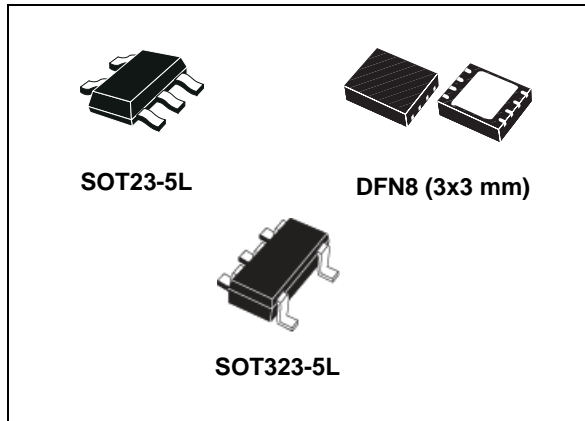


## High input voltage, 85 mA LDO linear regulator

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  $\mu$ 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  $\mu$ 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
- Compatible with ceramic output capacitors from 0.47  $\mu$ F to 10  $\mu$ 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    |           |         | ST715PUR      | 715AD   | ADJ            |
| ST715M25R   | 7125    |           |         | ST715PU25R    | 71525   | 2.5 V          |
| ST715M33R   | 7133    | ST715C33R | 733     | ST715PU33R    | 71533   | 3.3 V          |

# Contents

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# 1 Diagram

Figure 1. Block diagram (fixed version)

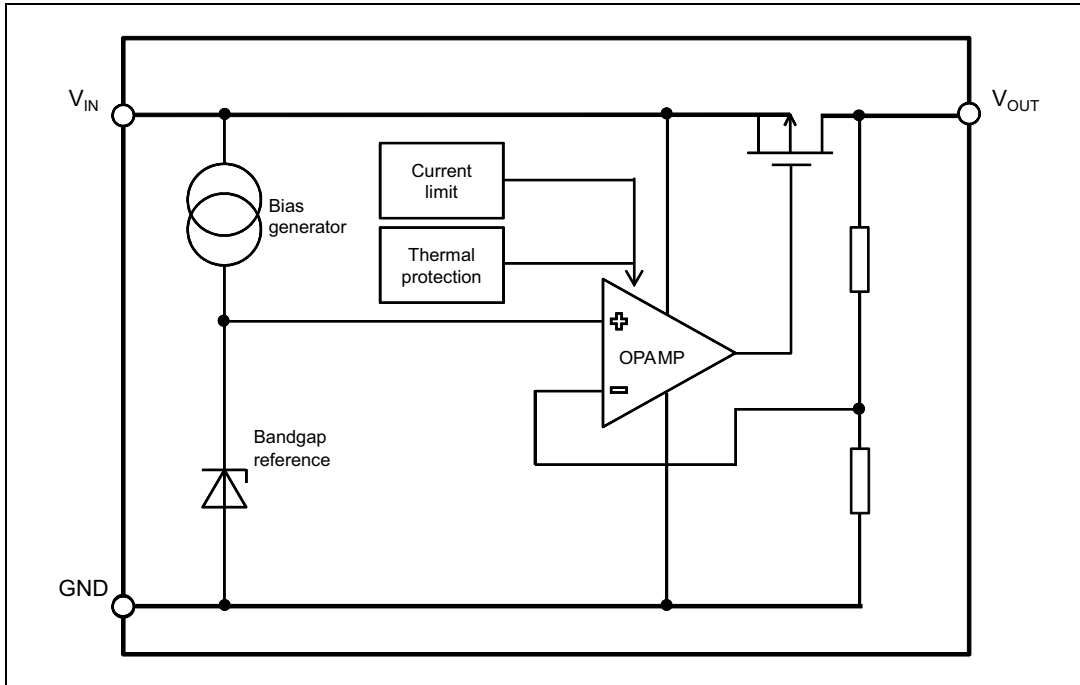
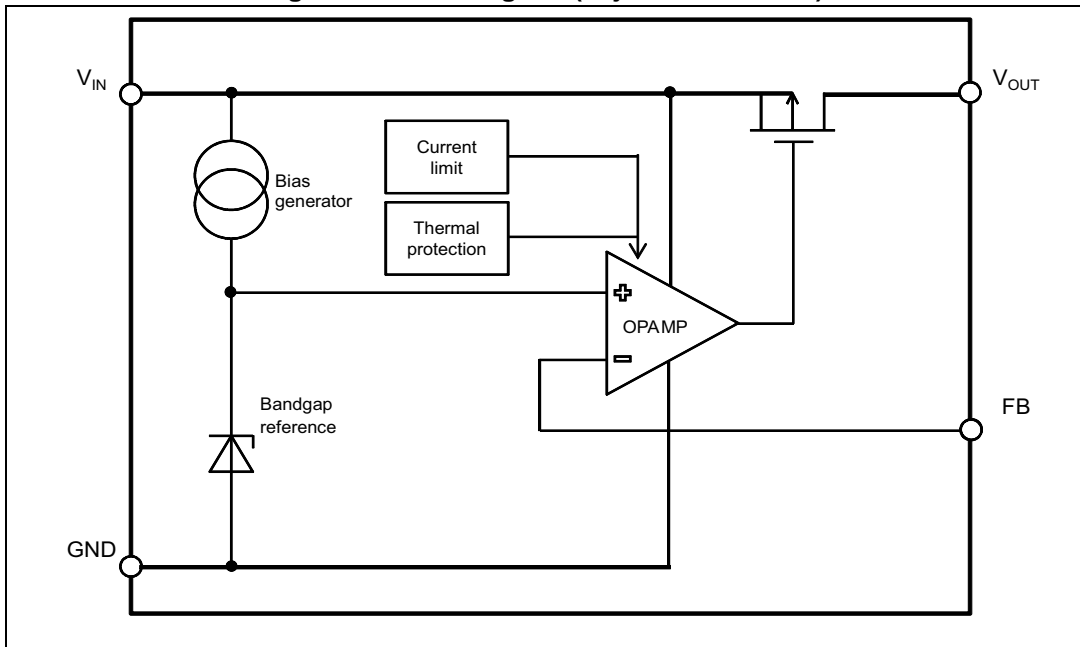


Figure 2. Block diagram (adjustable version)



## 2 Pin configuration

Figure 3. Pin connection (top view)

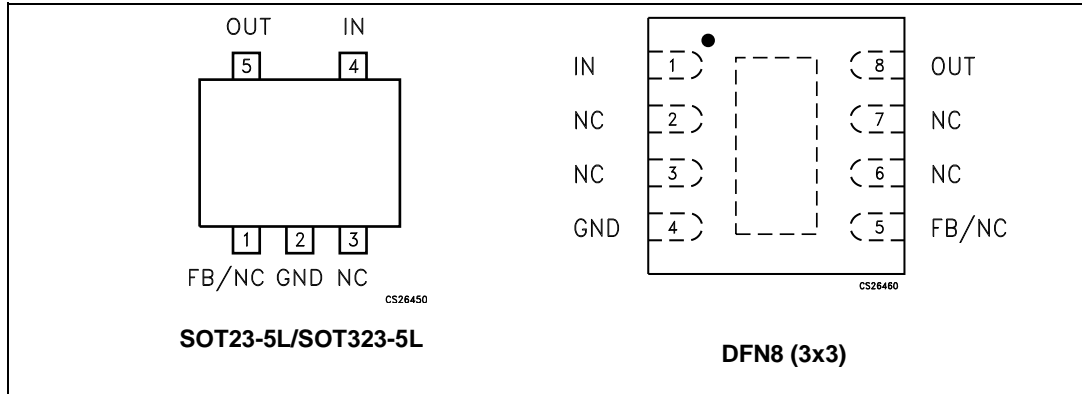


Table 2. Pin description (DFN8 3x3 mm)

| Symbol | Pin for fixed        | Pin for adjustable   | Name and function        |
|--------|----------------------|----------------------|--------------------------|
| IN     | 1                    | 1                    | Input voltage            |
| NC     | 2, 3, 5, 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/SOT323-5L)

| Symbol | Pin for fixed | Pin for adjustable | Name and function        |
|--------|---------------|--------------------|--------------------------|
| IN     | 4             | 4                  | Input voltage            |
| NC     | 3             | 1, 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.<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                   |
| $I_{OUT}$        | Output current                      | $V_{IN} = 2.5\text{ to }6\text{ V}$ , $T_J = -40\text{ °C to }125\text{ °C}$  |                      |       | 85    | mA                  |
| $V_{FB}$         | Feedback voltage                    |   |                      | 1.2   |       | V                   |
|                  | $V_{FB}$ accuracy <sup>(1)</sup>    | $V_{IN} = V_{OUT} + 1\text{ to }24\text{ V}$ ,<br>$I_{OUT} = 1\text{ mA to }85\text{ mA}$ ,<br>$T_J = -40\text{ °C to }125\text{ °C}$                     | -4.0                 |       | 4.0   | %                   |
| $\Delta V_{OUT}$ | Line regulation                     | $V_{IN} = V_{OUT} + 1\text{ to }24\text{ V}$ , $I_{OUT} = 1\text{ mA}$ ,<br>$T_J = -40\text{ °C to }125\text{ °C}$  |                      | 0.001 | 0.004 | %/V                 |
| $\Delta V_{OUT}$ | Load regulation                     | $I_{OUT} = 1\text{ mA to }85\text{ mA}$ ,<br>$T_J = -40\text{ °C to }125\text{ °C}$   |                      | 0.002 | 0.004 | %/mA                |
| $e_N$            | Output noise voltage <sup>(2)</sup> | 200 Hz to 100 kHz, $I_{OUT} = 50\text{ mA}$ ,<br>$C_{OUT} = 10\text{ }\mu\text{F}$ , $T_J = -40\text{ °C to }125\text{ °C}$ ,<br>$V_{OUT} = 1.2\text{ V}$ |                      |       | 95    | $\mu\text{V}_{RMS}$ |
| SVR              | Supply voltage rejection            | $V_{IN} = V_{OUT(NOM)} + 1\text{ V} \pm V_{RIPPLE}$ , $V_{RIPPLE} = 0.2\text{ V}$ ,<br>$I_{OUT} = 1\text{ mA}$ , $C_{OUT} = 10\text{ }\mu\text{F}$        | $f = 1\text{ kHz}$   |       | 45    | dB                  |
|                  |                                     | $T_J = -40\text{ °C to }125\text{ °C}$  | $f = 100\text{ kHz}$ |       | 62    |                     |
| $I_Q$            | Quiescent current                   | $I_{OUT} = 0\text{ mA to }85\text{ mA}$ ,<br>$T_J = -40\text{ °C to }125\text{ °C}$   |                      |       | 4.5   | $\mu\text{A}$       |
|                  |                                     | $I_{OUT} = 0\text{ mA to }85\text{ mA}$ , $V_{IN} = 24\text{ V}$<br>$T_J = -40\text{ °C to }125\text{ °C}$  |                      |       | 5.5   |                     |
| $I_{SC}$         | Short-circuit current               | $V_{OUT} = 0$ , $T_J = -40\text{ °C to }125\text{ °C}$<br>$V_{IN} = 3.8\text{ V}$   | 120                  |       |       | mA                  |
| $T_{ON}$         | Turn-on time <sup>(3)</sup>         | $V_{IN} = 4.2\text{ V}$ , $C_{OUT} = 10\text{ }\mu\text{F}$ , $I_{OUT} = 60\text{ mA}$ ,<br>$T_J = -40\text{ °C to }125\text{ °C}$                        |                      | 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.

$T_J = 25\text{ °C}$ ,  $V_{IN} = V_{OUT(NOM)} + 1\text{ V}$ ,  $C_{IN} = 0.1\text{ }\mu\text{F}$ ,  $C_{OUT} = 1\text{ }\mu\text{F}$ ,  $I_{OUT} = 1\text{ mA}$ ,  $V_{OUT} = 3.3\text{ V}$  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                 | $I_{OUT} = 85\text{ mA}$ , $T_J = -40\text{ °C}$ to $125\text{ °C}$   | $V_{OUT} + V_{DROPTYP}$ |       | 24    | V                   |               |
| $I_{OUT}$        | Output current                          | $V_{IN} = 4.3$ to $24\text{ V}$ , $T_J = -40\text{ °C}$ to $125\text{ °C}$  | 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 $85\text{ mA}$ , $T_J = -40\text{ °C}$ to $125\text{ °C}$                            | -5                      |       | +5    | %                   |               |
| $\Delta V_{OUT}$ | Line regulation                         | $V_{IN} = 4.3$ to $24\text{ V}$ , $I_{OUT} = 1\text{ mA}$ , $T_J = -40\text{ °C}$ to $125\text{ °C}$  |                         | 0.001 | 0.004 | %/V                 |               |
| $\Delta V_{OUT}$ | Load regulation                         | $I_{OUT} = 100\text{ }\mu\text{A}$ to $85\text{ mA}$ , $T_J = -40\text{ °C}$ to $125\text{ °C}$   |                         | 0.002 | 0.003 | %/mA                |               |
| $V_{DROPTYP}$    | Dropout voltage <sup>(2)</sup>          | $I_{OUT} = 85\text{ mA}$ , $T_J = -40\text{ °C}$ to $125\text{ °C}$   |                         | 500   | 1000  | mV                  |               |
| $e_N$            | Output noise voltage <sup>(3)</sup>     | 200 Hz to 100 kHz, $I_{OUT} = 50\text{ mA}$ , $C_{OUT} = 10\text{ }\mu\text{F}$ , $T_J = -40\text{ °C}$ to $125\text{ °C}$                      |                         |       | 210   | $\mu\text{V}_{RMS}$ |               |
| SVR              | Supply voltage rejection                | $V_{IN} = V_{OUT(NOM)} + 1\text{ V} \pm V_{RIPPLE}$ , $V_{RIPPLE} = 0.2\text{ V}$ , $I_{OUT} = 1\text{ mA}$ , $C_{OUT} = 10\text{ }\mu\text{F}$ | $f = 1\text{ kHz}$      |       | 38    | dB                  |               |
|                  |   | $T_J = -40\text{ °C}$ to $125\text{ °C}$  | $f = 100\text{ kHz}$    |       | 57    |                     |               |
| $I_Q$            | Quiescent current                       | $I_{OUT} = 0\text{ mA}$ to $85\text{ mA}$ , $T_J = -40\text{ °C}$ to $125\text{ °C}$  |                         |       | 3.75  | 4.5                 | $\mu\text{A}$ |
|                  |   |   | $V_{IN} = 24\text{ V}$  |       | 4.15  | 5.5                 |               |
| $I_{SC}$         | 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 <sup>(4)</sup>             | $V_{IN} = 4.2\text{ V}$ , $C_{OUT} = 10\text{ }\mu\text{F}$ , $I_{OUT} = 60\text{ mA}$ , $T_J = -40\text{ °C}$ to $125\text{ °C}$               |                         | 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. 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  $R_2 \geq 5$  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  $\mu$ F 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  $\mu$ F, 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

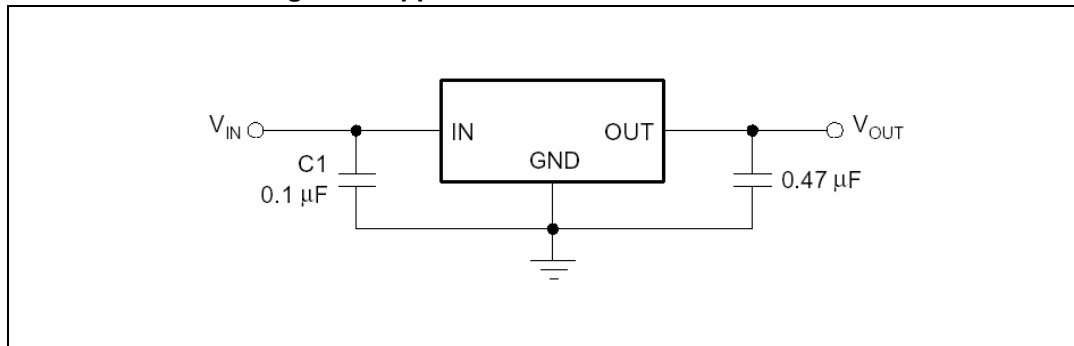
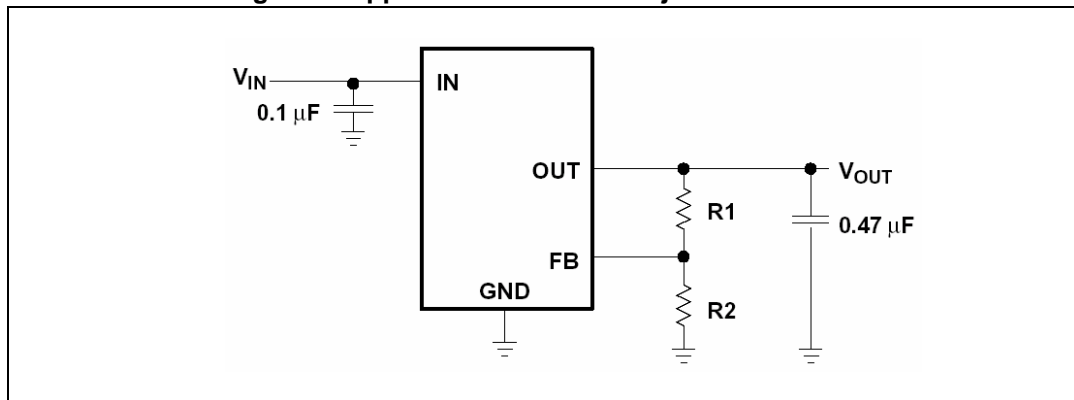


Figure 5. Application circuit for adjustable version



# 7 Typical performance characteristics

Figure 6. Output voltage vs. temperature

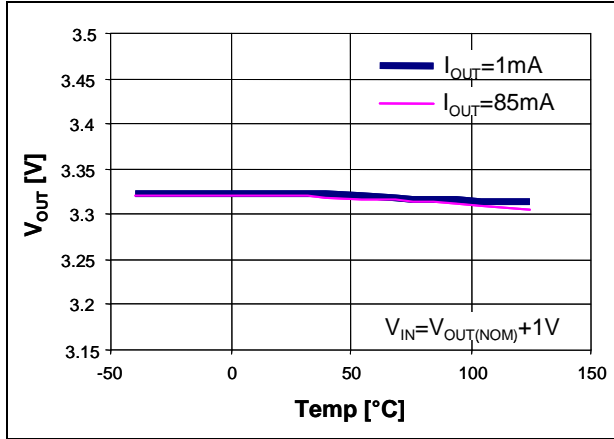


Figure 7. Output voltage vs. input voltage

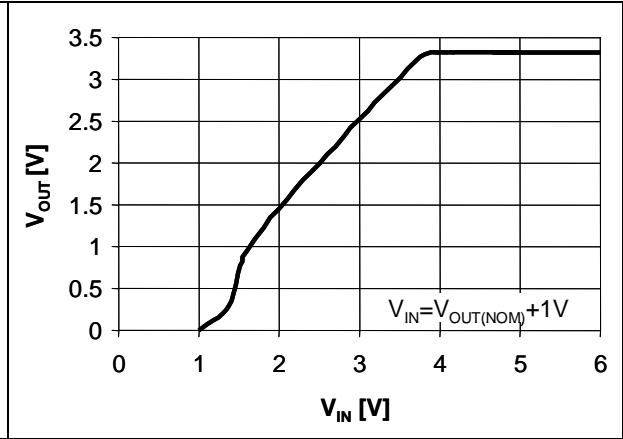


Figure 8. Dropout voltage vs. output current

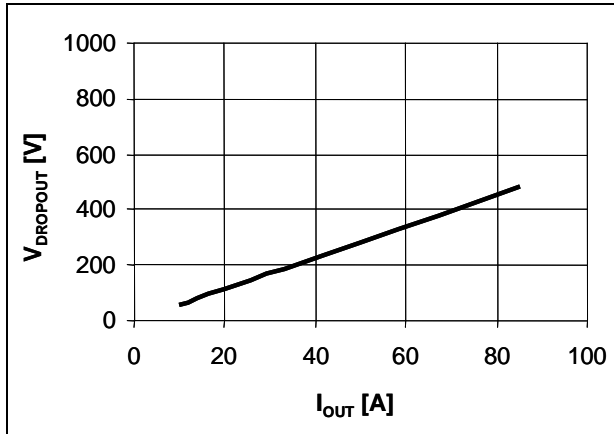


Figure 9.  $C_{OUT}$  stability region

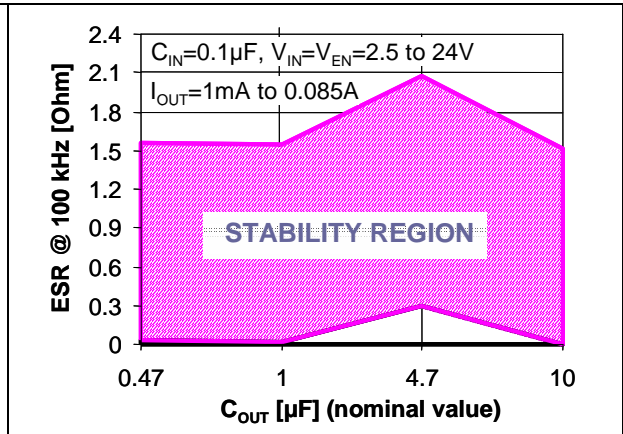


Figure 10. Supply voltage rejection vs. frequency

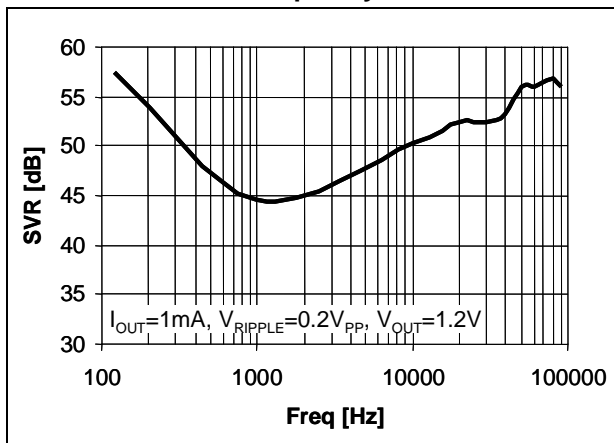


Figure 11. Output noise voltage vs. frequency

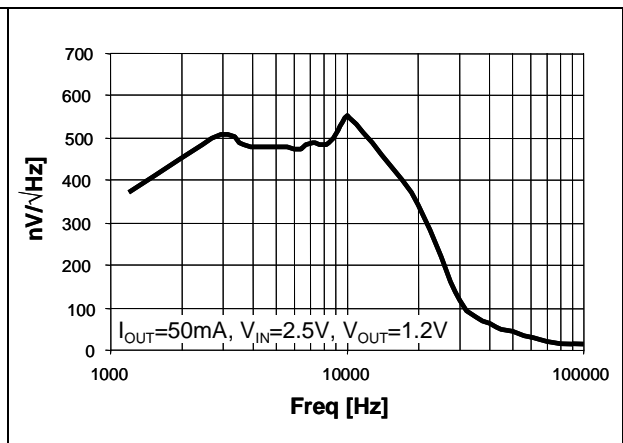


Figure 12. Quiescent current vs. input voltage

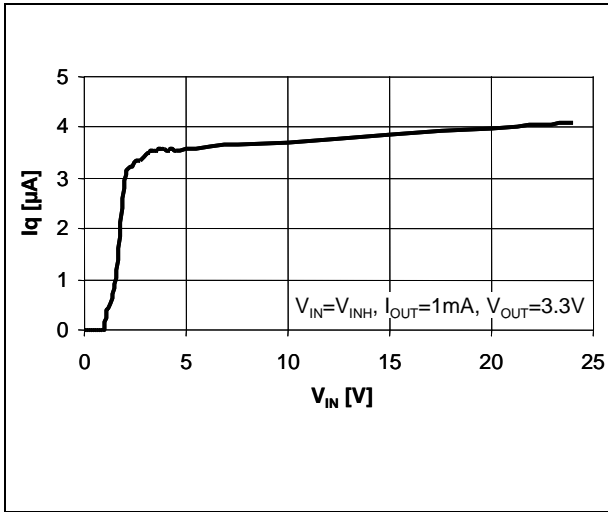


Figure 13. Load transient

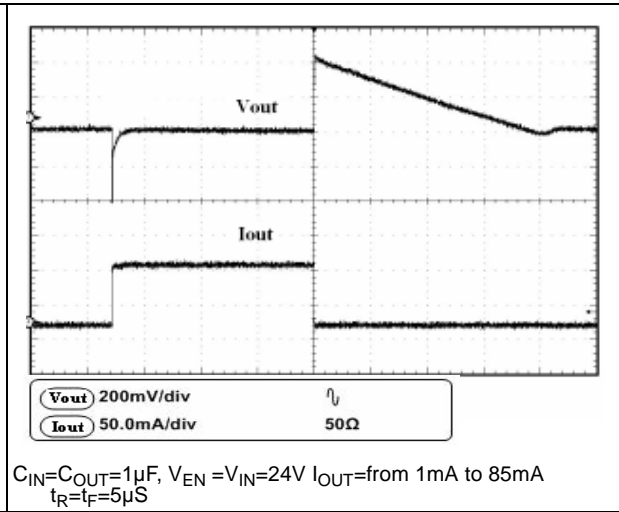


Figure 14. Line transient

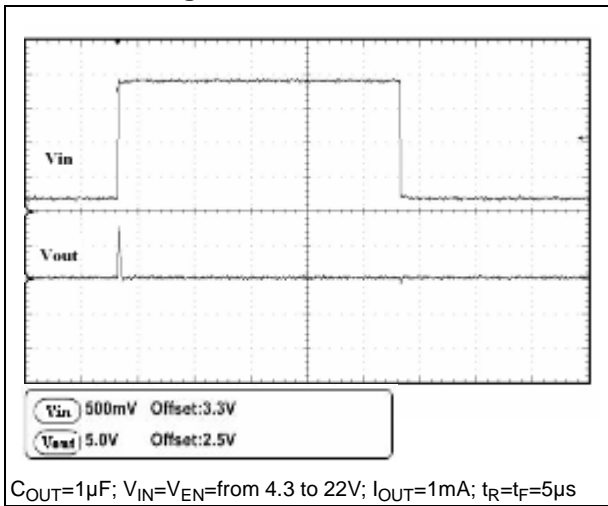
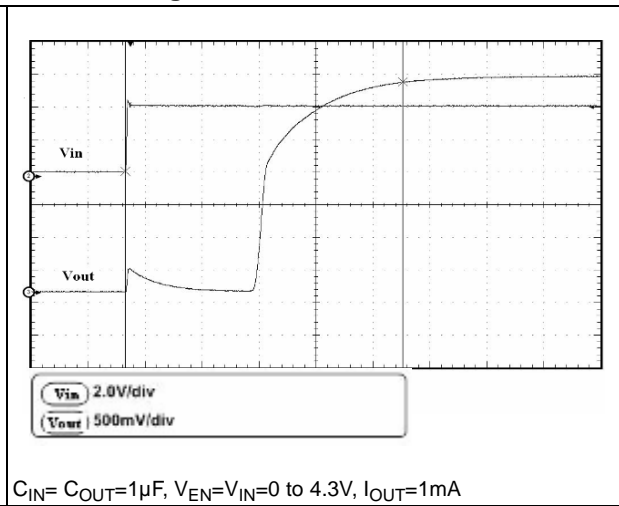


Figure 15. Enable transient



## 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](http://www.st.com). ECOPACK® is an ST trademark.

Figure 16. SOT23-5L drawing

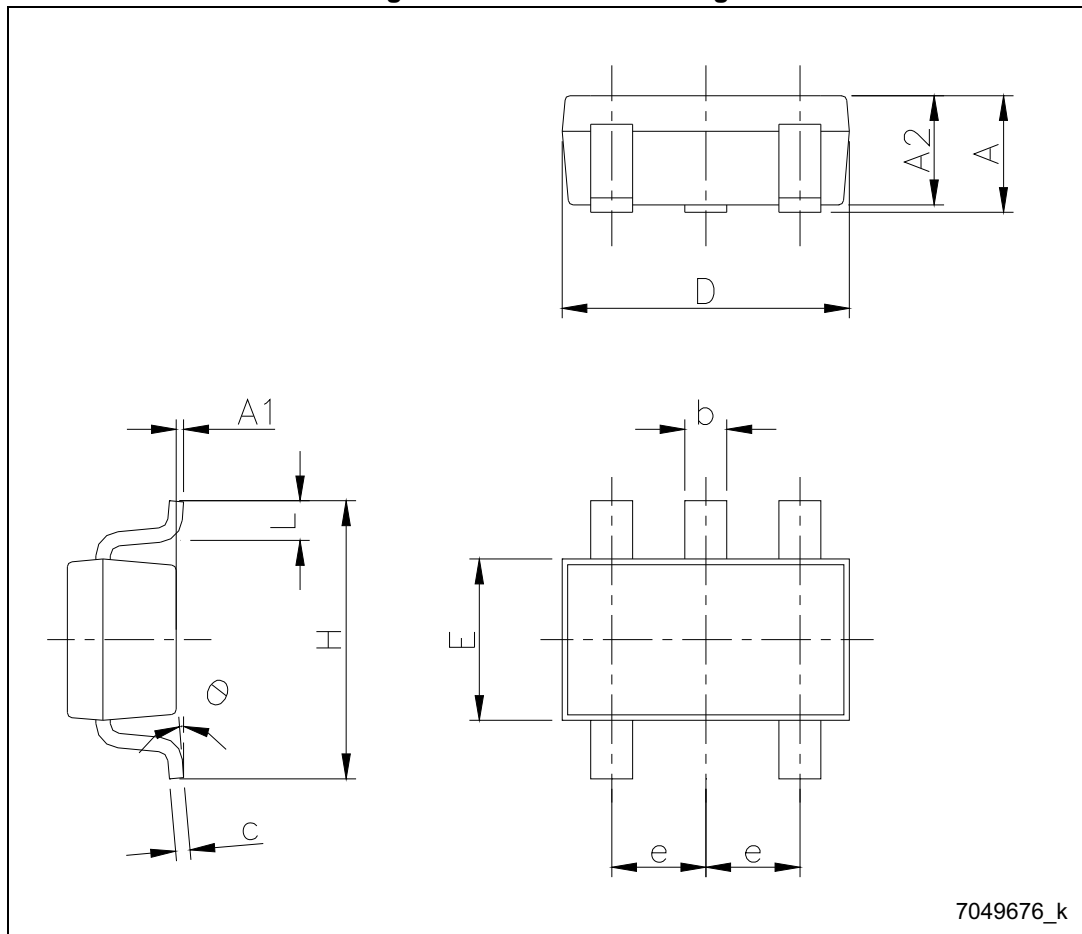


Table 8. SOT23-5L mechanical data

| 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 |
| $\theta$ | 0    |      | 8    |

Figure 17. SOT23-5L recommended footprint (dimensions in mm)

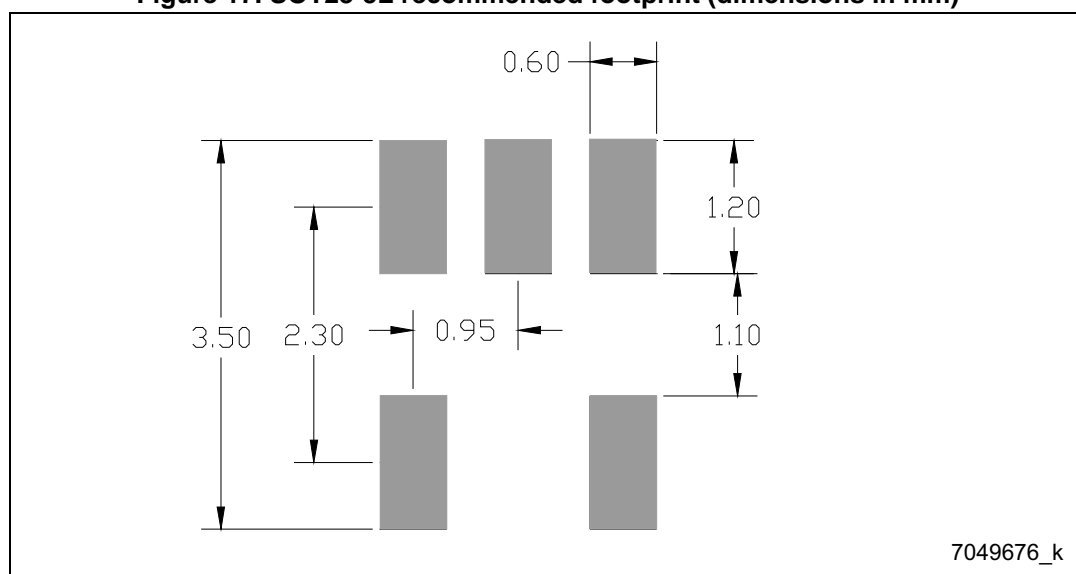


Figure 18. SOT323-5L drawing

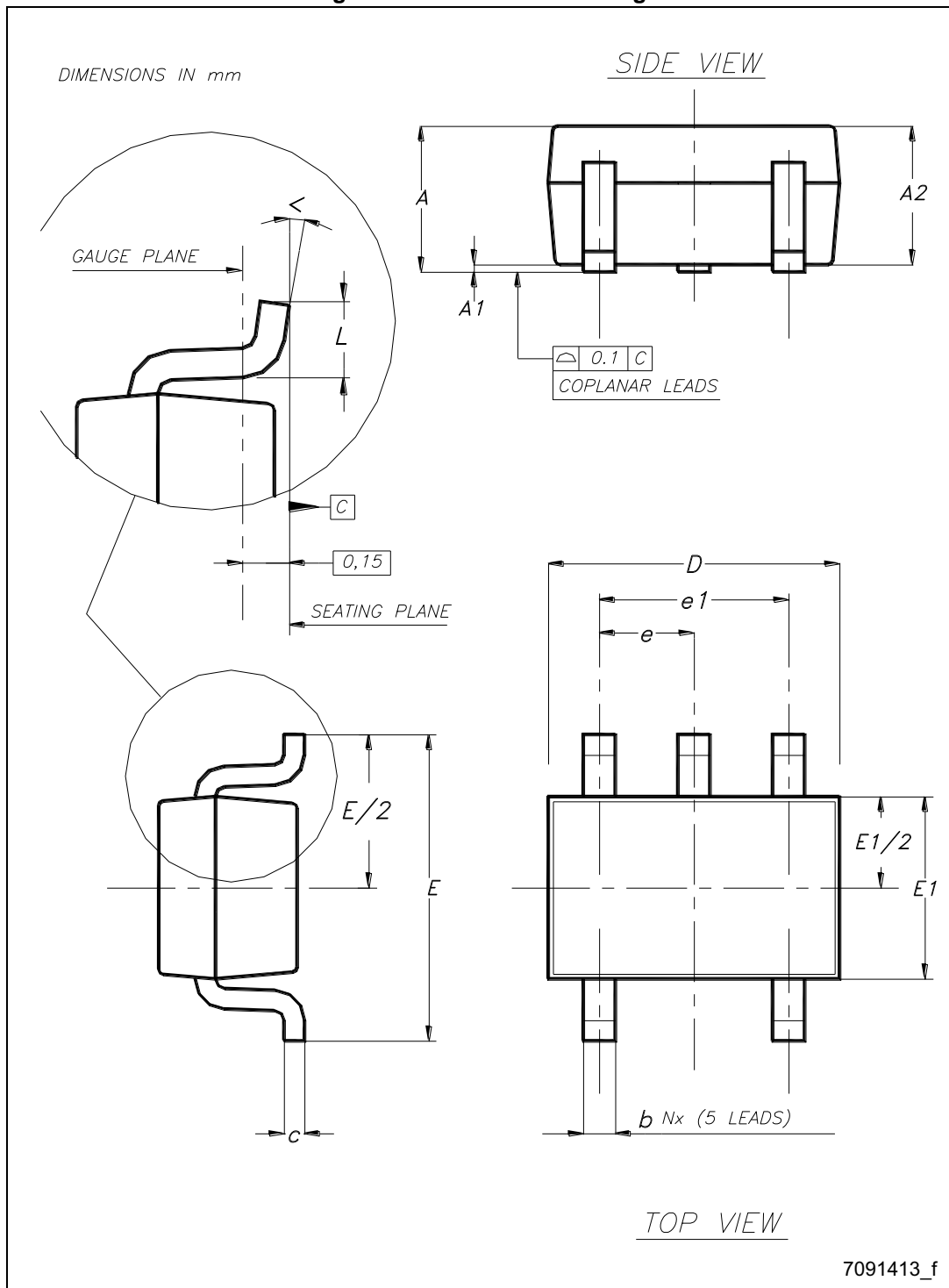


Table 9. SOT323-5L mechanical data

| 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 19. DFN8 (3x3 mm) drawing

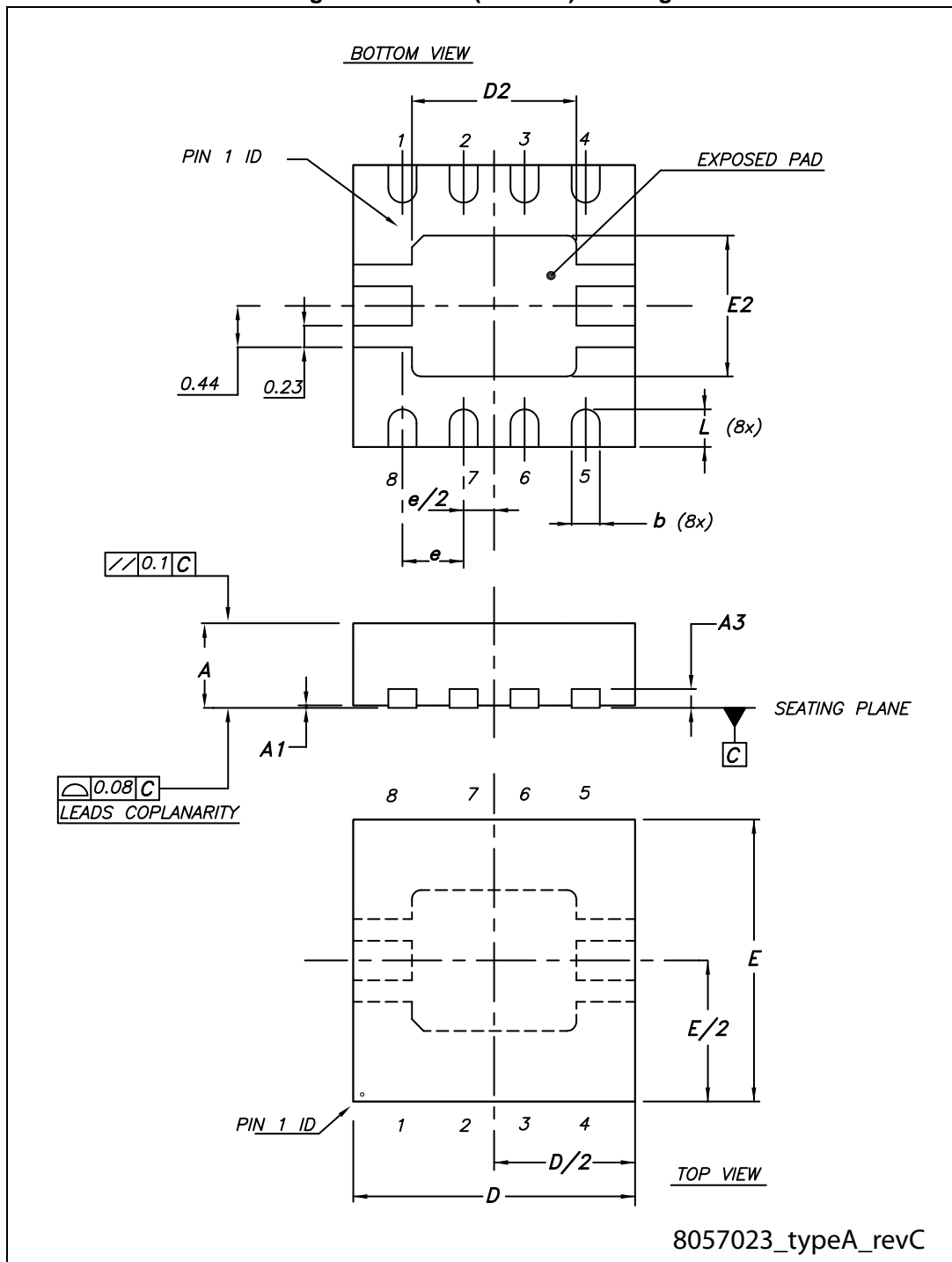
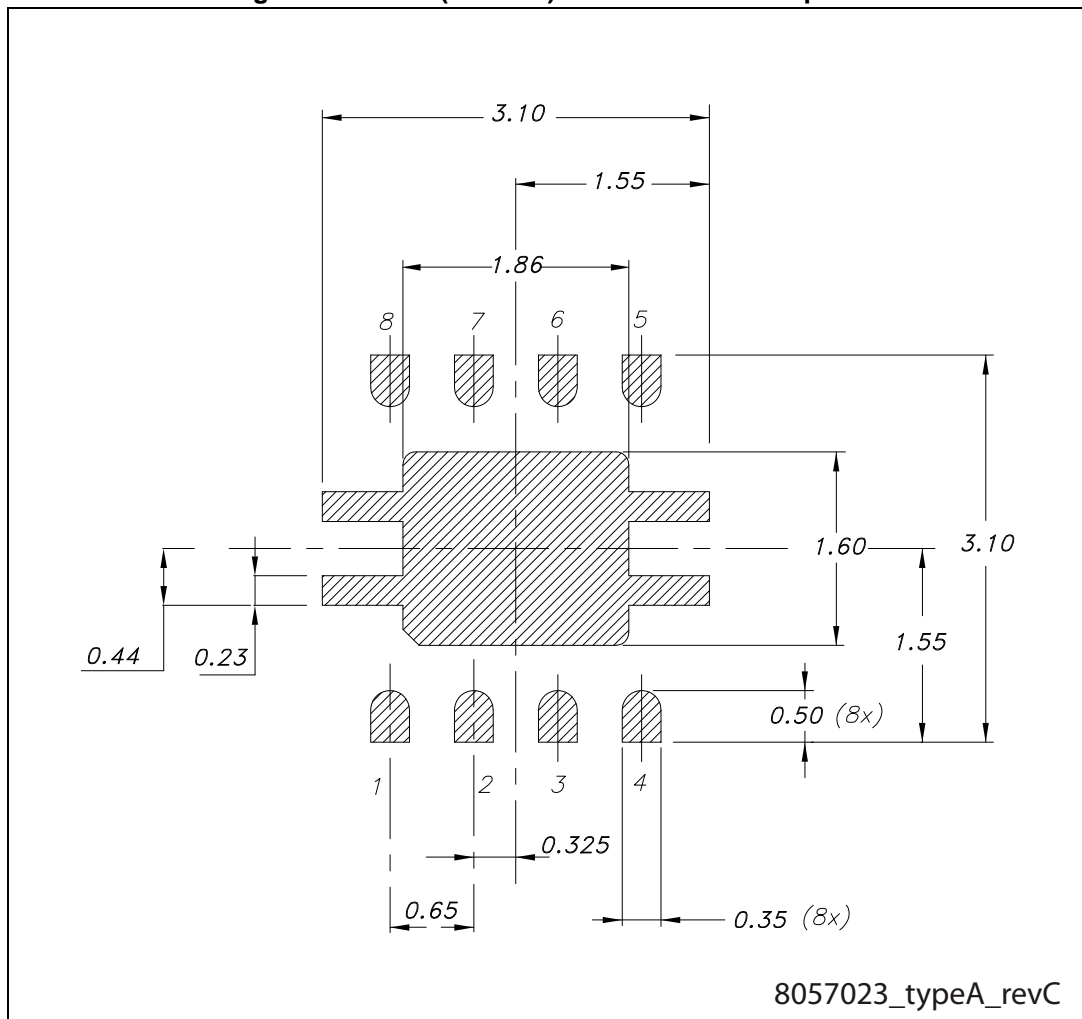


Table 10. DFN8 (3x3 mm) mechanical data

| 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 20. DFN8 (3x3 mm) recommended footprint



# 9 Packaging mechanical data

Figure 21. Tape and reel SOT23-5L drawing

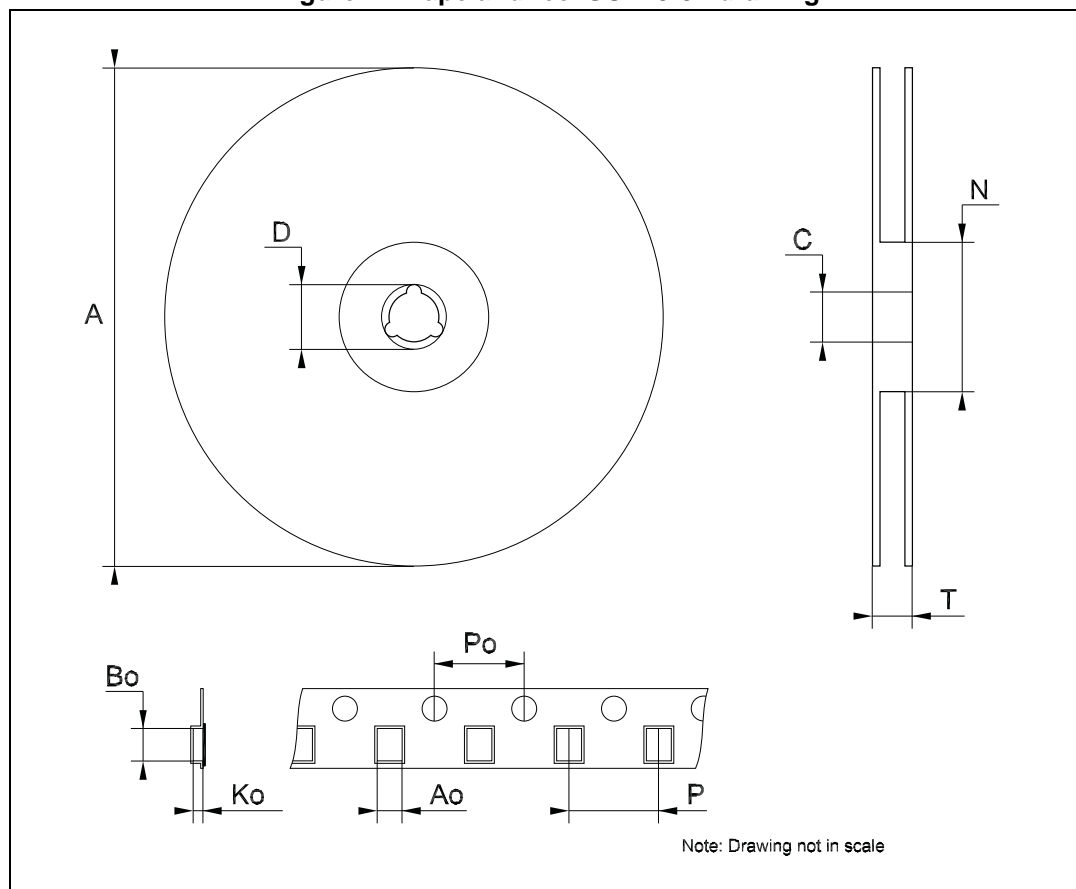


Table 11. SOT23-5L tape and reel mechanical data

| 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: <a href="#">Features on page 1</a> .   |
| 22-Sep-2008 | 3        | Modified: DFN8 (3x3 mm) mechanical data <a href="#">10 on page 23</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> .  |
| 24-Mar-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> .  |
| 20-May-2010 | 7        | Modified: <a href="#">Table 2</a> and <a href="#">Table 3 on page 4</a> .  |
| 28-Jan-2014 | 8        | Part numbers ST715xx, ST715xx25, ST715xx33 changed to ST715.<br>Added package DFN8 (3 x 3 mm).<br>Updated the title, the features and the description in cover page.<br>Updated <a href="#">Section 1: Diagram</a> , <a href="#">Section 2: Pin configuration</a> , <a href="#">Section 3: Maximum ratings</a> , <a href="#">Section 4: Electrical characteristics</a> and <a href="#">Section 8: Package mechanical data</a> .<br>Added <a href="#">Section 9: Packaging mechanical data</a> .<br>Minor text changes. |
| 21-May-2014 | 9        | Updated <a href="#">Section 8: Package mechanical data</a> .<br>Minor text changes.  |

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