# TSV611, TSV611A, TSV612, TSV612A

## Rail-to-rail input/output 10 µA, 120 kHz CMOS operational amplifiers

## Features

- Rail-to-rail input and output
- Low power consumption: 10 µA typ at 5 V
- Low supply voltage: 1.5 to 5.5 V
- Gain bandwidth product: 120 kHz typ
- Unity gain stable
- Low input offset voltage: 800 µV max (A version)
- Low input bias current: 1 pA typ
- Temperature range: -40 to +85° C

## Applications

- Battery-powered applications
- Smoke detectors
- Proximity sensors
- Portable devices
- Signal conditioning
- Active filtering
- Medical instrumentation

## Description

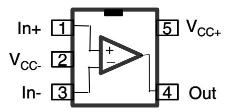
The TSV61x family of single and dual operational amplifiers offers low voltage, low power operation and rail-to-rail input and output.

The devices also feature an ultra-low input bias current as well as a low input offset voltage.

The TSV61x have a gain bandwidth product of 120 kHz while consuming only 10 µA at 5 V.

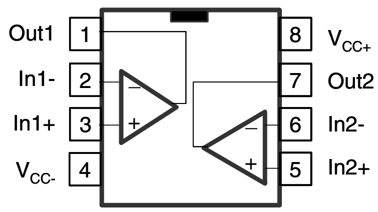
These features make the TSV61x family ideal for sensor interfaces, battery supplied and portable applications, as well as active filtering.

**TSV611ILT - TSV611ICT**




**SOT23-5/SC70-5**

**TSV612IST - TSV612ID/DT**




**MiniSO-8/SO-8**

# 1 Absolute maximum ratings and operating conditions

**Table 1. Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{CC}$ | Supply voltage(1) | 6 | V |
| $V_{id}$ | Differential input voltage (2) | $\pm V_{CC}$ | V |
| $V_{in}$ | Input voltage (3) | $V_{CC-}$ -0.2 to $V_{CC+}$+0.2 | V |
| $T_{stg}$ | Storage temperature | -65 to +150 | °C |
| $R_{thja}$ | Thermal resistance junction to ambient(4)(5) | | °C/W |
| | SC70-5 | 205 | |
| | SOT23-5 | 250 | |
| | MiniSO-8 | 190 | |
| | SO-8 | 125 | |
| $T_j$ | Maximum junction temperature | 150 | °C |
| ESD | HBM: human body model(6) | 4 | kV |
| | MM: machine model(7) | 200 | V |
| | CDM: charged device model(8) | 1.5 | kV |
| | Latch-up immunity | 200 | mA |

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.
3. Vcc-Vin must not exceed 6 V.
4. Short-circuits can cause excessive heating and destructive dissipation.
5. Rth are typical values.
6. Human body model: 100 pF discharged through a 1.5 kΩ resistor between two pins of the device, done for all couples of pin combinations with other pins floating.
7. Machine model: a 200 pF cap is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5 Ω), done for all couples of pin combinations with other pins floating.
8. Charged device model: all pins plus package are charged together to the specified voltage and then discharged directly to ground.

**Table 2. Operating conditions**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{CC}$ | Supply voltage | 1.5 to 5.5 | V |
| $V_{icm}$ | Common mode input voltage range | $V_{CC-}$ -0.1 to $V_{CC+}$ +0.1 | V |
| $T_{oper}$ | Operating free air temperature range | -40 to +85 | °C |

# 2 Electrical characteristics

Table 3. Electrical characteristics at $V_{CC+}$ = +1.8 V with $V_{CC-}$ = 0 V, $V_{icm}$ = $V_{CC}/2$, $T_{amb}$ = 25° C, and $R_L$ connected to $V_{CC}/2$ (unless otherwise specified)

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC performance** | | | | | | |
| $V_{io}$ | Offset voltage | TSV61x<br>TSV61xA | | | 4<br>0.8 | mV |
| | | $T_{min.} < T_{op} < T_{max.}$ TSV61x<br>$T_{min.} < T_{op} < T_{max}$TSV61xA | | | 5<br>2 | |
| $DV_{io}$ | Input offset voltage drift | | | 2 | | µV/°C |
| $I_{io}$ | Input offset current ($V_{out} = V_{cc}/2$) | | | 1 | 10(1) | pA |
| | | $T_{min.} < T_{op} < T_{max.}$ | | 1 | 100 | pA |
| $I_{ib}$ | Input bias current ($V_{out} = V_{cc}/2$) | | | 1 | 10(1) | pA |
| | | $T_{min.} < T_{op} < T_{max.}$ | | 1 | 100 | pA |
| CMR | Common mode rejection ratio 20 log ($\Delta V_{ic}/\Delta V_{io}$) | 0 V to 1.8 V, $V_{out}$ = 0.9 V | 55 | 71 | | dB |
| | | $T_{min.} < T_{op} < T_{max.}$ | 53 | | | dB |
| $A_{vd}$ | Large signal voltage gain | $R_L$ = 10 kΩ, Vout = 0.5 V to 1.3 V | 78 | 83 | | dB |
| | | $T_{min.} < T_{op} < T_{max.}$ | 74 | | | dB |
| $V_{OH}$ | High level output voltage | $R_L$ = 10 kΩ<br>$T_{min.} < T_{op} < T_{max.}$ | 35<br>50 | 4 | | mV |
| $V_{OL}$ | Low level output voltage | $R_L$ = 10 kΩ<br>$T_{min.} < T_{op} < T_{max.}$ | | 7 | 35<br>50 | mV |
| $I_{out}$ | Isink | $V_o$ = 1.8 V<br>$T_{min.} < T_{op} < T_{max.}$ | 9<br>9 | 13 | | mA |
| | Isource | $V_o$ = 0 V<br>$T_{min.} < T_{op} < T_{max.}$ | 8<br>8 | 10 | | |
| $I_{CC}$ | Supply current (per operator) | No load, $V_{out} = V_{cc}/2$ | 6.5 | 9 | 12 | µA |
| | | $T_{min.} < T_{op} < T_{max.}$ | 6 | | 12.5 | µA |
| **AC performance** | | | | | | |
| GBP | Gain bandwidth product | $R_L$ = 10 kΩ, $C_L$ = 20 pF | | 100 | | kHz |
| ϕm | Phase margin | $R_L$ = 10 kΩ, $C_L$ = 20 pF | | 60 | | Degrees |
| $G_m$ | Gain margin | $R_L$ = 10 kΩ, $C_L$ = 20 pF | | 9.5 | | dB |
| SR | Slew rate | $R_L$ = 10 kΩ, $C_L$ = 20 pF, $V_{out}$ = 0.5V to 1.3V | | 0.03 | | V/µs |

Table 3. Electrical characteristics at $V_{CC+}$ = +1.8 V with $V_{CC-}$ = 0 V, $V_{icm} = V_{CC}/2$, $T_{amb}$ = 25° C, and $R_L$ connected to $V_{CC}/2$ (unless otherwise specified) (continued)

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $e_n$ | Equivalent input noise voltage | f = 1 kHz | | 110 | | $\frac{nV}{\sqrt{Hz}}$ |
| THD+N | Total harmonic distortion + noise | $F_{in}$ = 1 kHz, Av = 1,<br>$V_{out}$ = 1 $V_{pp}$, $R_L$ = 100 kΩ,<br>BW = 22 kHz | | 0.07 | | % |

1. Guaranteed by design.

Table 4. $V_{CC+}$ = +3.3 V, $V_{CC-}$ = 0 V, $V_{icm}$ = $V_{CC}/2$, $T_{amb}$ = 25° C, $R_L$ connected to $V_{CC}/2$ (unless otherwise specified)

| Symbol | Parameter | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC performance** | | | | | | |
| $V_{io}$ | Offset voltage | TSV61x<br>TSV61xA | | | 4<br>0.8 | mV |
| | | $T_{min}<T_{op}<T_{max}$ TSV61x<br>$T_{min}<T_{op}<T_{max}$ TSV61xA | | | 5<br>2 | |
| $DV_{io}$ | Input offset voltage drift | | | 2 | | µV/°C |
| $I_{io}$ | Input offset current | | | 1 | 10[1] | pA |
| | | $T_{min.} < T_{op} < T_{max.}$ | | 1 | 100 | pA |
| $I_{ib}$ | Input bias current | | | 1 | 10[1] | pA |
| | | $T_{min.} < T_{op} < T_{max.}$ | | 1 | 100 | pA |
| CMR | Common mode rejection ratio 20 log ($\Delta V_{ic}/\Delta V_{io}$) | 0 V to 3.3 V, $V_{out}$ = 1.75 V | 61 | 76 | | dB |
| | | $T_{min.} < T_{op} < T_{max.}$ | 58 | | | dB |
| $A_{vd}$ | Large signal voltage gain | $R_L$ = 10 kΩ, Vout = 0.5 V to 2.8 V | 85 | 92 | | dB |
| | | $T_{min.} < T_{op} < T_{max.}$ | 83 | | | dB |
| $V_{OH}$ | High level output voltage | $R_L$ = 10 kΩ<br>$T_{min.} < T_{op} < T_{max.}$ | 35<br>50 | 5 | | mV |
| $V_{OL}$ | Low level output voltage | $R_L$ = 10 kΩ<br>$T_{min.} < T_{op} < T_{max.}$ | | 10 | 35<br>50 | mV |
| $I_{out}$ | Isink | $V_o = V_{CC}$<br>$T_{min.} < T_{op} < T_{max.}$ | 37<br>35 | 44 | | mA |
| | Isource | $V_o$ = 0 V<br>$T_{min.} < T_{op} < T_{max.}$ | 32<br>30 | 38 | | |
| $I_{CC}$ | Supply current (per operator) | No load, $V_{out} = V_{CC}/2$ | 6.5 | 9.5 | 12.5 | µA |
| | | $T_{min.} < T_{op} < T_{max.}$ | 6 | | 13 | µA |
| **AC performance** | | | | | | |
| GBP | Gain bandwidth product | $R_L$ = 10 kΩ, $C_L$ = 20 pF | | 110 | | kHz |
| ϕm | Phase margin | $R_L$ = 10 kΩ, $C_L$ = 20 pF | | 60 | | Degrees |
| $G_m$ | Gain margin | $R_L$ = 10 kΩ, $C_L$ = 20 pF, | | 9.5 | | dB |
| SR | Slew rate | $R_L$ = 10 kΩ, $C_L$ = 20 pF, $V_{out}$ = 0.5V to 2.8V | | 0.035 | | V/µs |
| $e_n$ | Equivalent input noise voltage | f = 1 kHz | | 110 | | $\frac{nV}{\sqrt{Hz}}$ |

1. Guaranteed by design.

Table 5. $V_{CC+}$ = +5 V, $V_{CC-}$ = 0 V, $V_{icm}$ = $V_{CC}/2$, $T_{amb}$ = 25° C, $R_L$ connected to $V_{CC}/2$ (unless otherwise specified)

| Symbol | Parameter | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC performance** | | | | | | |
| $V_{io}$ | Offset voltage | TSV61x<br>TSV61xA | | | 4<br>0.8 | mV |
| | | $T_{min}<T_{op}<T_{max}$ TSV61x<br>$T_{min}<T_{op}<T_{max}$ TSV61xA | | | 5<br>2 | |
| $DV_{io}$ | Input offset voltage drift | | | 2 | | µV/°C |
| $I_{io}$ | Input offset current | | | 1 | 10(1) | pA |
| | | $T_{min.} < T_{op} < T_{max.}$ | | 1 | 100 | pA |
| $I_{ib}$ | Input bias current | | | 1 | 10(1) | pA |
| | | $T_{min.} < T_{op} < T_{max.}$ | | 1 | 100 | pA |
| CMR | Common mode rejection ratio 20 log ($\Delta V_{ic}/\Delta V_{io}$) | 0 V to 5 V, $V_{out}$ = 2.5 V | 64 | 80 | | dB |
| | | $T_{min.} < T_{op} < T_{max.}$ | 63 | | | dB |
| SVR | Supply voltage rejection ratio 20 log ($\Delta V_{cc}/\Delta V_{io}$) | Vcc = 1.8 to 5 V | 76 | 93 | | dB |
| | | $T_{min.} < T_{op} < T_{max.}$ | 74 | | | dB |
| $A_{vd}$ | Large signal voltage gain | $R_L$ = 10 kΩ, Vout = 0.5 V to 4.5 V | 88 | 93 | | dB |
| | | $T_{min}<T_{op}<T_{max}$ | 85 | | | dB |
| $V_{OH}$ | High level output voltage | $R_L$ = 10 kΩ<br>$T_{min.} < T_{op} < T_{max.}$ | 35<br>50 | 7 | | mV |
| $V_{OL}$ | Low level output voltage | $R_L$ = 10 kΩ<br>$T_{min.} < T_{op} < T_{max.}$ | | 16 | 35<br>50 | mV |
| $I_{out}$ | Isink | $V_o = V_{CC}$<br>$T_{min.} < T_{op} < T_{max.}$ | 52<br>42 | 57 | | mA |
| | Isource | $V_o$ = 0 V<br>$T_{min.} < T_{op} < T_{max.}$ | 58<br>49 | 63 | | |
| $I_{CC}$ | Supply current (per operator) | No load, $V_{out} = V_{CC}/2$ | 7.5 | 10.5 | 14 | µA |
| | | $T_{min.} < T_{op} < T_{max.}$ | 7 | | 15 | µA |
| **AC performance** | | | | | | |
| GBP | Gain bandwidth product | $R_L$ = 10 kΩ, $C_L$ = 20 pF | | 120 | | kHz |
| ϕm | Phase margin | $R_L$ = 10 kΩ, $C_L$ = 20 pF | | 62 | | Degrees |
| $G_m$ | Gain margin | $R_L$ = 10 kΩ, $C_L$ = 20 pF | | 10 | | dB |
| SR | Slew rate | $R_L$ = 10 kΩ, $C_L$ = 20 pF,<br>$V_{out}$ = 0.5V to 4.5V | | 0.04 | | V/µs |

Table 5. $V_{CC+}$ = +5 V, $V_{CC-}$ = 0 V, $V_{icm}$ = $V_{CC}/2$, $T_{amb}$ = 25° C, $R_L$ connected to $V_{CC}/2$ (unless otherwise specified) (continued)

| Symbol | Parameter | | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $e_n$ | Equivalent input noise voltage | f = 1 kHz | | 105 | | $\frac{nV}{\sqrt{Hz}}$ |
| THD+N | Total harmonic distortion + noise | $F_{in}$ = 1 kHz, Av = 1, $V_{out}$ = 1 $V_{pp}$, $R_L$ = 100 kΩ, BW = 22kHz | | 0.02 | | % |

1. Guaranteed by design.

Figure 1. Supply current vs. supply voltage at $V_{icm} = V_{CC}/2$

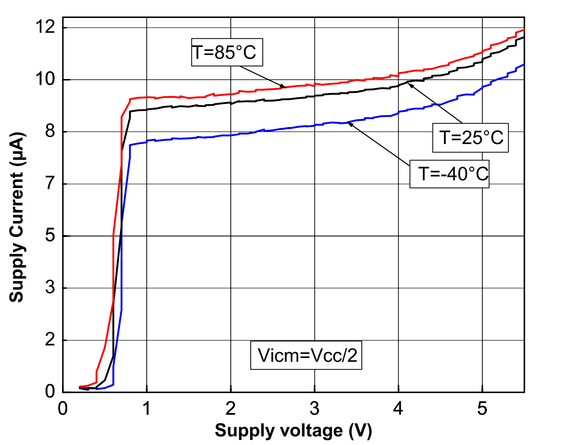



Figure 2. Output current vs. output voltage at $V_{CC}$ = 1.5 V

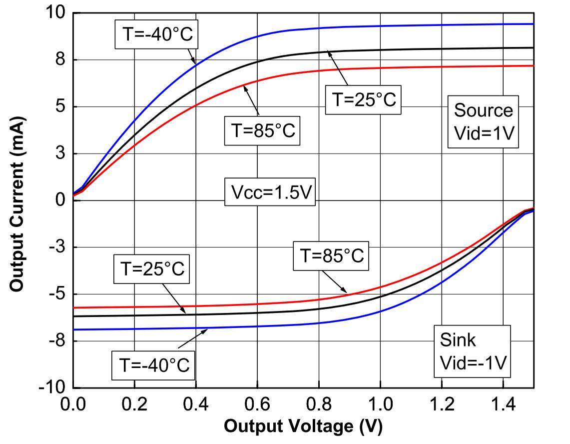



Figure 3. Output current vs. output voltage at $V_{CC}$ = 5 V

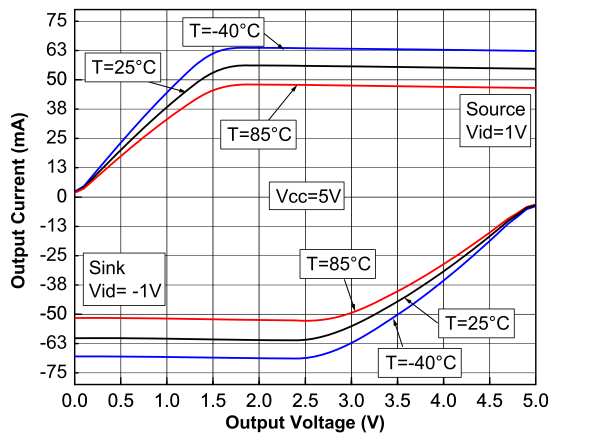



Figure 4. Voltage gain and phase vs. frequency at $V_{CC}$ = 1.5 V

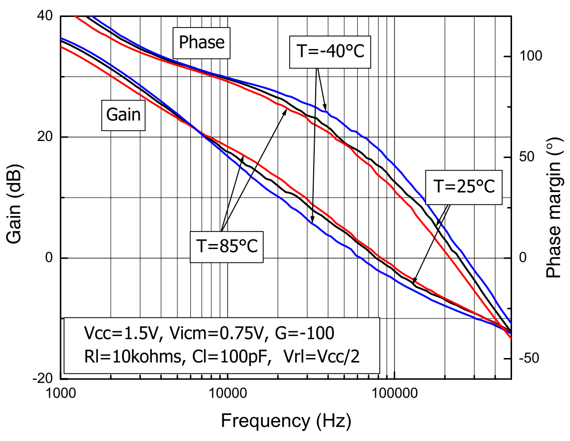


**Figure 5. Voltage gain and phase vs. frequency at $V_{CC}$ = 5 V**

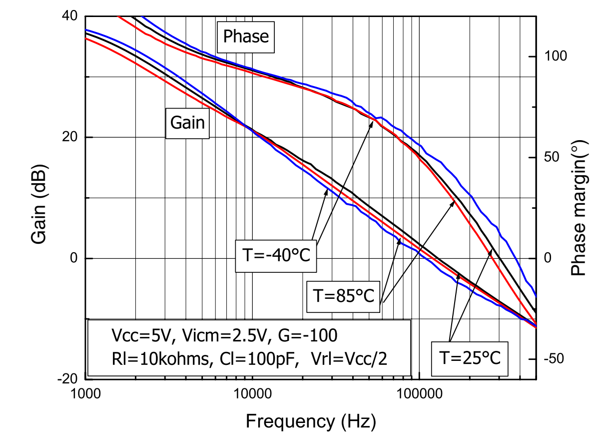



**Figure 6. Phase margin vs. output current**

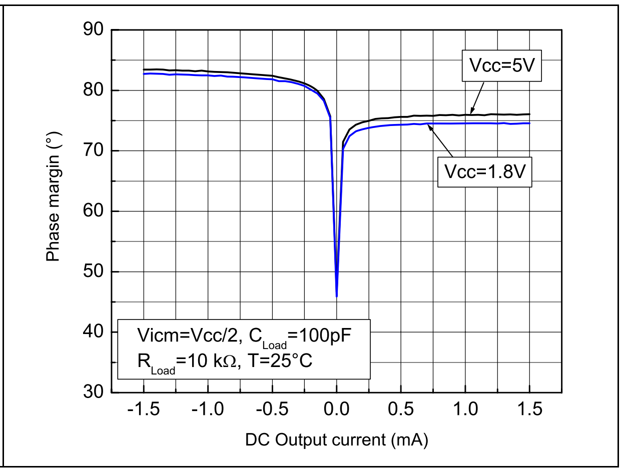



**Figure 7. Positive slew rate vs. time, $V_{CC}$ = 1.5 V, $C_{Load}$ = 100 pF, $R_{Load}$ = 10 kΩ**

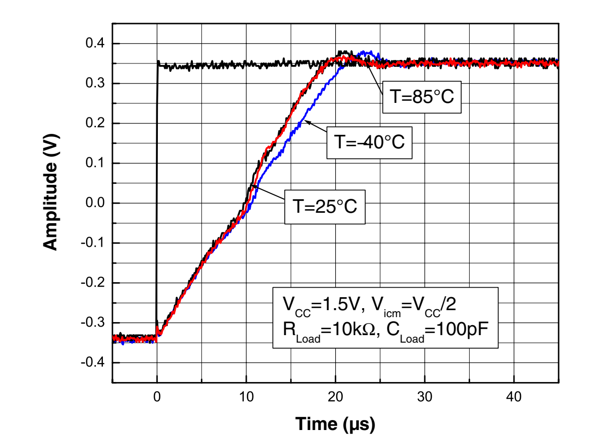



**Figure 8. Negative slew rate vs. time, $V_{CC}$ = 1.5 V, $C_{Load}$ = 100 pF, $R_{Load}$ = 10 kΩ**

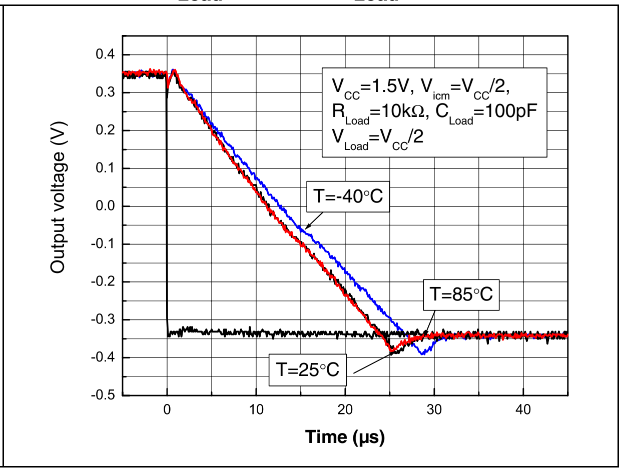



**Figure 9. Positive slew rate vs. time, $V_{CC}$ = 5.5 V, $C_{Load}$ = 100 pF, $R_{Load}$ = 100 kΩ**

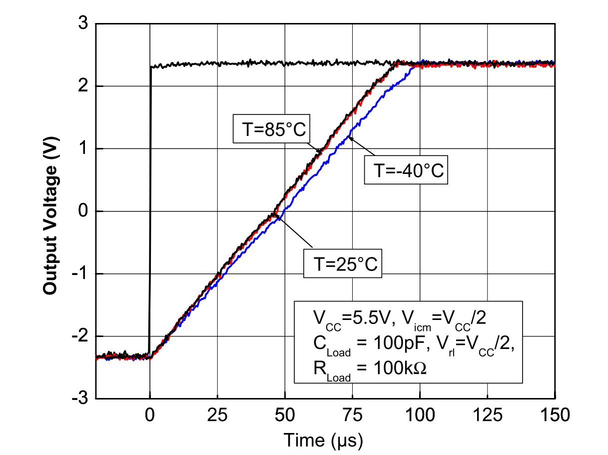



**Figure 10. Negative slew rate vs. time, $V_{CC}$ = 5.5 V, $C_{Load}$ = 100 pF, $R_{Load}$ = 100 kΩ**

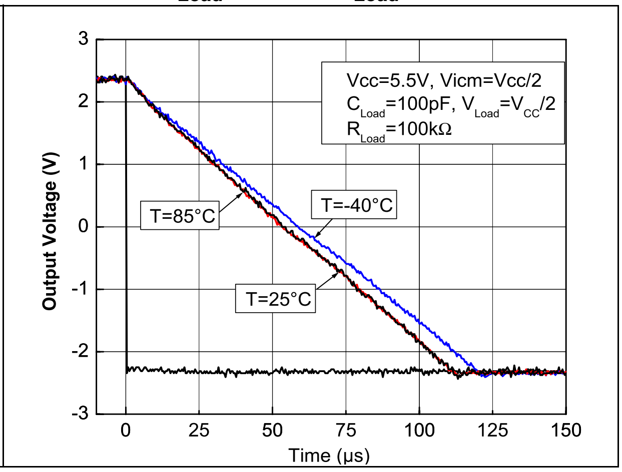


**Figure 11. Slew rate vs. supply voltage**

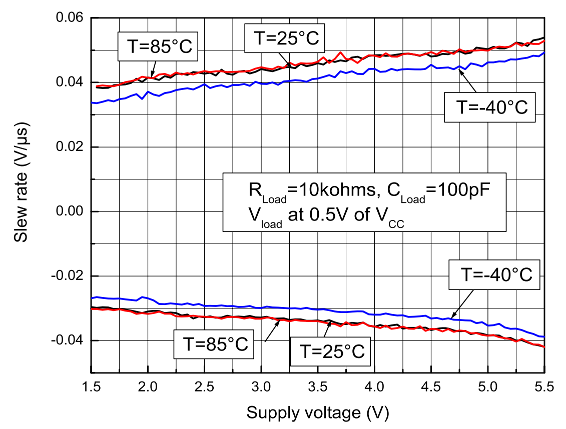



**Figure 12. Noise vs. frequency at Vcc = 5 V**

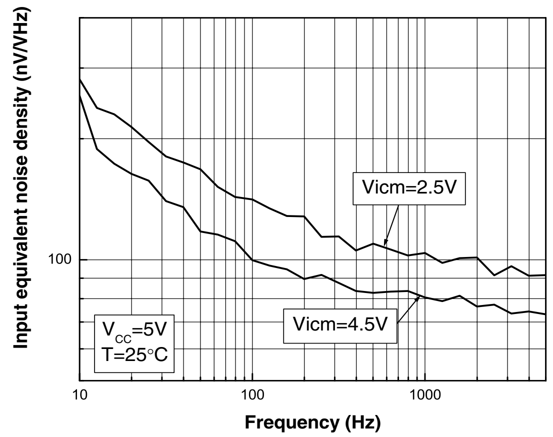



**Figure 13. Distortion + noise vs. frequency**

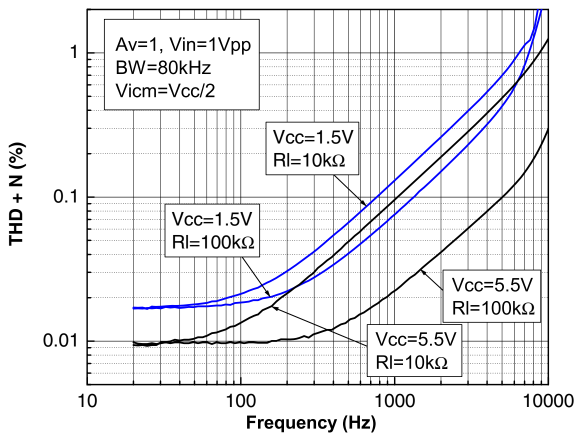



**Figure 14. Distortion + noise vs. output voltage**

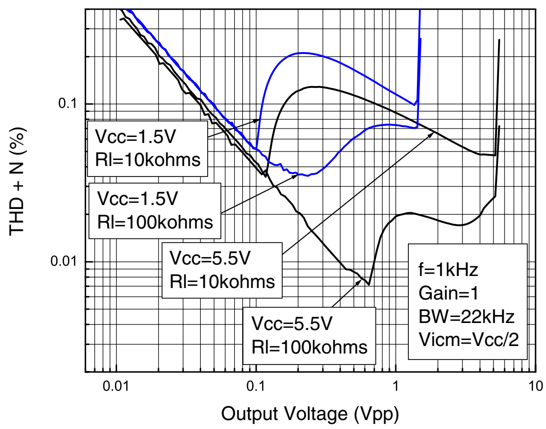



**Figure 15. Voltage gain and phase vs. frequency at $V_{CC}$ = 1.8 V (based on simulation results)**

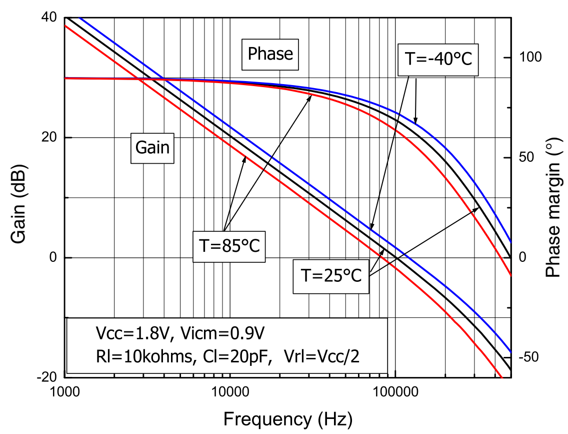
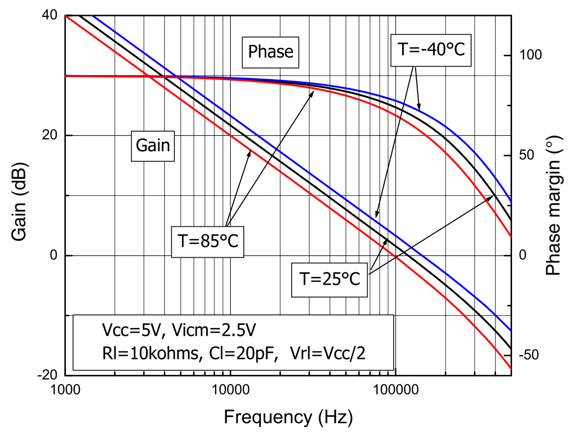



**Figure 16. Voltage gain and phase vs. frequency at $V_{CC}$ = 5 V (based on simulation results)**



# 3 Application information

## 3.1 Operating voltages

The TSV61x can operate from 1.5 to 5.5 V. Their parameters are fully specified for 1.8, 3.3 and 5 V power supplies. However, the parameters are very stable in the full $V_{CC}$ range and several characterization curves show the TSV61x characteristics at 1.5 V. Additionally, the main specifications are guaranteed in extended temperature ranges from -40° C to +85° C.

## 3.2 Rail-to-rail input

The TSV61x are built with two complementary PMOS and NMOS input differential pairs. The devices have a rail-to-rail input, and the input common mode range is extended from $V_{CC-}$ -0.1 V to $V_{CC+}$ +0.1 V. The transition between the two pairs appears at $V_{CC+}$ -0.7 V. In the transition region, the performance of CMRR, PSRR, $V_{io}$ and THD is slightly degraded (as shown in *Figure 17* and *Figure 18* for $V_{io}$ vs. $V_{icm}$).

**Figure 17. Input offset voltage vs input common mode at $V_{CC}$ = 1.5 V**

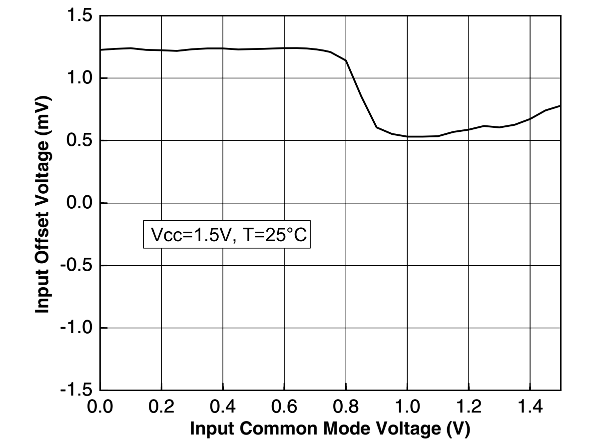
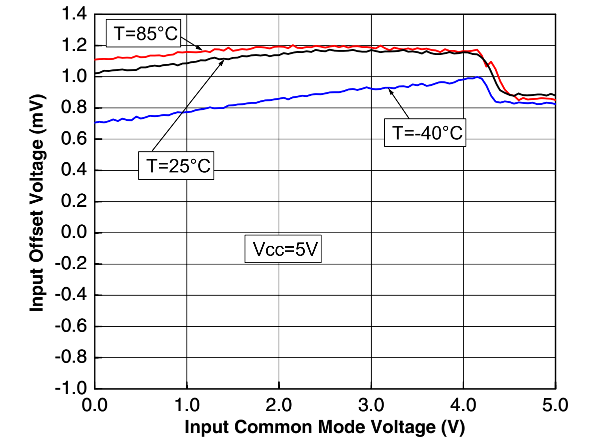



**Figure 18. Input offset voltage vs input common mode at $V_{CC}$ = 5 V**




The device is guaranteed without phase reversal.

## 3.3 Rail-to-rail output

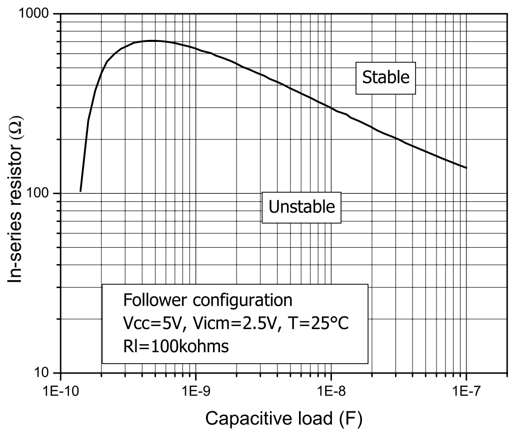
The operational amplifiers' output levels can go close to the rails: less than 35 mV above GND rail and less than 35 mV below $V_{CC}$ rail when connected to 10 kΩ load to $V_{CC}/2$.

## 3.4 Driving resistive and capacitive loads

These products are micro-power, low-voltage operational amplifiers optimized to drive rather large resistive loads, above 10 kΩ For lower resistive loads, the THD level may significantly increase.

In a follower configuration, these operational amplifiers can drive capacitive loads up to 100 pF with no oscillations. When driving larger capacitive loads, adding an in-series resistor at the output can improve the stability of the devices (see *Figure 19* for recommended in-series resistor values). Once the in-series resistor value has been selected, the stability of the circuit should be tested on bench and simulated with the simulation model.

**Figure 19. In-series resistor vs. capacitive load**




## 3.5 PCB layouts

For correct operation, it is advised to add 10 nF decoupling capacitors as close as possible to the power supply pins.

## 3.6 Macromodel

An accurate macromodel of the TSV61x is available on STMicroelectronics' web site at www.st.com. This model is a trade-off between accuracy and complexity (that is, time simulation) of the TSV61x operational amplifiers. It emulates the nominal performances of a typical device within the specified operating conditions mentioned in the datasheet. It also helps to validate a design approach and to select the right operational amplifier, *but it does not replace on-board measurements*.

# 4 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. ECOPACK® is an ST trademark.

## 4.1 SOT23-5 package information

Figure 20. SOT23-5 package mechanical drawing

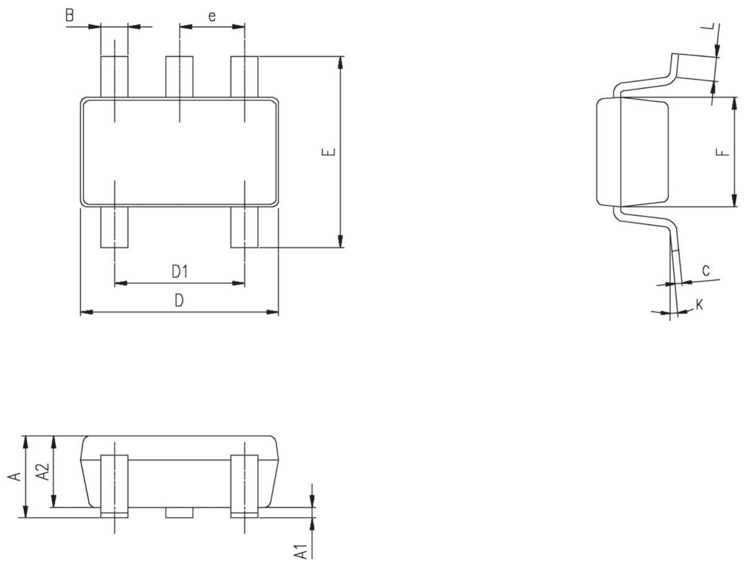



Table 6. SOT23-5 package mechanical data

| Ref. | 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 | | | |

## 4.2 SC70-5 (SOT323-5) package information

**Figure 21. SC70-5 (SOT323-5) package mechanical drawing**

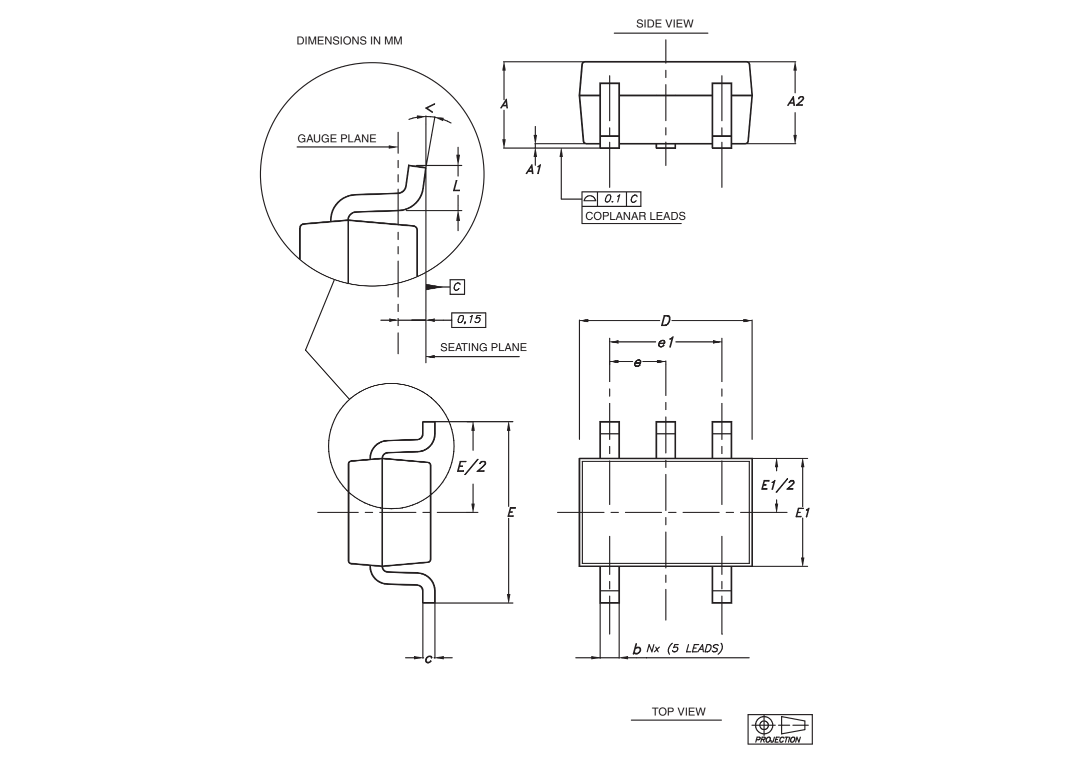



**Table 7. SC70-5 (SOT323-5) package mechanical data**

| Ref | Dimensions | | | | | |
|---|---|---|---|---|---|---|
| | Millimeters | | | Inches | | |
| | Min | Typ | Max | Min | Typ | Max |
| A | 0.80 | | 1.10 | 0.315 | | 0.043 |
| A1 | | | 0.10 | | | 0.004 |
| A2 | 0.80 | 0.90 | 1.00 | 0.315 | 0.035 | 0.039 |
| b | 0.15 | | 0.30 | 0.006 | | 0.012 |
| c | 0.10 | | 0.22 | 0.004 | | 0.009 |
| D | 1.80 | 2.00 | 2.20 | 0.071 | 0.079 | 0.087 |
| E | 1.80 | 2.10 | 2.40 | 0.071 | 0.083 | 0.094 |
| E1 | 1.15 | 1.25 | 1.35 | 0.045 | 0.049 | 0.053 |
| e | | 0.65 | | | 0.025 | |
| e1 | | 1.30 | | | 0.051 | |
| L | 0.26 | 0.36 | 0.46 | 0.010 | 0.014 | 0.018 |
| < | 0° | | 8° | | | |

## 4.3 SO-8 package information

**Figure 22. SO-8 package mechanical drawing**

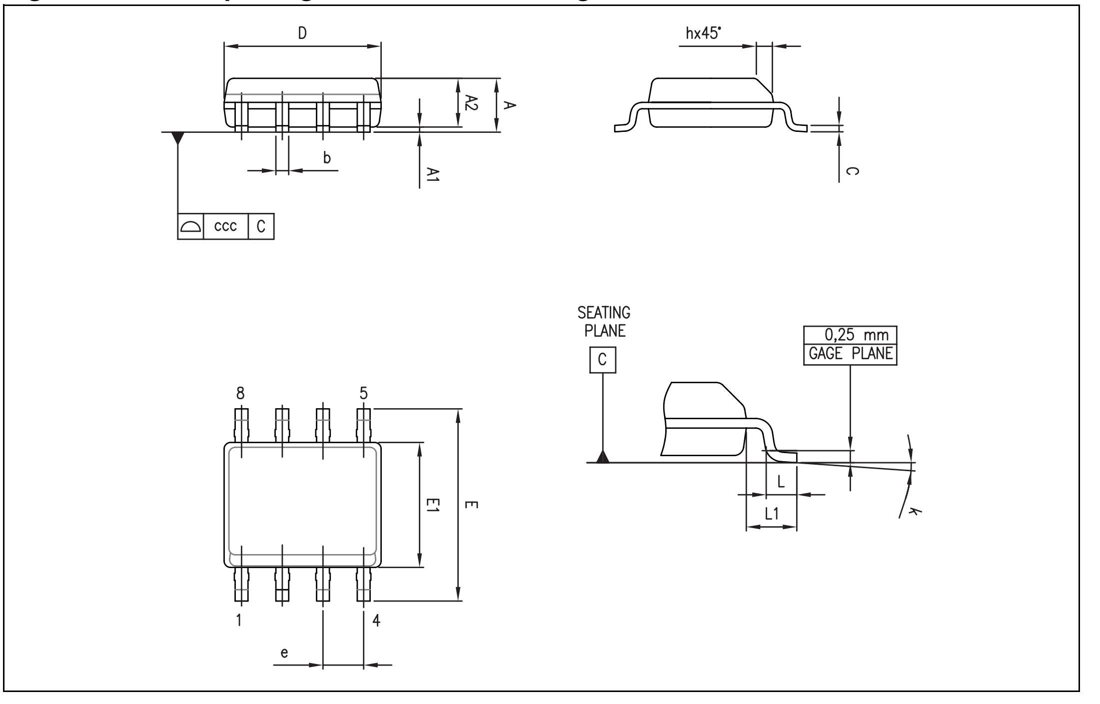



**Table 8. SO-8 package mechanical data**

| Ref. | 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 |

## 4.4 MiniSO-8 package information

**Figure 23. MiniSO-8 package mechanical drawing**

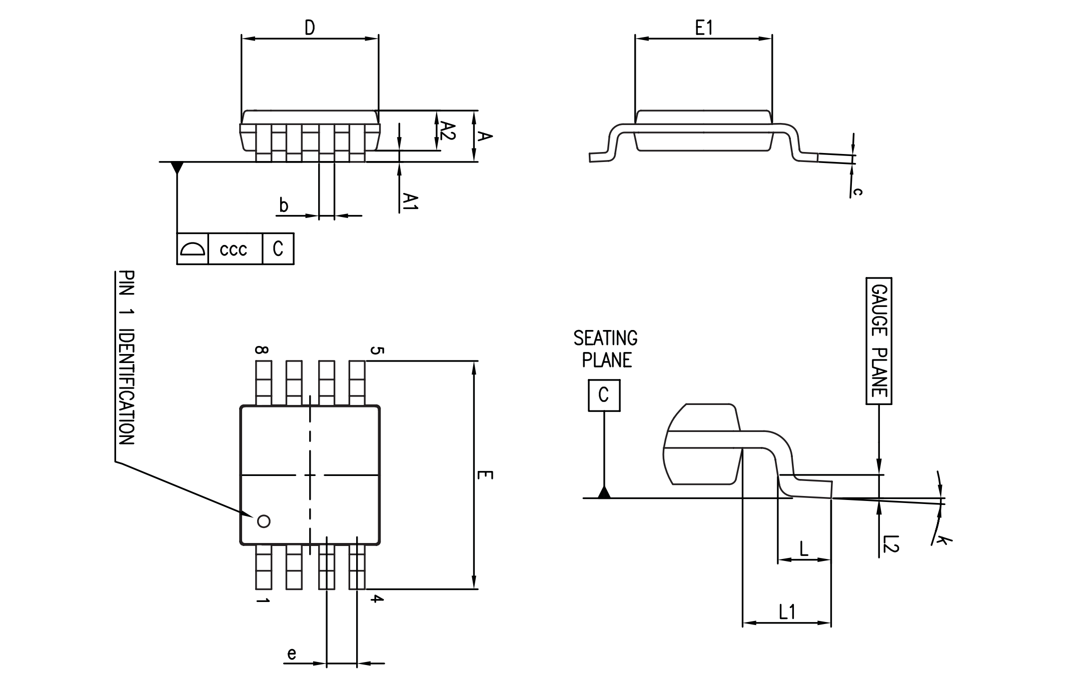



**Table 9. MiniSO-8 package mechanical data**

| Ref. | Dimensions | | | | | |
|---|---|---|---|---|---|---|
| | Millimeters | | | Inches | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 1.1 | | | 0.043 |
| A1 | 0 | | 0.15 | 0 | | 0.006 |
| A2 | 0.75 | 0.85 | 0.95 | 0.030 | 0.033 | 0.037 |
| b | 0.22 | | 0.40 | 0.009 | | 0.016 |
| c | 0.08 | | 0.23 | 0.003 | | 0.009 |
| D | 2.80 | 3.00 | 3.20 | 0.11 | 0.118 | 0.126 |
| E | 4.65 | 4.90 | 5.15 | 0.183 | 0.193 | 0.203 |
| E1 | 2.80 | 3.00 | 3.10 | 0.11 | 0.118 | 0.122 |
| e | | 0.65 | | | 0.026 | |
| L | 0.40 | 0.60 | 0.80 | 0.016 | 0.024 | 0.031 |
| L1 | | 0.95 | | | 0.037 | |
| L2 | | 0.25 | | | 0.010 | |
| k | 0° | | 8° | 0° | | 8° |
| ccc | | | 0.10 | | | 0.004 |

# 5 Ordering information

**Table 10. Order codes**

<table>
<tr><th>Order code</th><th>Temperature range</th><th>Package</th><th>Packing</th><th>Marking</th></tr>
<tr><td>TSV611ILT</td><td rowspan="8">-40° C to 85° C</td><td rowspan="2">SOT23-5</td><td rowspan="4">Tape & reel</td><td>K12</td></tr>
<tr><td>TSV611AILT</td><td>K11</td></tr>
<tr><td>TSV611ICT</td><td rowspan="2">SC70-5</td><td>K12</td></tr>
<tr><td>TSV611AICT</td><td>K11</td></tr>
<tr><td>TSV612ID/DT</td><td rowspan="2">SO-8</td><td rowspan="2">Tube & tape & reel</td><td>V612I</td></tr>
<tr><td>TSV612AID/DT</td><td>V612AI</td></tr>
<tr><td>TSV612IST</td><td rowspan="2">MiniSO-8</td><td rowspan="2">Tape & reel</td><td>K113</td></tr>
<tr><td>TSV612AIST</td><td>K115</td></tr>
</table>

# 6 Revision history

Table 11. Document revision history

| Date | Revision | Changes |
|---|---|---|
| 28-May-2009 | 1 | Initial release. |
| 18-Jan-2010 | 2 | Full datasheet for product now in production.<br>Added *Figure 1* to *Figure 19*. |