



# TS951, TS952, TS954

## Input/output rail-to-rail low power operational amplifiers

Datasheet —production data

### Features

- Rail-to-rail input common mode voltage range
- Rail-to-rail output voltage swing
- Operating from 2.7 V to 12 V
- High-speed (3 MHz, 1 V/μs)
- Low consumption (0.9 mA at 3 V)
- Supply voltage rejection ratio: 80 dB
- Latch-up immunity
- Available in SOT23-5 micropackage, DIP8, SO-8, TSSOP8, DIP14, SO-14, and TSSOP14 package

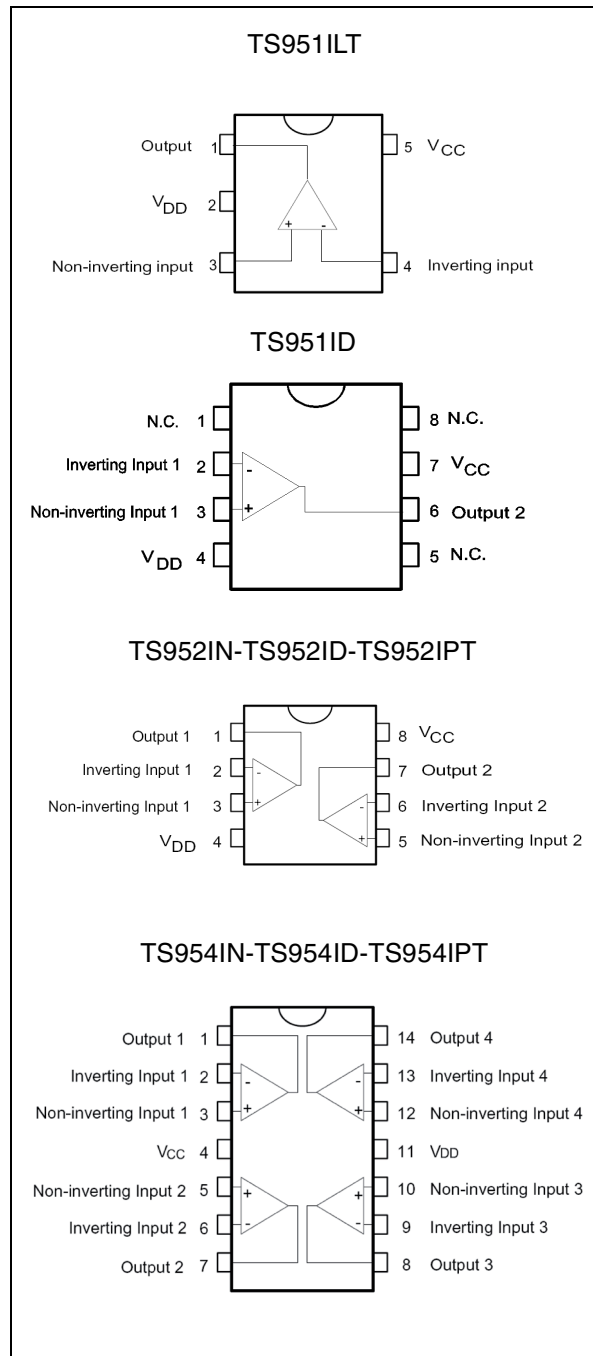
### Applications

- Set-top boxes
- Laptop/notebook computers
- Transformer/line drivers
- Personal entertainment (CD players)
- Portable communications (cell phones, pagers)
- Instrumentation and sensing
- Digital-to-analog converter buffers
- Portable headphone speaker drivers

### Description

The TS951, TS952 and TS954 family of devices are rail-to-rail BiCMOS operational amplifiers optimized and fully specified for 3 V and 5 V operation.

The TS951 device is housed in the space saving 5-pin SOT23 package that makes it well suited for battery powered systems. This micropackage simplifies the PC board design because of its ability to be placed in tight spaces (outside dimensions are: 2.8 mm x 2.9 mm).



# 1 Absolute maximum ratings and operating conditions

**Table 1. Absolute maximum ratings**

| Symbol     | Parameter                                                                                                               | Value                                       | Unit |
|------------|-------------------------------------------------------------------------------------------------------------------------|---------------------------------------------|------|
| $V_{CC}$   | Supply voltage <sup>(1)</sup>                                                                                           | 14                                          | V    |
| $V_{id}$   | Differential input voltage <sup>(2)</sup>                                                                               | $\pm 1$                                     | V    |
| $V_{in}$   | Input voltage <sup>(3)</sup>                                                                                            | $V_{DD}-0.3$ to $V_{CC}+0.3$                | V    |
| $T_{stg}$  | Storage temperature range                                                                                               | -65 to +150                                 |      |
| $T_j$      | Maximum junction temperature                                                                                            | 150                                         | °C   |
| $R_{thja}$ | Thermal resistance junction-to-ambient <sup>(4)</sup><br>SOT23-5<br>SO-8<br>SO-14<br>DIP8<br>DIP14<br>TSSOP8<br>TSSOP14 | 250<br>125<br>103<br>85<br>80<br>120<br>100 | °C/W |
| $R_{thjc}$ | Thermal resistance junction-to-case <sup>(4)</sup><br>SOT23-5<br>SO-8<br>SO-14<br>DIP8<br>DIP14<br>TSSOP8<br>TSSOP14    | 81<br>40<br>31<br>41<br>33<br>37<br>32      | °C/W |
| ESD        | HBM: human body model <sup>(5)</sup><br>TS951<br>TS952<br>TS954                                                         | 1<br>2<br>3                                 | kV   |
|            | MM: machine model <sup>(6)</sup>                                                                                        | 100                                         | V    |
|            | CDM: charged device model <sup>(7)</sup><br>TS951<br>TS952<br>TS954                                                     | 1.5<br>1.5<br>1                             | kV   |

**Table 1. Absolute maximum ratings (continued)**

| Symbol | Parameter                             | Value | Unit |
|--------|---------------------------------------|-------|------|
|        | Latch-up immunity                     | 200   | mA   |
|        | Lead temperature (soldering, 10 sec.) | 260   | °C   |

1. All voltage values, except differential voltage are with respect to network ground terminal.
2. Differential voltages are the non-inverting input terminal with respect to the inverting input terminal. If  $V_{id} > \pm 1$  V, the maximum input current must not exceed  $\pm 1$  mA. In this case ( $V_{id} > \pm 1$  V), an input series resistor must be added to limit input current.
3. Do not exceed 14 V.
4. Short-circuits can cause excessive heating and destructive dissipation.  $R_{th}$  are typical values.
5. Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5 k $\Omega$  resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
6. Machine model: a 200 pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5  $\Omega$ ). This is done for all couples of connected pin combinations while the other pins are floating.
7. Charged device model: all pins and the package are charged together to the specified voltage and then discharged directly to ground through only one pin. This is done for all pins.

**Table 2. Operating conditions**

| Symbol     | Parameter                            | Value                            | Unit |
|------------|--------------------------------------|----------------------------------|------|
| $V_{CC}$   | Supply voltage                       | 2.7 to 12                        | V    |
| $V_{icm}$  | Common mode input voltage range      | $V_{DD} - 0.2$ to $V_{CC} + 0.2$ | V    |
| $T_{oper}$ | Operating free air temperature range | -40 to +125                      | °C   |

## 2 Electrical characteristics

**Table 3. Electrical characteristics at  $V_{CC} = +3\text{ V}$ ,  $V_{DD} = 0\text{ V}$ ,  $R_L$  connected to  $V_{CC}/2$ ,  $T_{amb} = 25\text{ °C}$  (unless otherwise specified)**

| Symbol    | Parameter                                                                                                                 | Min. | Typ. | Max.       | Unit                                 |
|-----------|---------------------------------------------------------------------------------------------------------------------------|------|------|------------|--------------------------------------|
| $V_{io}$  | Input offset voltage<br>$T_{min} \leq T_{amb} \leq T_{max}$                                                               |      |      | 6<br>8     | mV                                   |
| $DV_{io}$ | Input offset voltage drift                                                                                                |      | 2    |            | $\mu\text{V}/\text{°C}$              |
| $I_{io}$  | Input offset current<br>$T_{min} \leq T_{amb} \leq T_{max}$                                                               |      | 1    | 30<br>80   | nA                                   |
| $I_{ib}$  | Input bias current<br>$V_{icm} = V_{CC}/2$<br>$T_{min} \leq T_{amb} \leq T_{max}$                                         |      | 35   | 100<br>200 | nA                                   |
| CMR       | Common mode rejection ratio                                                                                               | 50   | 80   |            | dB                                   |
| SVR       | Supply voltage rejection ratio<br>$V_{CC} = 2.7\text{ V to } 3.3\text{ V}$                                                | 60   | 80   |            | dB                                   |
| $A_{vd}$  | Large signal voltage gain<br>$V_o = 2\text{ V}_{pk-pk}$ , $R_L = 600\ \Omega$                                             |      | 80   |            | dB                                   |
| $V_{OH}$  | High level output voltage<br>$R_L = 600\ \Omega$                                                                          | 2.8  | 2.9  |            | V                                    |
| $V_{OL}$  | Low level output voltage<br>$R_L = 600\ \Omega$                                                                           |      | 80   | 250        | mV                                   |
| $I_{sc}$  | Output short-circuit current                                                                                              | 10   |      |            | mA                                   |
| $I_{CC}$  | Supply current (per amplifier)<br>No load, $V_{icm} = V_{CC}/2$                                                           |      | 0.9  | 1.3        | mA                                   |
| GBP       | Gain bandwidth product<br>$R_L = 2\text{ k}\ \Omega$                                                                      |      | 3    |            | MHz                                  |
| SR        | Slew rate                                                                                                                 |      | 1    |            | V/ $\mu\text{s}$                     |
| $\phi_m$  | Phase margin at unit gain<br>$R_L = 600\ \Omega$ , $C_L = 100\text{ pF}$                                                  |      | 60   |            | Degrees                              |
| Gm        | Gain margin<br>$R_L = 600\ \Omega$ , $C_L = 100\text{ pF}$                                                                |      | 10   |            | dB                                   |
| $e_n$     | Equivalent input noise voltage<br>$f = 1\text{ kHz}$                                                                      |      | 25   |            | $\frac{\text{nV}}{\sqrt{\text{Hz}}}$ |
| THD       | Total harmonic distortion<br>$V_{out} = 4\text{ V}_{pk-pk}$ , $F = 10\text{ kHz}$ , $A_V = 2$ , $R_L = 10\text{ k}\Omega$ |      | 0.01 |            | %                                    |

**Table 4. Electrical characteristics at  $V_{CC} = +5\text{ V}$ ,  $V_{DD} = 0\text{ V}$ ,  $R_L$  connected to  $V_{CC}/2$ ,  $T_{amb} = 25\text{ °C}$  (unless otherwise specified)**

| Symbol    | Parameter                                                                                                                 | Min. | Typ. | Max.       | Unit                                 |
|-----------|---------------------------------------------------------------------------------------------------------------------------|------|------|------------|--------------------------------------|
| $V_{io}$  | Input offset voltage<br>$T_{min} \leq T_{amb} \leq T_{max}$                                                               |      |      | 6<br>8     | mV                                   |
| $DV_{io}$ | Input offset voltage drift                                                                                                |      | 2    |            | $\mu\text{V}/\text{°C}$              |
| $I_{io}$  | Input offset current<br>$V_{icm} = V_{CC}/2$<br>$T_{min} \leq T_{amb} \leq T_{max}$                                       |      | 1    | 30<br>80   | nA                                   |
| $I_{ib}$  | Input bias current<br>$V_{icm} = V_{CC}/2$<br>$T_{min} \leq T_{amb} \leq T_{max}$                                         |      | 35   | 100<br>200 | nA                                   |
| CMR       | Common mode rejection ratio                                                                                               | 50   | 80   |            | dB                                   |
| SVR       | Supply voltage rejection ratio<br>$V_{CC} = 2.7\text{ V to }3.3\text{ V}$                                                 | 60   | 80   |            | dB                                   |
| $A_{vd}$  | Large signal voltage gain<br>$V_o = 2\text{ V}_{pk-pk}$ , $R_L = 600\text{ }\Omega$                                       |      | 86   |            | dB                                   |
| $V_{OH}$  | High level output voltage<br>$R_L = 600\text{ }\Omega$                                                                    | 4.7  | 4.8  |            | V                                    |
| $V_{OL}$  | Low level output voltage<br>$R_L = 600\text{ }\Omega$                                                                     |      | 80   | 300        | mV                                   |
| $I_{sc}$  | Output short-circuit current                                                                                              | 10   |      |            | mA                                   |
| $I_{CC}$  | Supply current (per amplifier)<br>No load, $V_{icm} = V_{CC}/2$                                                           |      | 0.95 | 1.4        | mA                                   |
| GBP       | Gain bandwidth product<br>$R_L = 2\text{ k}\Omega$                                                                        |      | 3    |            | MHz                                  |
| SR        | Slew rate                                                                                                                 |      | 1    |            | $\text{V}/\mu\text{s}$               |
| $\phi_m$  | Phase margin at unit gain<br>$R_L = 600\text{ }\Omega$ , $C_L = 100\text{ pF}$                                            |      | 60   |            | Degrees                              |
| Gm        | Gain margin<br>$R_L = 600\text{ }\Omega$ , $C_L = 100\text{ pF}$                                                          |      | 10   |            | dB                                   |
| $e_n$     | Equivalent input noise voltage<br>$f = 1\text{ kHz}$                                                                      |      | 25   |            | $\frac{\text{nV}}{\sqrt{\text{Hz}}}$ |
| THD       | Total harmonic distortion<br>$V_{out} = 4\text{ V}_{pk-pk}$ , $F = 10\text{ kHz}$ , $A_V = 2$ , $R_L = 10\text{ k}\Omega$ |      | 0.01 |            | %                                    |

Figure 1. Supply current vs. supply voltage

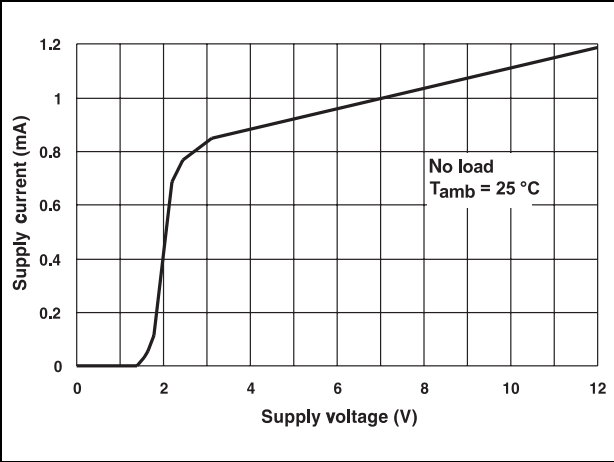


Figure 2. Output short-circuit current vs. output voltage

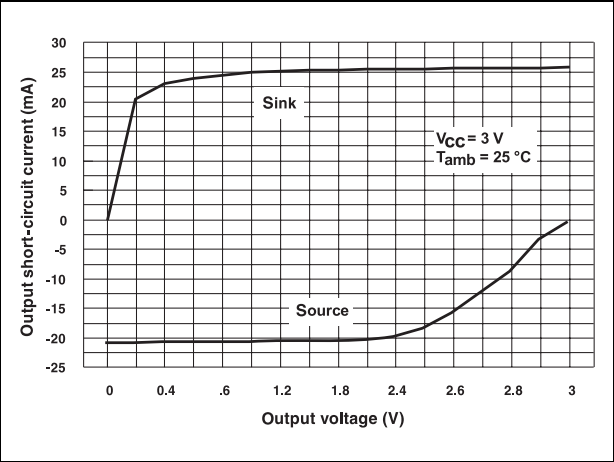


Figure 3. Voltage gain and phase vs. frequency

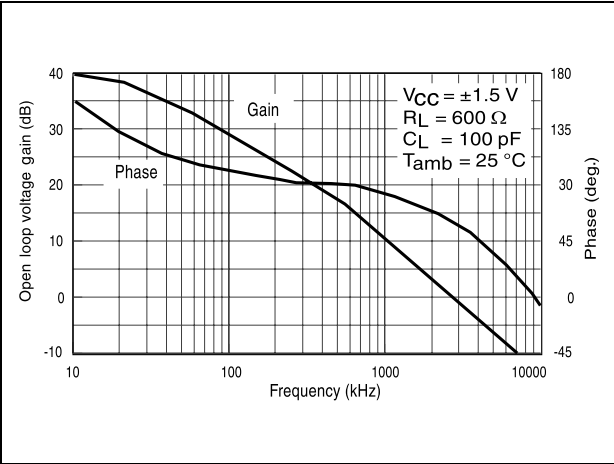


Figure 4. Supply current vs. temperature

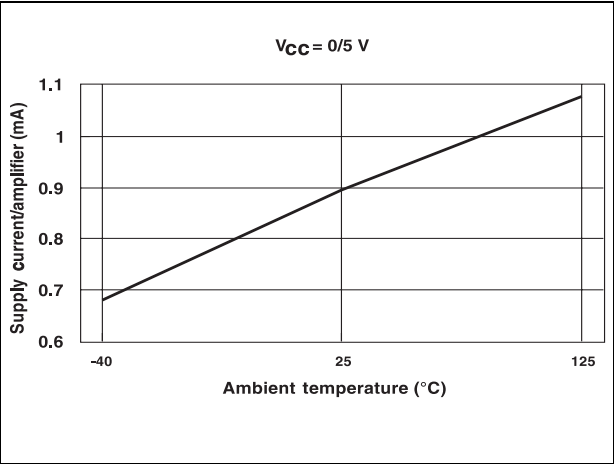


Figure 5. Output short-circuit current vs. temperature

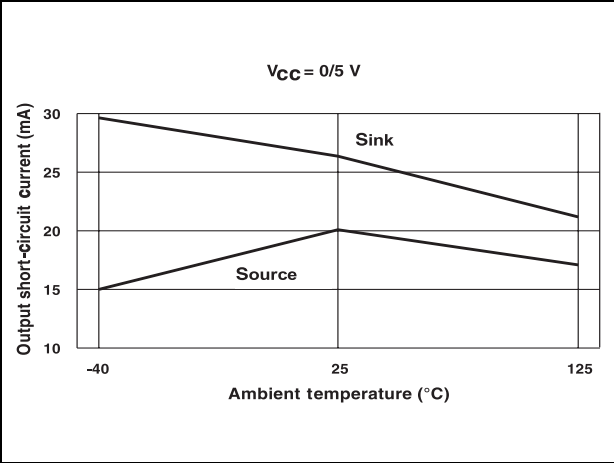
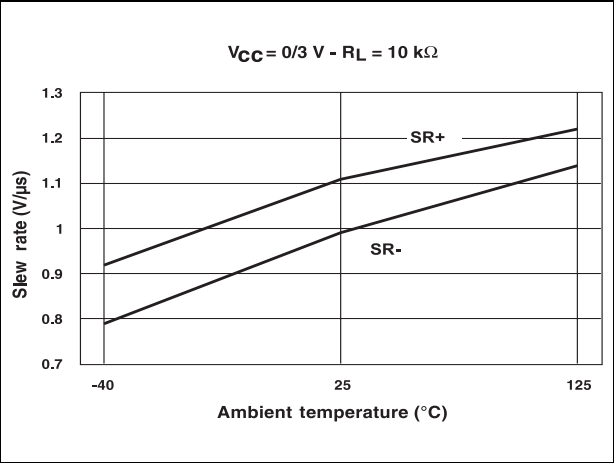
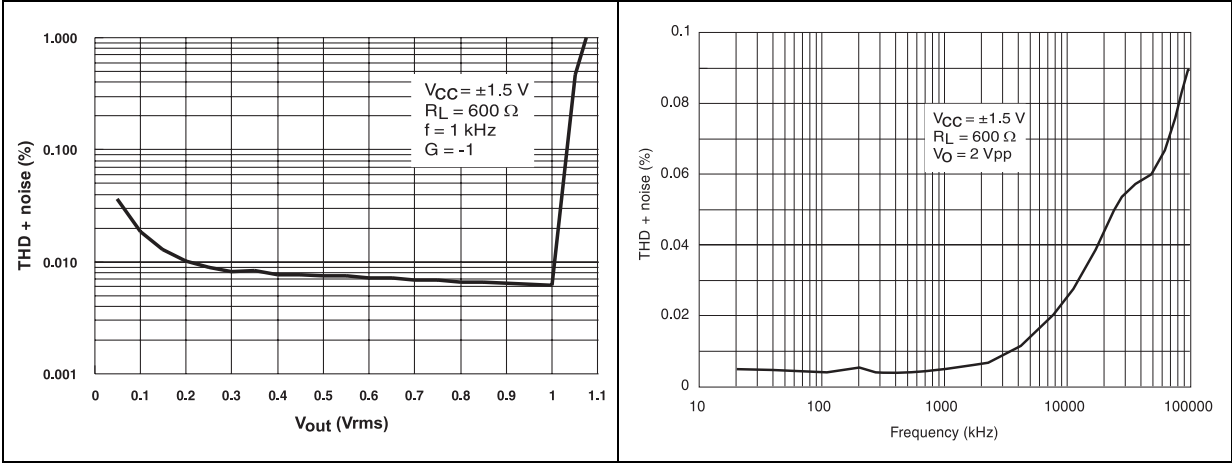


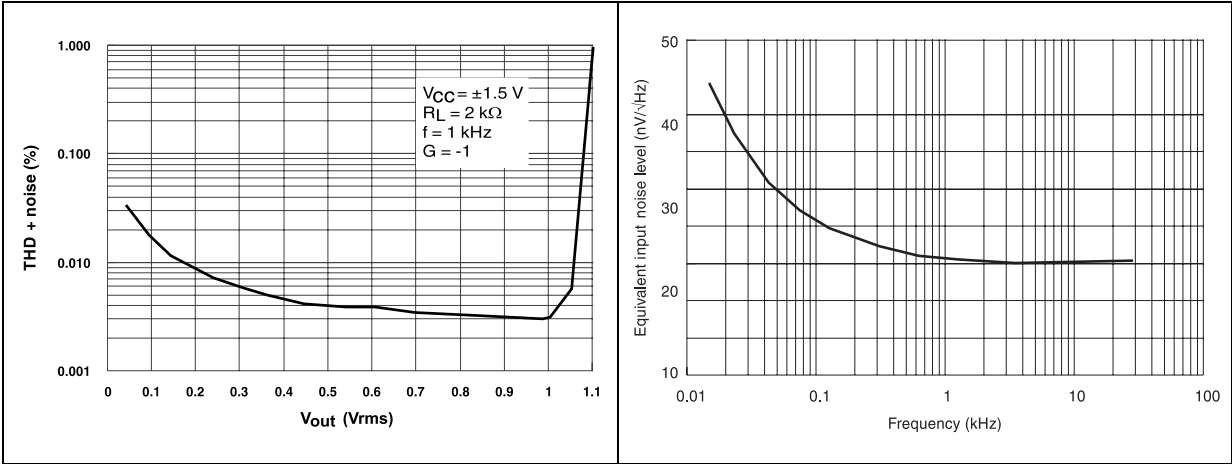
Figure 6. Slew rate vs. temperature



**Figure 7.** THD + noise vs.  $V_{out}$  ( $V_{CC} = \pm 1.5\text{ V}$ ,  $R_L = 600\ \Omega$ ,  $f = 1\text{ kHz}$ ,  $G = -1$ ) **Figure 8.** THD + noise vs. frequency



**Figure 9.** THD + noise vs.  $V_{out}$  ( $V_{CC} = \pm 1.5\text{ V}$ ,  $R_L = 2\text{ k}\Omega$ ,  $f = 1\text{ kHz}$ ,  $G = -1$ ) **Figure 10.** Equivalent input noise voltage vs. frequency



### 3 Package information

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.

### 3.1 SOT23-5 package information

Figure 11. SOT23-5 package outline

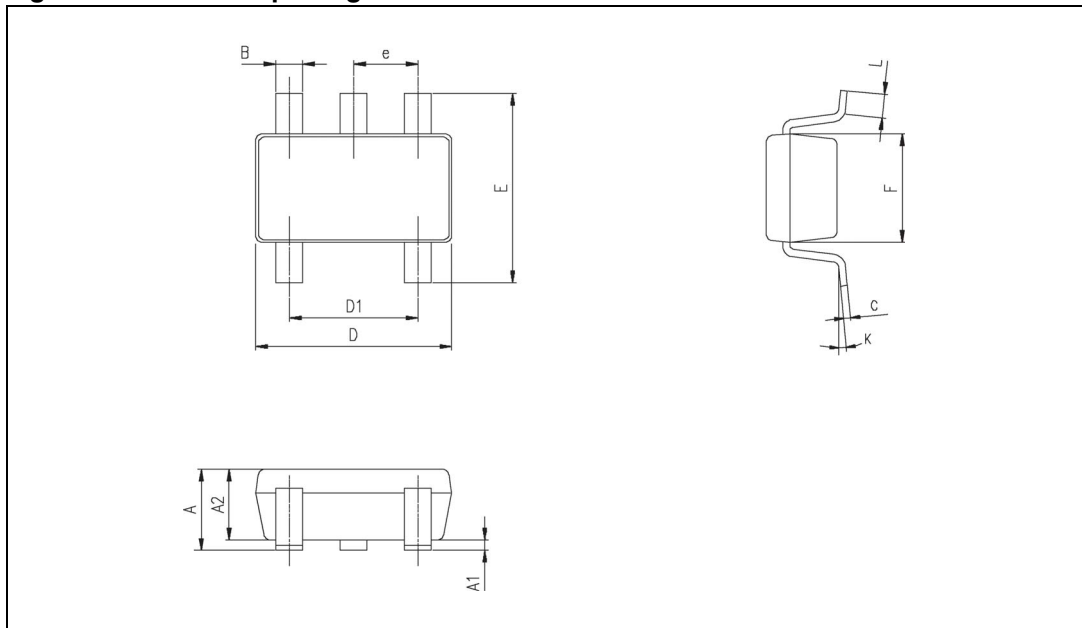


Table 5. SOT23-5 package mechanical data

| Symbol | Dimensions  |      |            |        |       |       |
|--------|-------------|------|------------|--------|-------|-------|
|        | Millimeters |      |            | Inches |       |       |
|        | Min.        | Typ. | Max.       | Min.   | Typ.  | Max.  |
| A      | 0.90        | 1.20 | 1.45       | 0.035  | 0.047 | 0.057 |
| A1     |             |      | 0.15       |        |       | 0.006 |
| A2     | 0.90        | 1.05 | 1.30       | 0.035  | 0.041 | 0.051 |
| B      | 0.35        | 0.40 | 0.50       | 0.013  | 0.015 | 0.019 |
| C      | 0.09        | 0.15 | 0.20       | 0.003  | 0.006 | 0.008 |
| D      | 2.80        | 2.90 | 3.00       | 0.110  | 0.114 | 0.118 |
| D1     |             | 1.90 |            |        | 0.075 |       |
| e      |             | 0.95 |            |        | 0.037 |       |
| E      | 2.60        | 2.80 | 3.00       | 0.102  | 0.110 | 0.118 |
| F      | 1.50        | 1.60 | 1.75       | 0.059  | 0.063 | 0.069 |
| L      | 0.10        | 0.35 | 0.60       | 0.004  | 0.013 | 0.023 |
| K      | 0 degrees   |      | 10 degrees |        |       |       |

## 3.2 DIP8 package information

Figure 12. DIP8 package outline

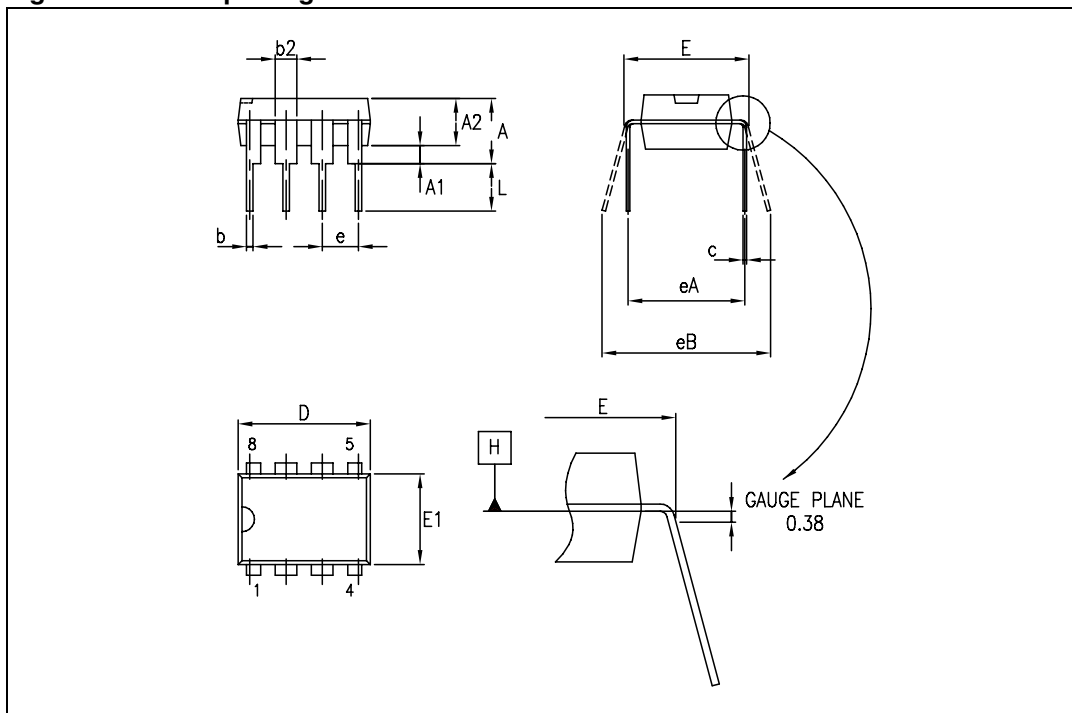


Table 6. DIP8 package mechanical data

| Symbol | Dimensions  |      |       |        |       |       |
|--------|-------------|------|-------|--------|-------|-------|
|        | Millimeters |      |       | Inches |       |       |
|        | Min.        | Typ. | Max.  | Min.   | Typ.  | Max.  |
| A      |             |      | 5.33  |        |       | 0.210 |
| A1     | 0.38        |      |       | 0.015  |       |       |
| A2     | 2.92        | 3.30 | 4.95  | 0.115  | 0.130 | 0.195 |
| b      | 0.36        | 0.46 | 0.56  | 0.014  | 0.018 | 0.022 |
| b2     | 1.14        | 1.52 | 1.78  | 0.045  | 0.060 | 0.070 |
| c      | 0.20        | 0.25 | 0.36  | 0.008  | 0.010 | 0.014 |
| D      | 9.02        | 9.27 | 10.16 | 0.355  | 0.365 | 0.400 |
| E      | 7.62        | 7.87 | 8.26  | 0.300  | 0.310 | 0.325 |
| E1     | 6.10        | 6.35 | 7.11  | 0.240  | 0.250 | 0.280 |
| e      |             | 2.54 |       |        | 0.100 |       |
| eA     |             | 7.62 |       |        | 0.300 |       |
| eB     |             |      | 10.92 |        |       | 0.430 |
| L      | 2.92        | 3.30 | 3.81  | 0.115  | 0.130 | 0.150 |

### 3.3 SO-8 package information

Figure 13. SO-8 package outline

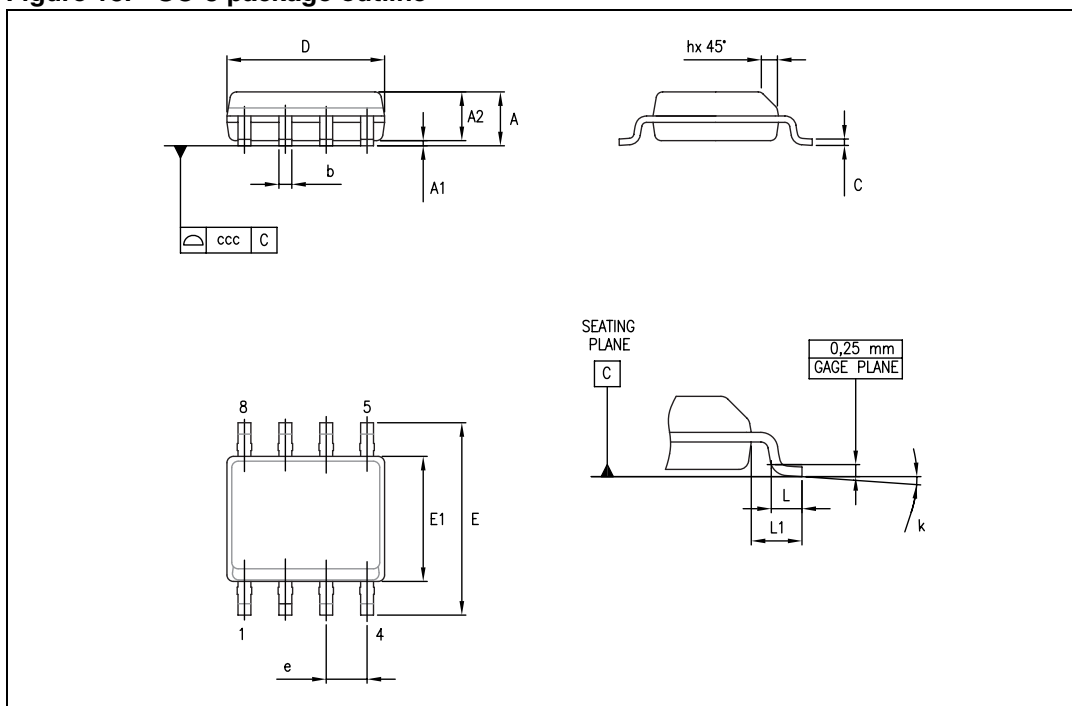


Table 7. SO-8 package mechanical data

| Symbol | Dimensions  |      |      |        |       |       |
|--------|-------------|------|------|--------|-------|-------|
|        | Millimeters |      |      | Inches |       |       |
|        | Min.        | Typ. | Max. | Min.   | Typ.  | Max.  |
| A      |             |      | 1.75 |        |       | 0.069 |
| A1     | 0.10        |      | 0.25 | 0.004  |       | 0.010 |
| A2     | 1.25        |      |      | 0.049  |       |       |
| b      | 0.28        |      | 0.48 | 0.011  |       | 0.019 |
| c      | 0.17        |      | 0.23 | 0.007  |       | 0.010 |
| D      | 4.80        | 4.90 | 5.00 | 0.189  | 0.193 | 0.197 |
| E      | 5.80        | 6.00 | 6.20 | 0.228  | 0.236 | 0.244 |
| E1     | 3.80        | 3.90 | 4.00 | 0.150  | 0.154 | 0.157 |
| e      |             | 1.27 |      |        | 0.050 |       |
| h      | 0.25        |      | 0.50 | 0.010  |       | 0.020 |
| L      | 0.40        |      | 1.27 | 0.016  |       | 0.050 |
| L1     |             | 1.04 |      |        | 0.040 |       |
| k      | 1°          |      | 8°   | 1°     |       | 8°    |
| ccc    |             |      | 0.10 |        |       | 0.004 |

### 3.4 TSSOP8 package information

Figure 14. TSSOP8 package outline

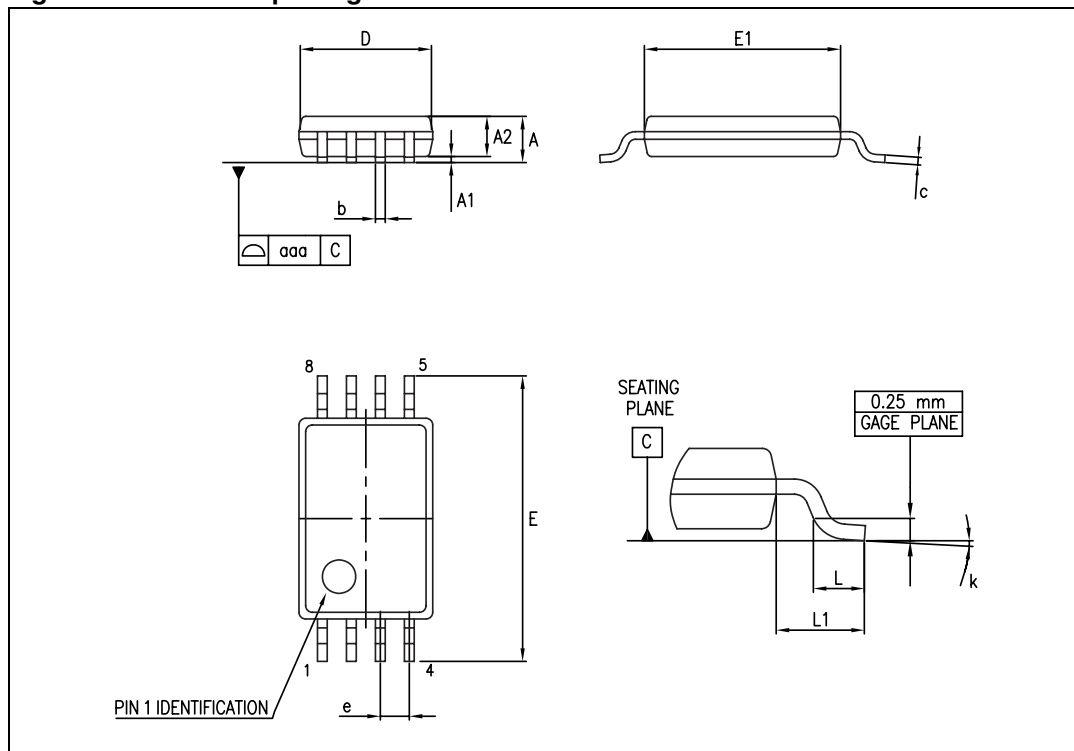


Table 8. TSSOP8 package mechanical data

| Symbol | Dimensions  |      |      |        |        |       |
|--------|-------------|------|------|--------|--------|-------|
|        | Millimeters |      |      | Inches |        |       |
|        | Min.        | Typ. | Max. | Min.   | Typ.   | Max.  |
| A      |             |      | 1.20 |        |        | 0.047 |
| A1     | 0.05        |      | 0.15 | 0.002  |        | 0.006 |
| A2     | 0.80        | 1.00 | 1.05 | 0.031  | 0.039  | 0.041 |
| b      | 0.19        |      | 0.30 | 0.007  |        | 0.012 |
| c      | 0.09        |      | 0.20 | 0.004  |        | 0.008 |
| D      | 2.90        | 3.00 | 3.10 | 0.114  | 0.118  | 0.122 |
| E      | 6.20        | 6.40 | 6.60 | 0.244  | 0.252  | 0.260 |
| E1     | 4.30        | 4.40 | 4.50 | 0.169  | 0.173  | 0.177 |
| e      |             | 0.65 |      |        | 0.0256 |       |
| k      | 0°          |      | 8°   | 0°     |        | 8°    |
| L      | 0.45        | 0.60 | 0.75 | 0.018  | 0.024  | 0.030 |
| L1     |             | 1    |      |        | 0.039  |       |
| aaa    |             |      | 0.10 |        |        | 0.004 |

### 3.5 DIP14 package information

Figure 15. DIP14 package outline

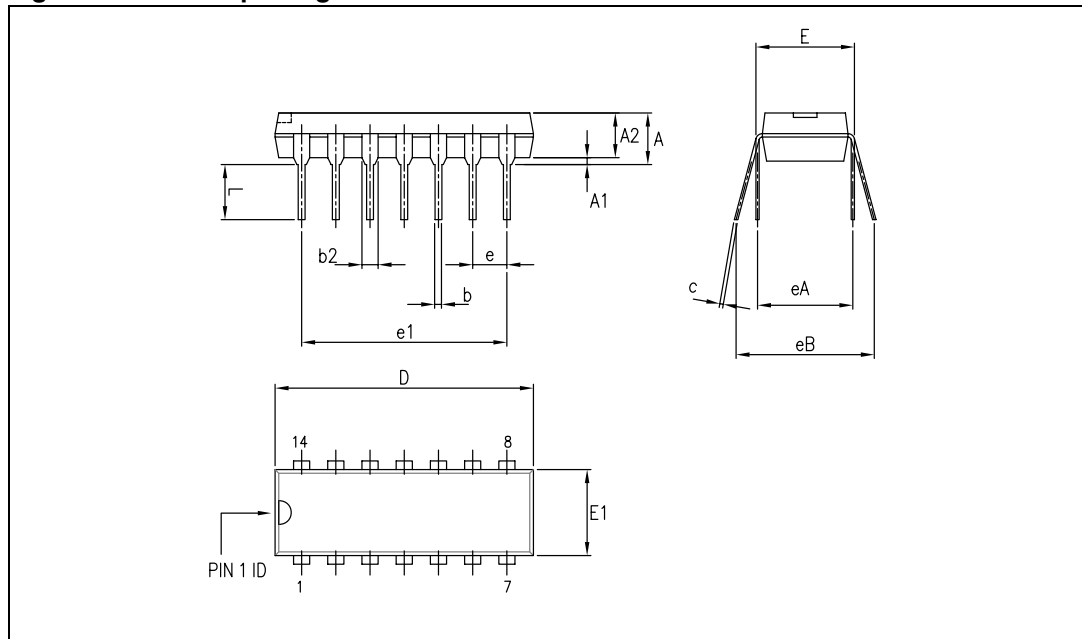


Table 9. DIP14 package mechanical data

| Symbol | Dimensions  |       |       |        |       |       |
|--------|-------------|-------|-------|--------|-------|-------|
|        | Millimeters |       |       | Inches |       |       |
|        | Min.        | Typ.  | Max.  | Min.   | Typ.  | Max.  |
| A      |             |       | 5.33  |        |       | 0.21  |
| A1     | 0.38        |       |       | 0.015  |       |       |
| A2     | 2.92        | 3.30  | 4.95  | 0.11   | 0.13  | 0.19  |
| b      | 0.36        | 0.46  | 0.56  | 0.014  | 0.018 | 0.022 |
| b2     | 1.14        | 1.52  | 1.78  | 0.04   | 0.06  | 0.07  |
| c      | 0.20        | 0.25  | 0.36  | 0.007  | 0.009 | 0.01  |
| D      | 18.67       | 19.05 | 19.69 | 0.73   | 0.75  | 0.77  |
| E      | 7.62        | 7.87  | 8.26  | 0.30   | 0.31  | 0.32  |
| E1     | 6.10        | 6.35  | 7.11  | 0.24   | 0.25  | 0.28  |
| e      |             | 2.54  |       |        | 0.10  |       |
| e1     |             | 15.24 |       |        | 0.60  |       |
| eA     |             | 7.62  |       |        | 0.30  |       |
| eB     |             |       | 10.92 |        |       | 0.43  |
| L      | 2.92        | 3.30  | 3.81  | 0.11   | 0.13  | 0.15  |

### 3.6 SO-14 package information

Figure 16. SO-14 package outline

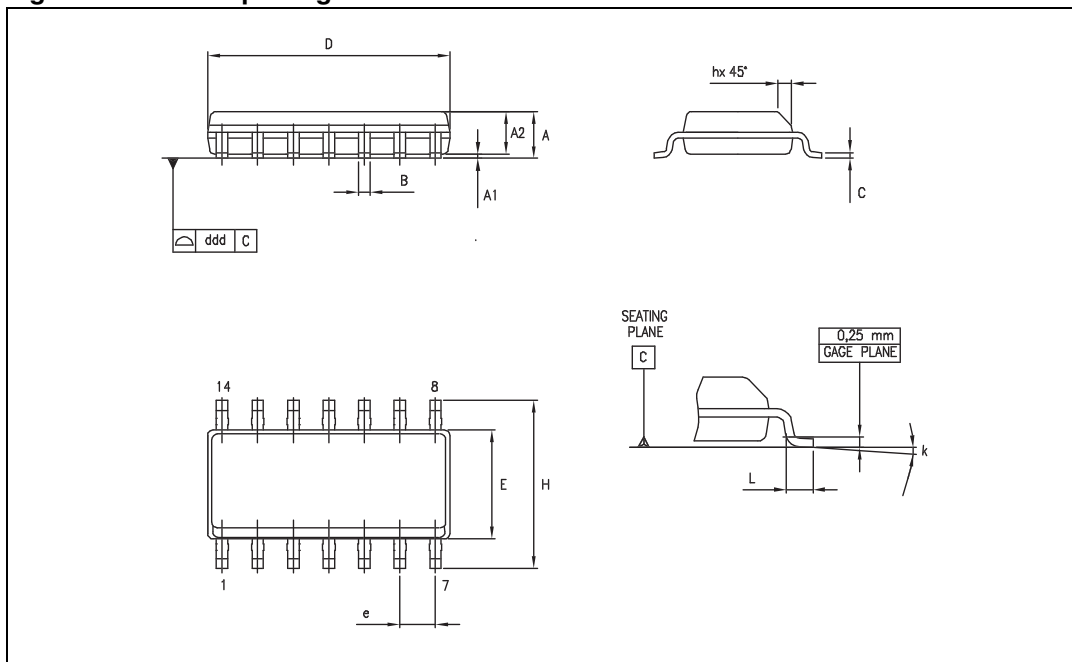


Table 10. SO-14 package mechanical data

| Symbol | Dimensions  |      |      |        |      |       |
|--------|-------------|------|------|--------|------|-------|
|        | Millimeters |      |      | Inches |      |       |
|        | Min.        | Typ. | Max. | Min.   | Typ. | Max.  |
| A      | 1.35        |      | 1.75 | 0.05   |      | 0.068 |
| A1     | 0.10        |      | 0.25 | 0.004  |      | 0.009 |
| A2     | 1.10        |      | 1.65 | 0.04   |      | 0.06  |
| B      | 0.33        |      | 0.51 | 0.01   |      | 0.02  |
| C      | 0.19        |      | 0.25 | 0.007  |      | 0.009 |
| D      | 8.55        |      | 8.75 | 0.33   |      | 0.34  |
| E      | 3.80        |      | 4.0  | 0.15   |      | 0.15  |
| e      |             | 1.27 |      |        | 0.05 |       |
| H      | 5.80        |      | 6.20 | 0.22   |      | 0.24  |
| h      | 0.25        |      | 0.50 | 0.009  |      | 0.02  |
| L      | 0.40        |      | 1.27 | 0.015  |      | 0.05  |
| k      | 8° (max.)   |      |      |        |      |       |
| ddd    |             |      | 0.10 |        |      | 0.004 |

### 3.7 TSSOP14 package information

Figure 17. TSSOP14 package outline

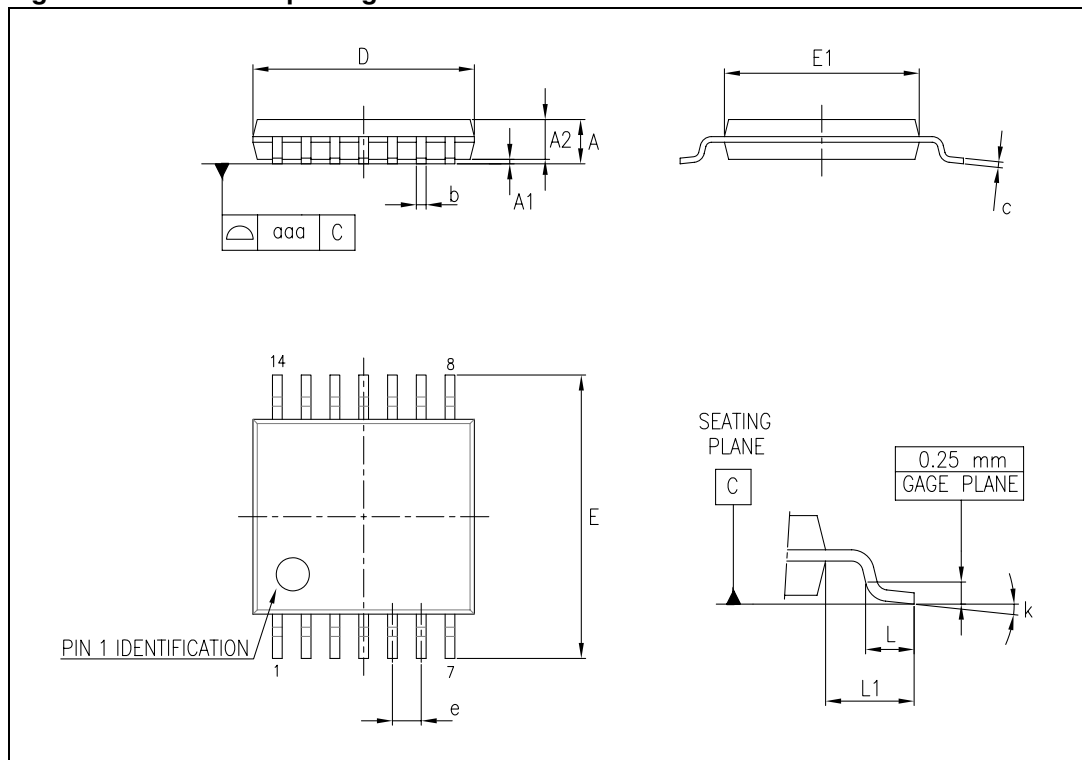


Table 11. TSSOP14 package mechanical data

| Symbol | Dimensions  |      |      |        |        |        |
|--------|-------------|------|------|--------|--------|--------|
|        | Millimeters |      |      | Inches |        |        |
|        | Min.        | Typ. | Max. | Min.   | Typ.   | Max.   |
| A      |             |      | 1.20 |        |        | 0.047  |
| A1     | 0.05        |      | 0.15 | 0.002  | 0.004  | 0.006  |
| A2     | 0.80        | 1.00 | 1.05 | 0.031  | 0.039  | 0.041  |
| b      | 0.19        |      | 0.30 | 0.007  |        | 0.012  |
| c      | 0.09        |      | 0.20 | 0.004  |        | 0.0089 |
| D      | 4.90        | 5.00 | 5.10 | 0.193  | 0.197  | 0.201  |
| E      | 6.20        | 6.40 | 6.60 | 0.244  | 0.252  | 0.260  |
| E1     | 4.30        | 4.40 | 4.50 | 0.169  | 0.173  | 0.176  |
| e      |             | 0.65 |      |        | 0.0256 |        |
| L      | 0.45        | 0.60 | 0.75 | 0.018  | 0.024  | 0.030  |
| L1     |             | 1.00 |      |        | 0.039  |        |
| k      | 0°          |      | 8°   | 0°     |        | 8°     |
| aaa    |             |      | 0.10 |        |        | 0.004  |

## 4 Ordering information

Table 12. Order codes

| Order code               | Temperature range | Package                        | Packaging                | Marking |
|--------------------------|-------------------|--------------------------------|--------------------------|---------|
| TS951ID<br>TS951IDT      | -40 °C to +125 °C | SO-8                           | Tube or<br>tape and reel | 951I    |
| TS951ILT                 |                   | SOT23-5L                       | Tape and reel            | K101    |
| TS951IYLT <sup>(1)</sup> |                   | SOT23-5L<br>(automotive grade) |                          | K1A2    |
| TS952IN                  |                   | DIP8                           | Tube                     | TS952IN |
| TS952ID<br>TS952IDT      |                   | SO-8                           | Tube or<br>tape and reel | 952I    |
| TS952IYDT <sup>(1)</sup> |                   | SO-8<br>(automotive grade)     |                          | 952IY   |
| TS952IPT                 |                   | TSSOP8                         | Tape and reel            | 952I    |
| TS952IYPT <sup>(1)</sup> |                   | TSSOP8<br>(automotive grade)   |                          | 952Y    |
| TS954IN                  |                   | DIP14                          | Tube                     | TS954IN |
| TS954ID<br>TS954IDT      |                   | SO-14                          | Tube or<br>tape and reel | 954I    |
| TS954IYDT <sup>(1)</sup> |                   | SO-14<br>(automotive grade)    |                          | 954IY   |
| TS954IPT                 |                   | TSSOP14                        | Tape and reel            | 954I    |
| TS954IYPT <sup>(1)</sup> |                   | TSSOP14<br>(automotive grade)  |                          | 954Y    |

1. Qualified and characterized according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 and Q 002 or equivalent.

## 5 Revision history

**Table 13. Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
|-------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 01-May-2001 | 1        | Initial release.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
| 02-Jan-2005 | 2        | Modifications on AMR <a href="#">Table 1 on page 2</a> (explanation of $V_{id}$ and $V_i$ limits, ESD MM and CDM values added, $R_{thja}$ added).                                                                                                                                                                                                                                                                                                                                                   |
| 03-Jul-2005 | 3        | PPAP references inserted in the datasheet see <a href="#">Table 12: Order codes</a> .                                                                                                                                                                                                                                                                                                                                                                                                               |
| 04-Aug-2005 | 4        | Table data was badly formatted, see <a href="#">Table 4 on page 5</a> .                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 15-Dec-2005 | 5        | TS951IYLT PPAP reference added, see <a href="#">Table 12: Order codes</a> .                                                                                                                                                                                                                                                                                                                                                                                                                         |
| 10-Dec-2007 | 6        | Added missing order codes, and automotive grade status in <a href="#">Table 12: Order codes</a> .<br>Updated footnotes for ESD parameters in <a href="#">Table 1: Absolute maximum ratings</a> .<br>Reformatted package information.                                                                                                                                                                                                                                                                |
| 10-Mar-2009 | 7        | Removed TS951IN and TS951IYD/DT from <a href="#">Table 12: Order codes</a> .                                                                                                                                                                                                                                                                                                                                                                                                                        |
| 24-Feb-2011 | 8        | Changed TS951IYLT marking and updated automotive grade status in <a href="#">Table 12: Order codes</a> .                                                                                                                                                                                                                                                                                                                                                                                            |
| 21-Nov-2012 | 9        | Updated <a href="#">Features</a> (added DIP8, SO-8, TSSOP8, DIP14, SO-14, and TSSOP14 package).<br>Updated <a href="#">Table 1</a> (added values of DIP8 and DIP14 packages for $R_{thja}$ and $R_{thjc}$ symbols).<br>Updated title of <a href="#">Figure 7</a> and <a href="#">Figure 9</a> (added conditions).<br>Updated <a href="#">Table 12</a> (removed TS952IYD and TS954IYD order code, qualified status of TS954IYPT and TS952IYPT order code).<br>Minor corrections throughout document. |

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