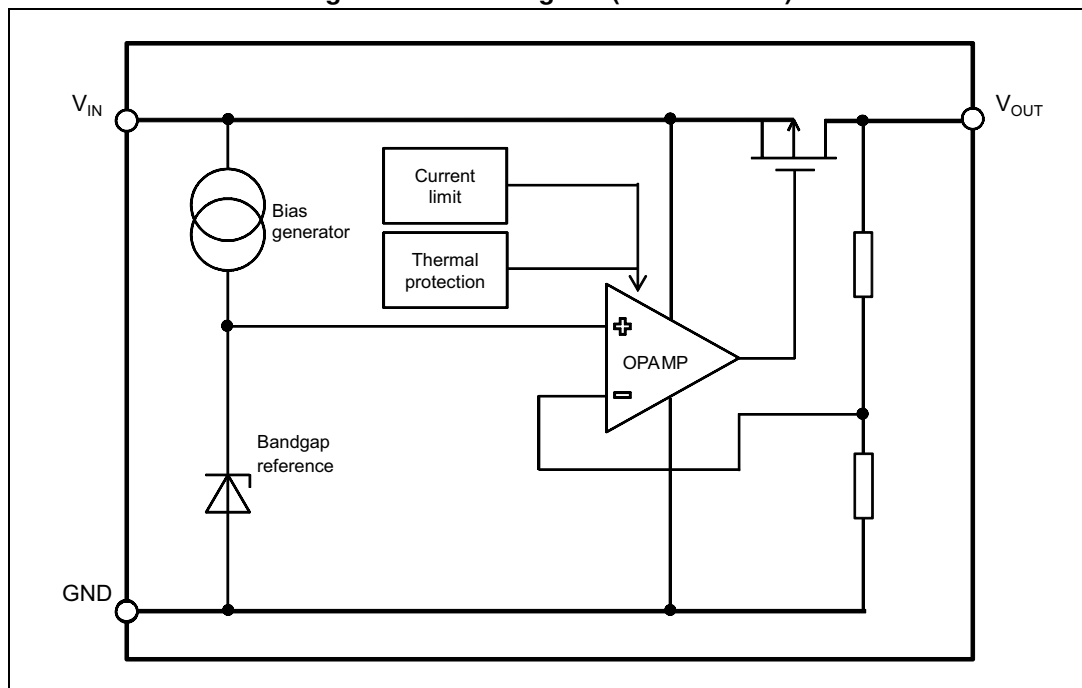
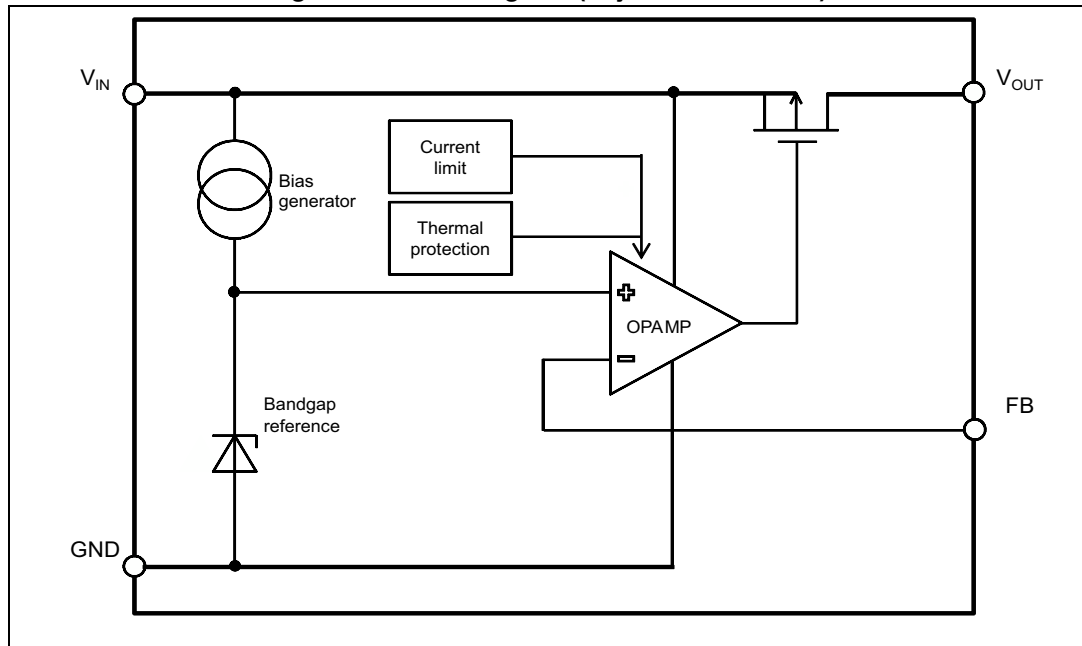


Figure 2. Block diagram (adjustable version)



2 Pin configuration

Figure 3. Pin connection (top view)

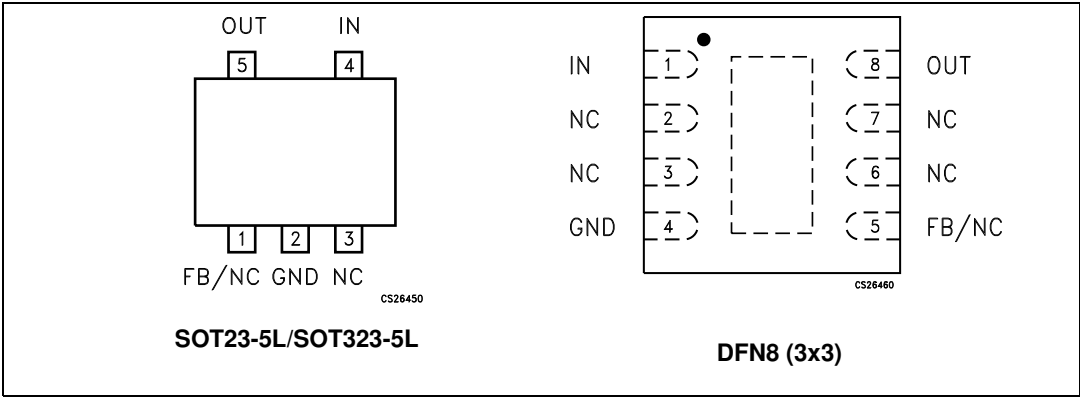


Table 2. Pin description (DFN8 3x3 mm)

Symbol	Pin for fixed	Pin for adjustable	Name and function
IN	1	1	Input voltage
NC	2, 3, 5, 6, 7	2, 3, 6, 7	Not internally connected
GND	4	4	Common ground
FB	-	5	Feedback pin
OUT	8	8	Output voltage
	Exp pad	Exp pad	Leave floating or connect to GND

Table 3. Pin description (SOT23-5L/SOT323-5L)

Symbol	Pin for fixed	Pin for adjustable	Name and function
IN	4	4	Input voltage
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
FB	Feedback pin	4	V
I_{OUT}	Continuous output current	According to package power dissipation	A
$P_D^{(1)}$	Maximum power dissipation, DFN package	2	W
	Maximum power dissipation, SOT23-5L and SOT323-5L packages	0.45	
T_{STG}	Storage temperature range	-65 to 150	°C
T_{OP}	Operating junction temperature range	-40 to 125	°C

1. P_D is based on an operating temperature of 25 °C or less. It must be derated according to the operating temperature.

Note: *Absolute maximum ratings are those 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	SOT323-5L	DFN8	Unit
R_{thJA}	Thermal resistance junction-ambient	195	245	52	°C/W

4 Electrical characteristics

$T_J = 25\text{ °C}$, $V_{IN} = V_{OUT(NOM)} + 1\text{ V}$, $C_{IN} = 0.1\text{ }\mu\text{F}$, $C_{OUT} = 1\text{ }\mu\text{F}$, $I_{OUT} = 1\text{ mA}$, 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
I_{OUT}	Output current	$V_{IN} = 2.5\text{ to }6\text{ V}$, $T_J = -40\text{ °C to }125\text{ °C}$				85	mA
V_{FB}	V_{FB} accuracy ⁽¹⁾	$V_{IN} = V_{OUT} + 1\text{ to }24\text{ V}$, $I_{OUT} = 1\text{ mA to }30\text{ mA}$, $T_J = 0\text{ °C to }85\text{ °C}$		1.195		1.245	V
		$V_{IN} = V_{OUT} + 1\text{ to }24\text{ V}$, $I_{OUT} = 1\text{ mA to }85\text{ mA}$, $T_J = -40\text{ °C to }125\text{ °C}$		1.152		1.248	
ΔV_{OUT}	Line regulation	$V_{IN} = V_{OUT} + 1\text{ to }24\text{ V}$, $I_{OUT} = 1\text{ mA}$, $T_J = -40\text{ °C to }125\text{ °C}$			0.001	0.004	%/V
ΔV_{OUT}	Load regulation	$I_{OUT} = 1\text{ mA to }85\text{ mA}$, $T_J = -40\text{ °C to }125\text{ °C}$			0.002	0.004	%/mA
e_N	Output noise voltage ⁽²⁾	200 Hz to 100 kHz, $I_{OUT} = 50\text{ mA}$, $C_{OUT} = 10\text{ }\mu\text{F}$, $T_J = -40\text{ °C to }125\text{ °C}$, $V_{OUT} = 1.2\text{ V}$				95	μV_{RMS}
SVR	Supply voltage rejection	$V_{IN} = V_{OUT(NOM)} + 1\text{ V} \pm V_{RIPPLE}$, $V_{RIPPLE} = 0.2\text{ V}$, $I_{OUT} = 1\text{ mA}$, $C_{OUT} = 10\text{ }\mu\text{F}$	$f = 1\text{ kHz}$		45		dB
		$T_J = -40\text{ °C to }125\text{ °C}$	$f = 100\text{ kHz}$		62		
I_Q	Quiescent current	$I_{OUT} = 0\text{ mA to }85\text{ mA}$, $T_J = -40\text{ °C to }125\text{ °C}$				5.5	μA
		$I_{OUT} = 0\text{ mA to }85\text{ mA}$, $V_{IN} = 24\text{ V}$, $T_J = -40\text{ °C to }125\text{ °C}$				6.5	
I_{SC}	Short-circuit current	$V_{OUT} = 0$, $T_J = -40\text{ °C to }125\text{ °C}$, $V_{IN} = 3.8\text{ V}$		120			mA
T_{ON}	Turn-on time ⁽³⁾	$V_{IN} = 4.2\text{ V}$, $C_{OUT} = 10\text{ }\mu\text{F}$, $I_{OUT} = 60\text{ mA}$, $T_J = -40\text{ °C to }125\text{ °C}$			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 $125\text{ }^{\circ}\text{C}$	$V_{OUT} + V_{DROP}$		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}	Dropout 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⁾	200 Hz to 100 kHz, $I_{OUT} = 50\text{ mA}$, $C_{OUT} = 10\text{ }\mu\text{F}$, $T_J = -40\text{ }^{\circ}\text{C}$ to $125\text{ }^{\circ}\text{C}$			210	μV_{RMS}
SVR	Supply voltage rejection	$V_{IN} = V_{OUT(NOM)} + 1\text{ V} \pm V_{RIPPLE}$, $V_{RIPPLE} = 0.2\text{ V}$, $I_{OUT} = 1\text{ mA}$, $C_{OUT} = 10\text{ }\mu\text{F}$, $T_J = -40\text{ }^{\circ}\text{C}$ to $125\text{ }^{\circ}\text{C}$	$f = 1\text{ kHz}$		38	dB
			$f = 100\text{ kHz}$		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	μA
			$V_{IN} = 24\text{ V}$		4.15	
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 $f = 100\text{ kHz}$	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 to 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 ST715 features an adjustable output voltage due to two external resistors connected as a voltage divider to the FB pin as shown in [Figure 4](#). The output voltage is set by the following equation:

Equation 1

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

where typically $V_{FB} = 1.2$ V. Choose $1\text{ M}\Omega \geq R_2 \geq 5\text{ k}\Omega$ to optimize the quiescent current, accuracy, and high-frequency power supply rejection. The resistor selection is given by the following equation:

Equation 2

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

5.1 External capacitor requirements

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

The ST715 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 μF , stabilizes this loop.

5.2 Power dissipation and junction temperature

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

The maximum power dissipation limit is given by 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 by the following equation:

Equation 4

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

Power dissipation coming from quiescent current is negligible.

The ST715 features the internal current limit. During normal operation, it limits the output current to approximately 350 mA. When the current limit engages, the output voltage scales back linearly until the overcurrent condition ends. Do not exceed the power dissipation ratings of the package.

6 Typical application

Figure 4. Application circuit for fixed version

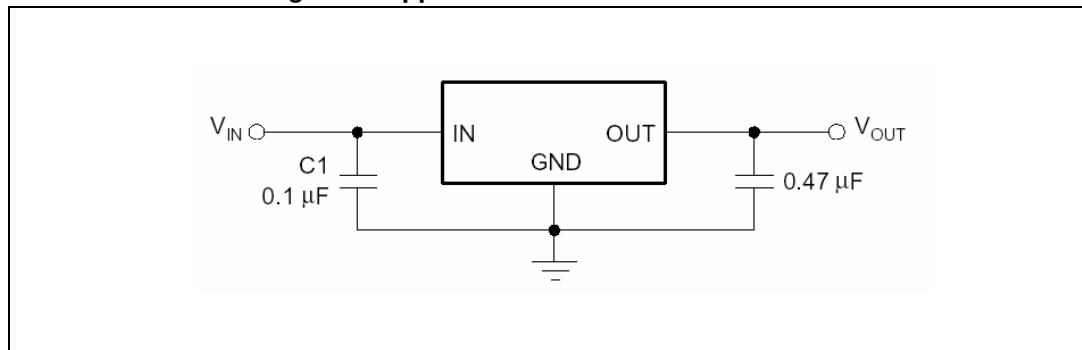
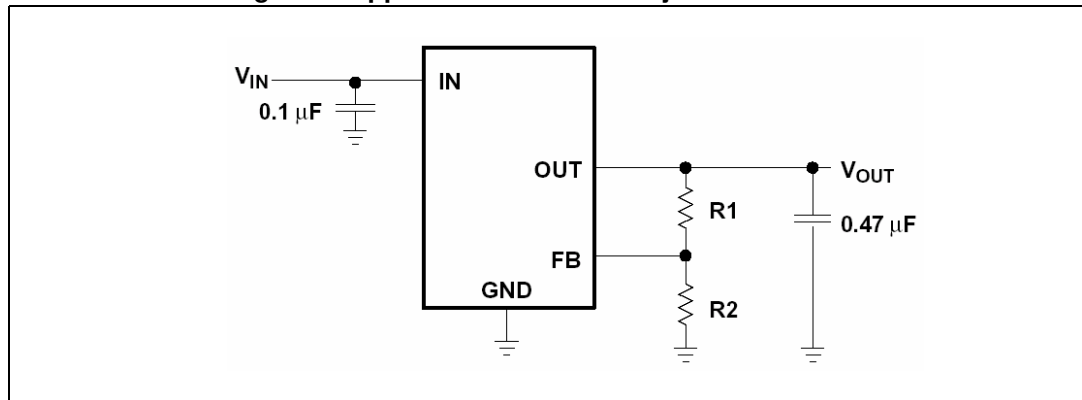


Figure 5. Application circuit for adjustable version



7 Typical performance characteristics

Figure 6. Output voltage vs. temperature

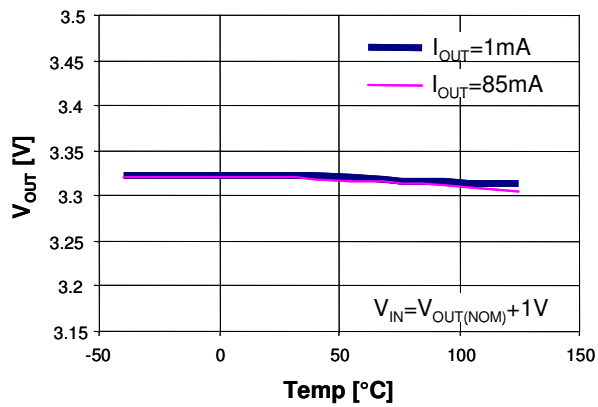


Figure 7. Output voltage vs. input voltage

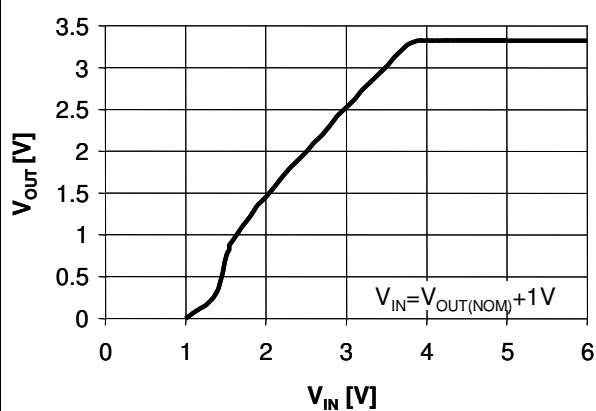


Figure 8. Dropout voltage vs. output current

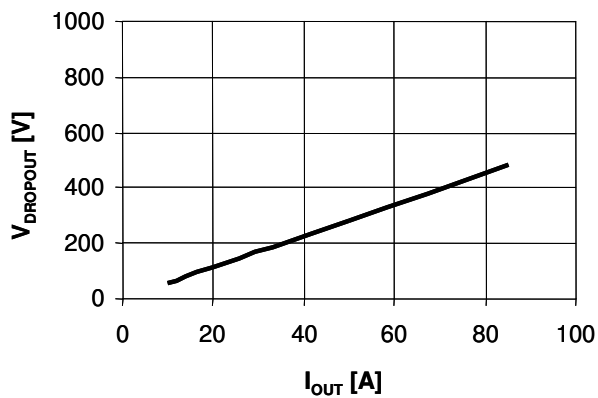
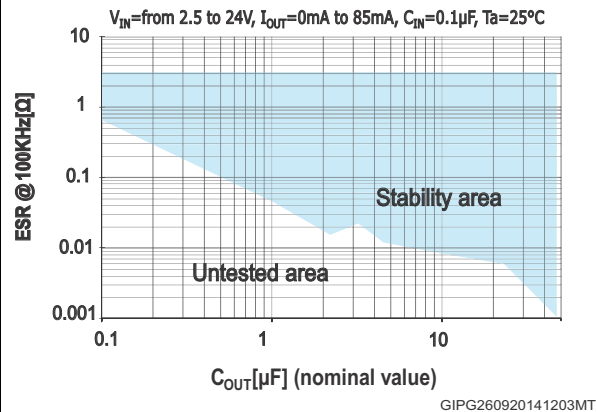
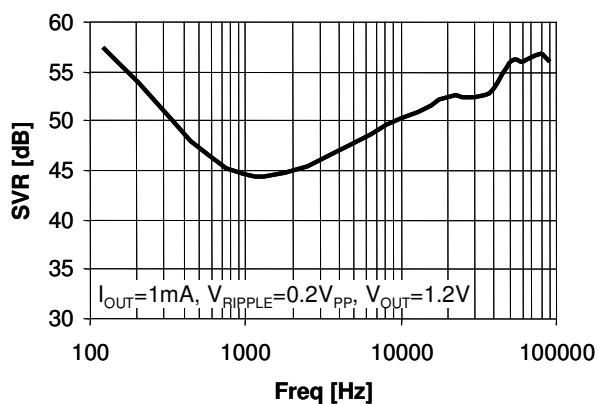


Figure 9. C_OUT stability region



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Figure 10. Supply voltage rejection vs. frequency



Output noise voltage vs. frequency

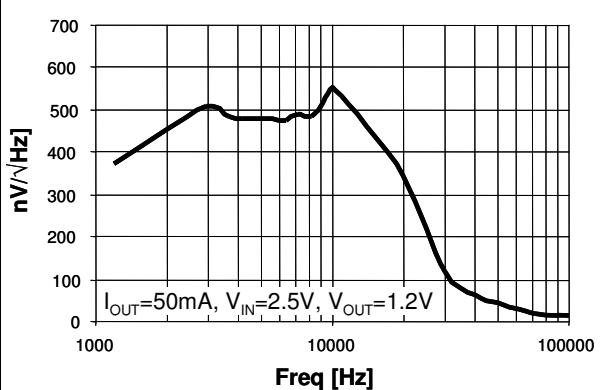


Figure 11. Quiescent current vs. input voltage

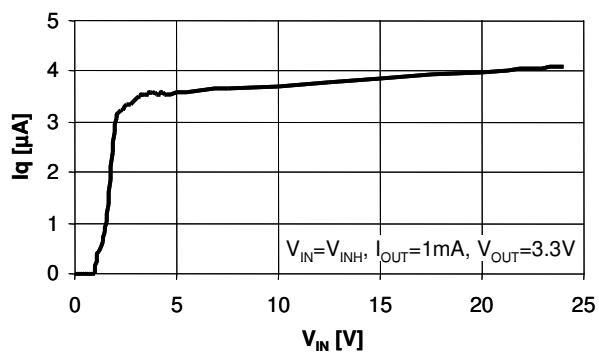
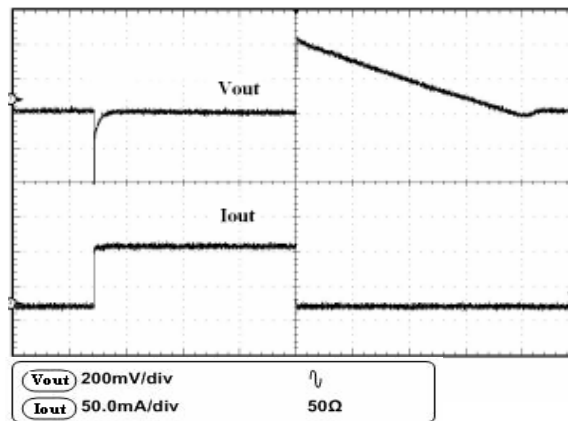
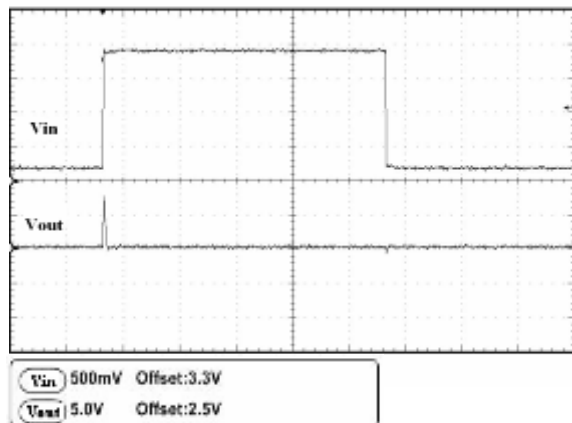


Figure 12. Load transient



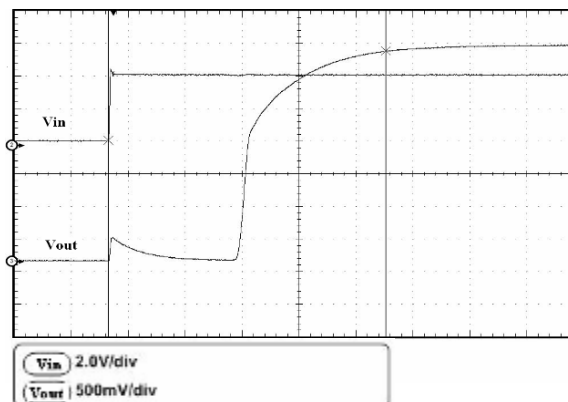
$C_{IN} = C_{OUT} = 1\mu\text{F}$, $V_{EN} = V_{IN} = 24\text{V}$, I_{OUT} = from 1mA to 85mA
 $t_R = t_F = 5\mu\text{s}$

Figure 13. Line transient



$C_{OUT} = 1\mu\text{F}$; $V_{IN} = V_{EN}$ = from 4.3 to 22V; $I_{OUT} = 1\text{mA}$; $t_R = t_F = 5\mu\text{s}$

Figure 14. Enable transient



$C_{IN} = C_{OUT} = 1\mu\text{F}$, $V_{EN} = V_{IN} = 0$ to 4.3V, $I_{OUT} = 1\text{mA}$

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.

Figure 15. SOT23-5L drawing

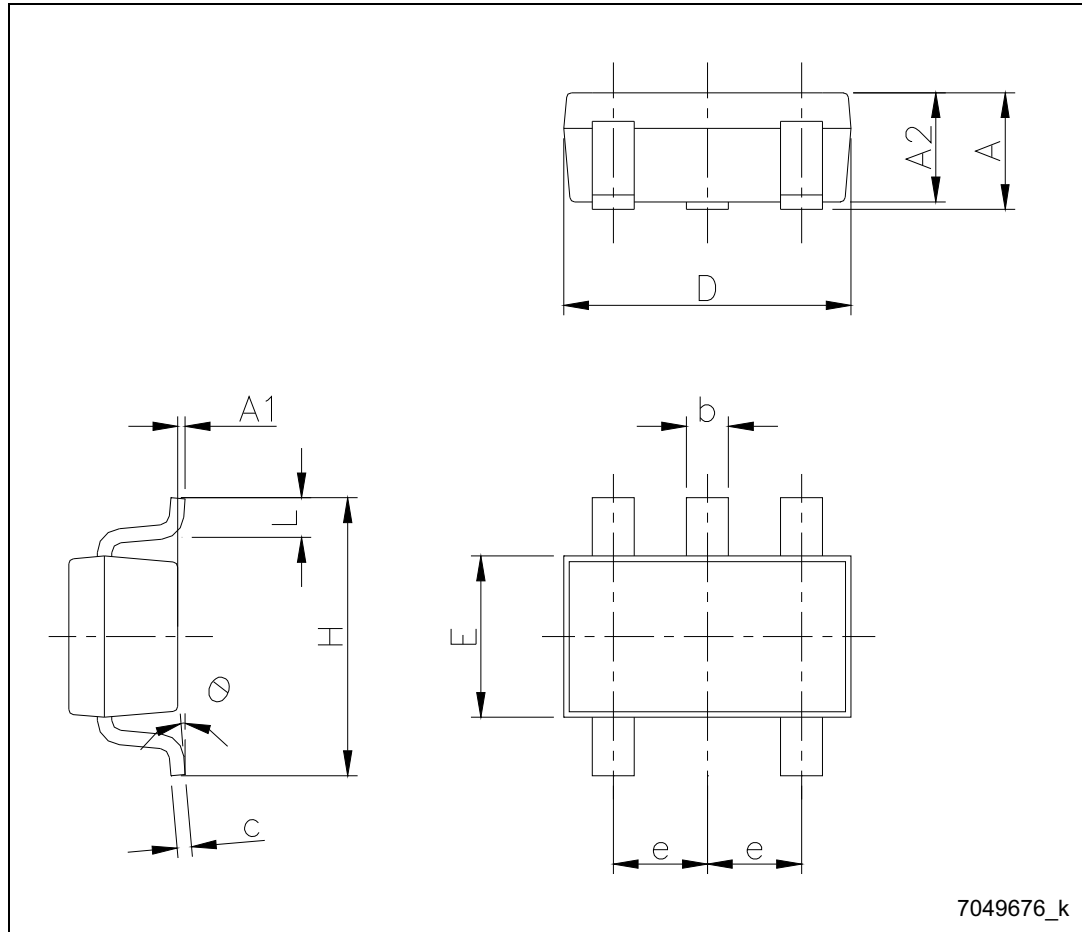


Table 8. SOT23-5L mechanical data

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
q	0		8

Figure 16. SOT23-5L recommended footprint (dimensions in mm)

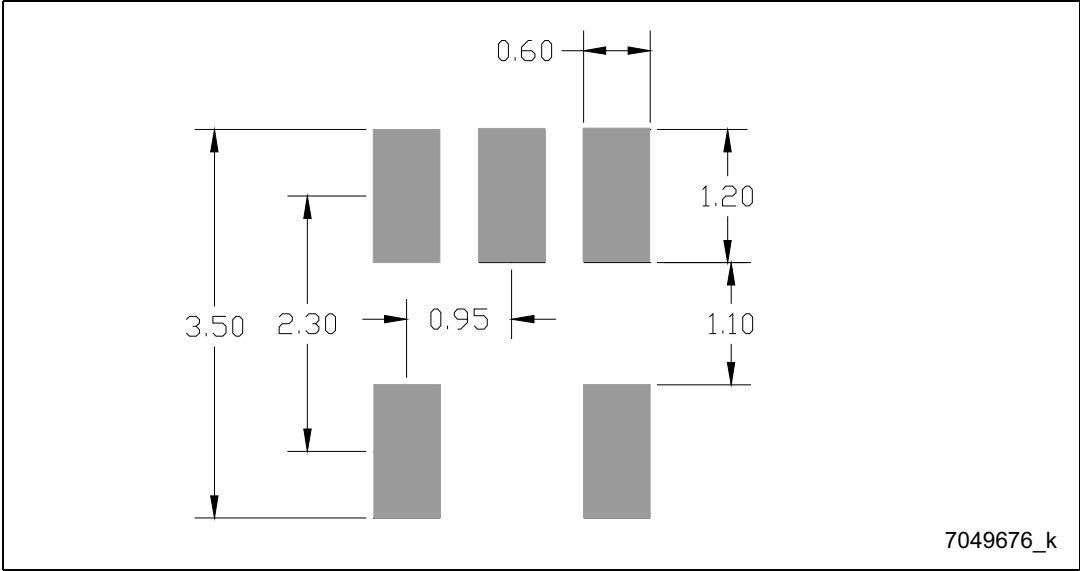


Figure 17. SOT323-5L drawing

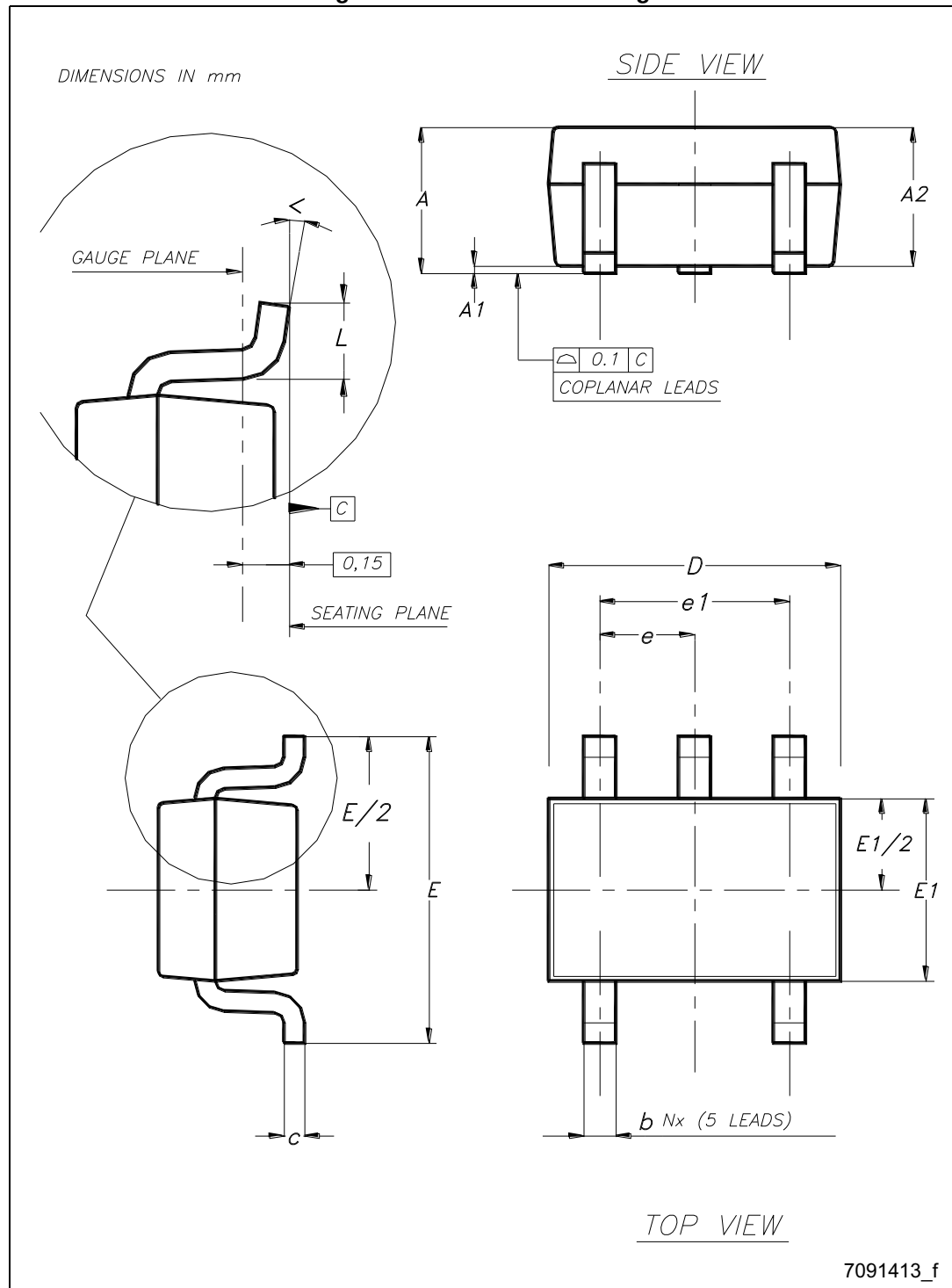


Table 9. SOT323-5L mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	0.80		1.10
A1	0		0.10
A2	0.80	0.90	1
b	0.15		0.30
c	0.10		0.22
D	1.80	2	2.20
E	1.80	2.10	2.40
E1	1.15	1.25	1.35
e		0.65	
e1		1.30	
L	0.26	0.36	0.46
<	0°		8°

Figure 18. DFN8 (3x3 mm) drawing

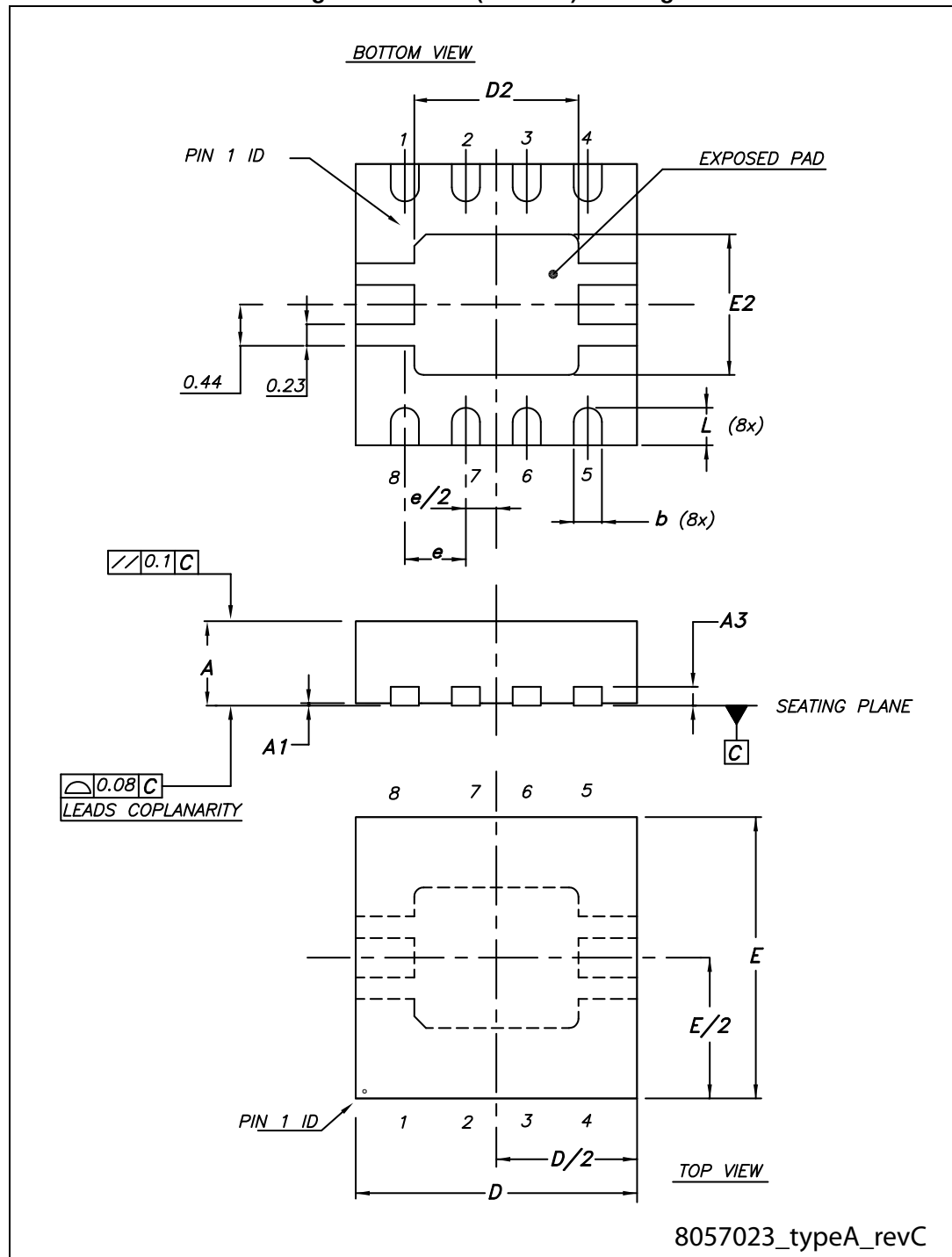
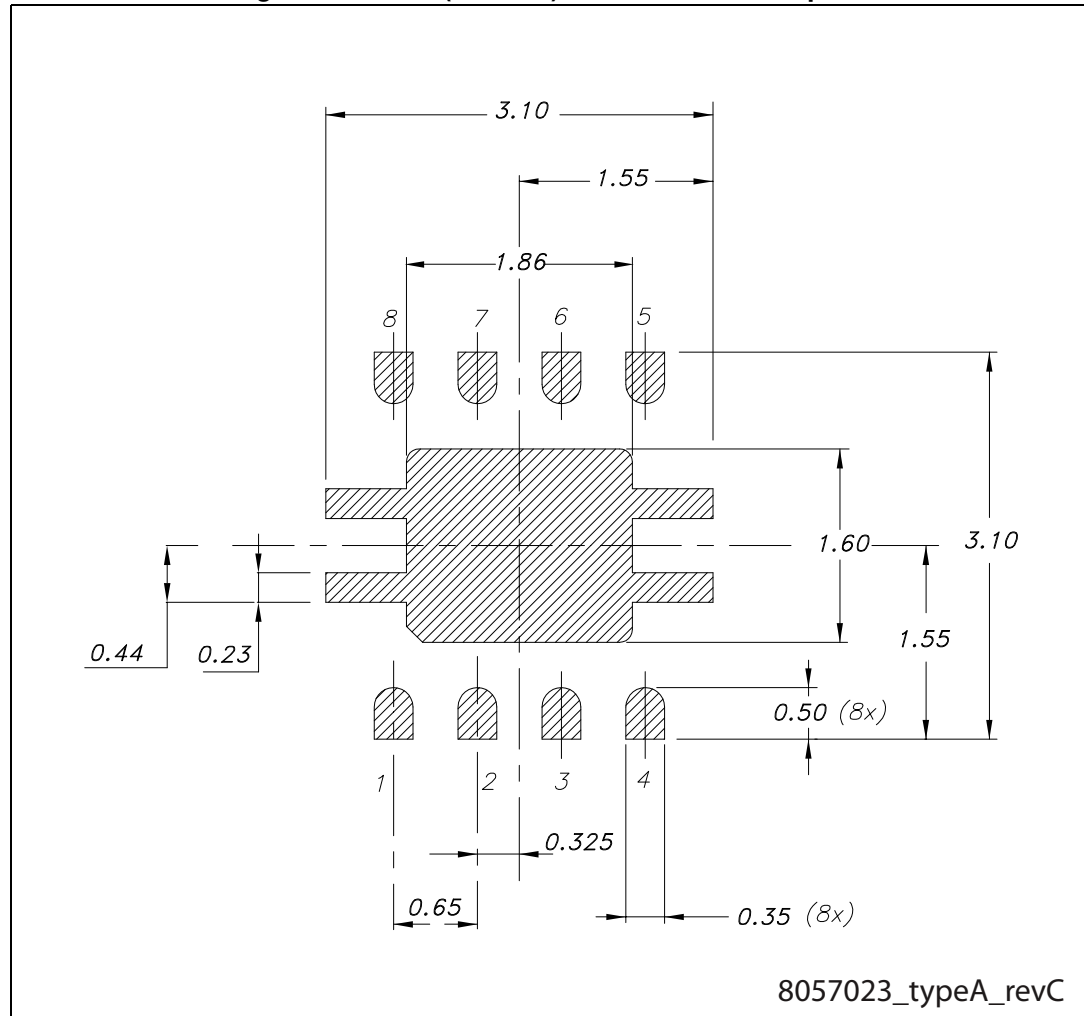


Table 10. DFN8 (3x3 mm) mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	0.80	0.90	1.00
A1	0	0.02	0.05
A3		0.20	
b	0.25	0.30	0.35
D	2.85	3	3.15
D2	1.603	1.753	1.853
E	2.85	3	3.15
E2	1.345	1.495	1.595
e		0.65	
L	0.30	0.40	0.50

Figure 19. DFN8 (3x3 mm) recommended footprint



9 Packaging mechanical data

Figure 20. Tape and reel SOT23-5L drawing

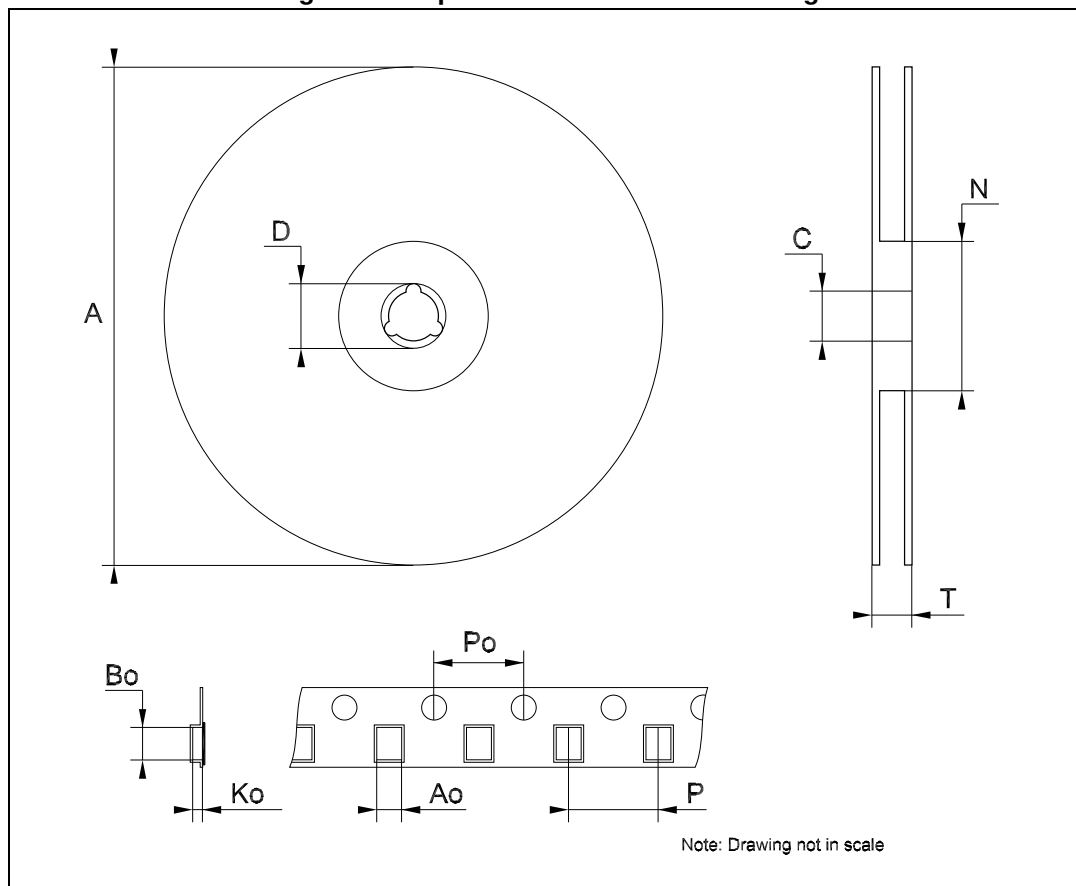


Table 11. SOT23-5L tape and reel mechanical data

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

Table 12. SOT323-xL tape and reel mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A	175	180	185
C	12.8	13	13.2
D	20.2		
N	59.5	60	60.5
T			14.4
Ao		2.25	
Bo		3.17	
Ko		1.2	
Po	3.9	4.0	4.1
P	3.9	4.0	4.2

Table 13. DFN8 (3x3 mm) tape and reel mechanical data

Dim.	mm		
	Min.	Typ.	Max.
A			180
C	12.8		13.2
D	20.2		
N	60		
T			14.4
Ao		3.3	
Bo		3.3	
Ko		1.1	
Po		4	
P		8	

10 Revision history

Table 14. 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>10 on page 23.</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>
24-Mar-2010	6	Modified: I_Q max values <i>Table 6 on page 6 and Table 7 on page 7.</i>
20-May-2010	7	Modified: <i>Table 2 and Table 4 on page 4.</i>
28-Jan-2014	8	Part numbers ST715xx, ST715xx25, ST715xx33 changed to ST715. Added package DFN8 (3 x 3 mm). Updated the title, the features and the description in cover page. Updated <i>Section 1: Diagram, Section 2: Pin configuration, Section 3: Maximum ratings, Section 4: Electrical characteristics and Section 8: Package mechanical data.</i> Added <i>Section 9: Packaging mechanical data.</i> Minor text changes.
21-May-2014	9	Updated <i>Section 8: Package mechanical data.</i> Minor text changes.
26-Sep-2014	10	Updated <i>Table 2: Pin description (DFN8 3x3 mm) and Table 3: Pin description (SOT23-5L/SOT323-5L).</i> Updated <i>Figure 9: COUT stability region.</i> Minor text changes.
15-Oct-2014	11	Updated <i>Table 6 on page 6 and Table 7 on page 7.</i> Minor text changes.
08-Jan-2018	12	Updated Table 6: Electrical characteristics - adjustable version.
06-Jul-2018	13	Added new order code ST715C50R on Table 1: Device summary.
06-Apr-2020	14	Updated Table 2: Pin description (DFN8 3x3 mm).
12-Oct-2020	15	Added new order code ST715CR in Table 1 on the cover page.
03-Mar-2025	16	Updated feature on the cover page and Section 5 .

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