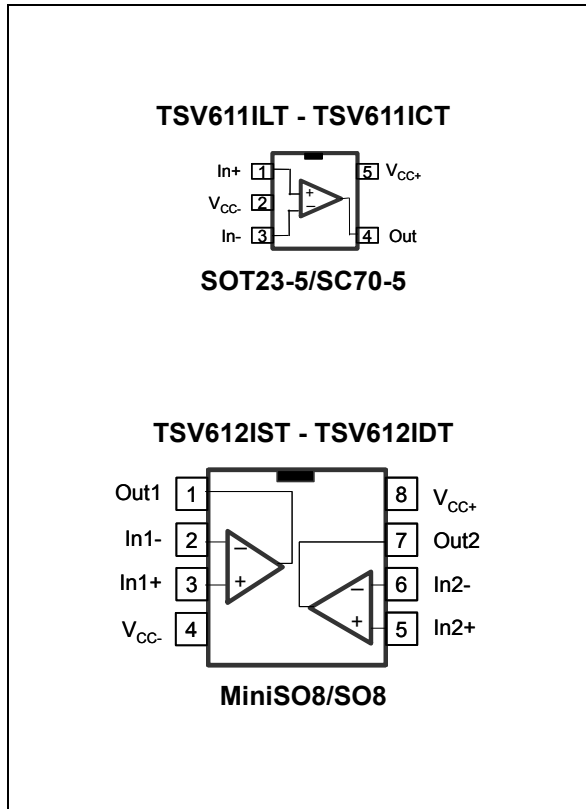


## Rail-to-rail input/output 10 $\mu$ A, 120 kHz CMOS operational amplifiers

Datasheet - production data



### 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  $\mu$ A at 5 V.

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

### Features

- Rail-to-rail input and output
- Low power consumption: 10  $\mu$ A 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  $\mu$ V max (A version)
- Low input bias current: 1 pA typ
- Temperature range: -40 to 85  $^{\circ}$ C

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# 1 Absolute maximum ratings and operating conditions

**Table 1. Absolute maximum ratings**

| Symbol     | Parameter  | Value                                  | Unit |
|------------|--|--|------|
| $V_{CC}$   | Supply voltage <sup>(1)</sup>  | 6                                      | V    |
| $V_{id}$   | Differential input voltage <sup>(2)</sup>                            | $\pm V_{CC}$                           |      |
| $V_{in}$   | Input voltage <sup>(3)</sup>   | $(V_{CC-}) - 0.2$ to $(V_{CC+}) + 0.2$ |      |
| $T_{stg}$  | Storage temperature  | -65 to 150                             | °C   |
| $R_{thja}$ | Thermal resistance junction to ambient <sup>(4)</sup> <sup>(5)</sup> |  | °C/W |
|            | SC70-5   | 205                                    |      |
|            | SOT23-5  | 250                                    |      |
|            | MiniSO8  | 190                                    |      |
|            | SO8  | 125                                    |      |
| $T_j$      | Maximum junction temperature   | 150                                    | °C   |
| ESD        | HBM: human body model <sup>(6)</sup>                                 | 4                                      | kV   |
|            | MM: machine model <sup>(7)</sup>                                     | 200                                    | V    |
|            | CDM: charged device model <sup>(8)</sup>                             | 1.5                                    | kV   |
|            | Latch-up immunity  | 200                                    | mA   |

- All voltage values, except differential voltage are with respect to network ground terminal.
- Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.
- $V_{CC}$ - $V_{in}$  must not exceed 6 V.
- Short-circuits can cause excessive heating and destructive dissipation.
- $R_{th}$  are typical values.
- Human body model: 100 pF discharged through a 1.5 k $\Omega$  resistor between two pins of the device, done for all couples of pin combinations with other pins floating.
- 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  $\Omega$ ), done for all couples of pin combinations with other pins floating.
- 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 $(V_{CC+}) + 0.1$ |      |
| $T_{oper}$ | Operating free air temperature range | -40 to 85                              | °C   |

## 2 Electrical characteristics

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

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

**Table 3. Electrical characteristics at  $V_{CC+} = 1.8\text{ V}$  with  $V_{CC-} = 0\text{ V}$ ,  $V_{icm} = V_{CC}/2$ ,  $T_{amb} = 25\text{ °C}$ , 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    | $f = 1\text{ kHz}$  |      | 110  |      | $\frac{nV}{\sqrt{Hz}}$ |
| THD+N  | Total harmonic distortion + noise | $F_{in} = 1\text{ kHz}$ , $A_v = 1$ ,<br>$V_{out} = 1\text{ V}_{pp}$ , $R_L = 100\text{ k}\Omega$ ,<br>$BW = 22\text{ kHz}$ |      | 0.07 |      | %                      |

1. Guaranteed by design.

**Table 4. Electrical characteristics at  $V_{CC+} = 3.3\text{ V}$ ,  $V_{CC-} = 0\text{ V}$ ,  $V_{icm} = V_{CC}/2$ ,  $T_{amb} = 25\text{ }^{\circ}\text{C}$ ,  $R_L$  connected to  $V_{CC}/2$  (unless otherwise specified)**

| Symbol                   | Parameter   |  | Min.     | Typ.  | Max.       | Unit                                 |
|--------------------------|---|--|----------|-------|------------|--------------------------------------|
| <b>DC performance</b>    |   |  |          |       |            |                                      |
| $V_{io}$                 | Offset voltage  | TSV61x   |          |       | 4          | mV                                   |
|                          |   | TSV61xA  |          |       | 0.8        |                                      |
|                          |   | $T_{min} < T_{op} < T_{max}$ TSV61x  |          |       | 5          |                                      |
|                          |   | $T_{min} < T_{op} < T_{max}$ TSV61xA   |          |       | 2          |                                      |
| $\Delta V_{io}/\Delta T$ | Input offset voltage drift  |  |          | 2     |            | $\mu\text{V}/^{\circ}\text{C}$       |
| $I_{io}$                 | Input offset current  |  |          | 1     | $10^{(1)}$ | pA                                   |
|                          |   | $T_{min.} < T_{op} < T_{max.}$   |          | 1     | 100        |                                      |
| $I_{ib}$                 | Input bias current  |  |          | 1     | $10^{(1)}$ | pA                                   |
|                          |   | $T_{min.} < T_{op} < T_{max.}$   |          | 1     | 100        |                                      |
| CMR                      | Common mode rejection ratio $20 \log (\Delta V_{ic}/\Delta V_{io})$ | 0 V to 3.3 V, $V_{out} = 1.75\text{ V}$  | 61       | 76    |            | dB                                   |
|                          |   | $T_{min.} < T_{op} < T_{max.}$   | 58       |       |            |                                      |
| $A_{vd}$                 | Large signal voltage gain   | $R_L = 10\text{ k}\Omega$ , $V_{out} = 0.5\text{ V}$ to $2.8\text{ V}$                           | 85       | 92    |            | dB                                   |
|                          |   | $T_{min.} < T_{op} < T_{max.}$   | 83       |       |            |                                      |
| $V_{OH}$                 | High level output voltage ( $V_{OH} = V_{CC} - V_{out}$ )           | $R_L = 10\text{ k}\Omega$<br>$T_{min.} < T_{op} < T_{max.}$                                      |          | 5     | 35<br>50   | mV                                   |
| $V_{OL}$                 | Low level output voltage  | $R_L = 10\text{ k}\Omega$<br>$T_{min.} < T_{op} < T_{max.}$                                      |          | 10    | 35<br>50   |                                      |
| $I_{out}$                | Isink   | $V_o = V_{CC}$<br>$T_{min.} < T_{op} < T_{max.}$   | 37<br>35 | 44    |            | mA                                   |
|                          | Isource   | $V_o = 0\text{ V}$<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       | $\mu\text{A}$                        |
|                          |   | $T_{min.} < T_{op} < T_{max.}$   | 6        |       | 13         |                                      |
| <b>AC performance</b>    |   |  |          |       |            |                                      |
| GBP                      | Gain bandwidth product  |  |          | 110   |            | kHz                                  |
| $\phi_m$                 | Phase margin  | $R_L = 10\text{ k}\Omega$ , $C_L = 20\text{ pF}$   |          | 60    |            | Degrees                              |
| $G_m$                    | Gain margin   |  |          | 9.5   |            | dB                                   |
| SR                       | Slew rate   | $R_L = 10\text{ k}\Omega$ , $C_L = 20\text{ pF}$ ,<br>$V_{out} = 0.5\text{ V}$ to $2.8\text{ V}$ |          | 0.035 |            | $\text{V}/\mu\text{s}$               |
| $e_n$                    | Equivalent input noise voltage                                      | $f = 1\text{ kHz}$   |          | 110   |            | $\frac{\text{nV}}{\sqrt{\text{Hz}}}$ |

1. Guaranteed by design.

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

| Symbol                   | Parameter  |   | Min.     | Typ. | Max.              | Unit                           |
|--------------------------|--|---|----------|------|-------------------|--------------------------------|
| <b>DC performance</b>    |  |   |          |      |                   |                                |
| $V_{io}$                 | Offset voltage   | TSV61x  |          |      | 4                 | mV                             |
|                          |  | TSV61xA   |          |      | 0.8               |                                |
|                          |  | $T_{min} < T_{op} < T_{max}$ TSV61x   |          |      | 5                 |                                |
|                          |  | $T_{min} < T_{op} < T_{max}$ TSV61xA  |          |      | 2                 |                                |
| $\Delta V_{io}/\Delta T$ | Input offset voltage drift   |   |          | 2    |                   | $\mu\text{V}/^{\circ}\text{C}$ |
| $I_{io}$                 | Input offset current   |   |          | 1    | 10 <sup>(1)</sup> | pA                             |
|                          |  | $T_{min} < T_{op} < T_{max}$ .  |          | 1    | 100               |                                |
| $I_{ib}$                 | Input bias current   |   |          | 1    | 10 <sup>(1)</sup> | pA                             |
|                          |  | $T_{min} < T_{op} < T_{max}$ .  |          | 1    | 100               |                                |
| CMR                      | Common mode rejection ratio $20 \log (\Delta V_{ic}/\Delta V_{io})$    | 0 V to 5 V, $V_{out} = 2.5\text{ V}$  | 64       | 80   |                   | dB                             |
|                          |  | $T_{min} < T_{op} < T_{max}$ .  | 63       |      |                   |                                |
| SVR                      | Supply voltage rejection ratio $20 \log (\Delta V_{cc}/\Delta V_{io})$ | $V_{cc} = 1.8\text{ to }5\text{ V}$   | 76       | 93   |                   | dB                             |
|                          |  | $T_{min} < T_{op} < T_{max}$ .  | 74       |      |                   |                                |
| $A_{vd}$                 | Large signal voltage gain  | $R_L = 10\text{ k}\Omega$ , $V_{out} = 0.5\text{ V to }4.5\text{ V}$                      | 88       | 93   |                   | dB                             |
|                          |  | $T_{min} < T_{op} < T_{max}$  | 85       |      |                   |                                |
| $V_{OH}$                 | High level output voltage ( $V_{OH} = V_{CC} - V_{out}$ )              | $R_L = 10\text{ k}\Omega$<br>$T_{min} < T_{op} < T_{max}$ .                               |          | 7    | 35<br>50          | mV                             |
| $V_{OL}$                 | Low level output voltage   | $R_L = 10\text{ k}\Omega$<br>$T_{min} < T_{op} < T_{max}$ .                               |          | 16   | 35<br>50          |                                |
| $I_{out}$                | Isink  | $V_o = V_{CC}$<br>$T_{min} < T_{op} < T_{max}$ .  | 52<br>42 | 57   |                   | mA                             |
|                          | Isource  | $V_o = 0\text{ V}$<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                | $\mu\text{A}$                  |
|                          |  | $T_{min} < T_{op} < T_{max}$ .  | 7        |      | 15                |                                |
| <b>AC performance</b>    |  |   |          |      |                   |                                |
| GBP                      | Gain bandwidth product   |   |          | 120  |                   | kHz                            |
| $\phi_m$                 | Phase margin   | $R_L = 10\text{ k}\Omega$ , $C_L = 20\text{ pF}$  |          | 62   |                   | Degrees                        |
| $G_m$                    | Gain margin  |   |          | 10   |                   | dB                             |
| SR                       | Slew rate  | $R_L = 10\text{ k}\Omega$ , $C_L = 20\text{ pF}$ , $V_{out} = 0.5\text{V to }4.5\text{V}$ |          | 0.04 |                   | V/ $\mu\text{s}$               |

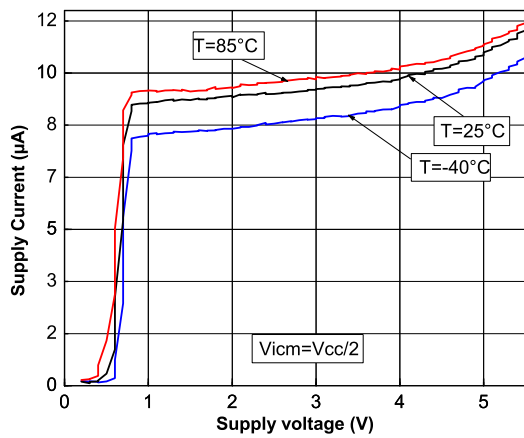
**Table 5. Electrical characteristics at  $V_{CC+} = 5\text{ V}$ ,  $V_{CC-} = 0\text{ V}$ ,  $V_{icm} = V_{CC}/2$ ,  $T_{amb} = 25\text{ °C}$ ,  $R_L$  connected to  $V_{CC}/2$  (unless otherwise specified) (continued)**

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

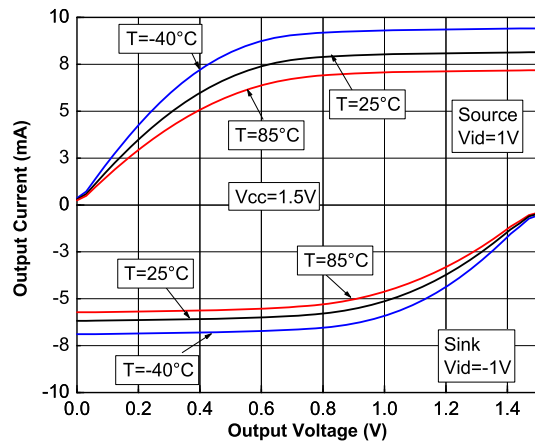
1. Guaranteed by design.



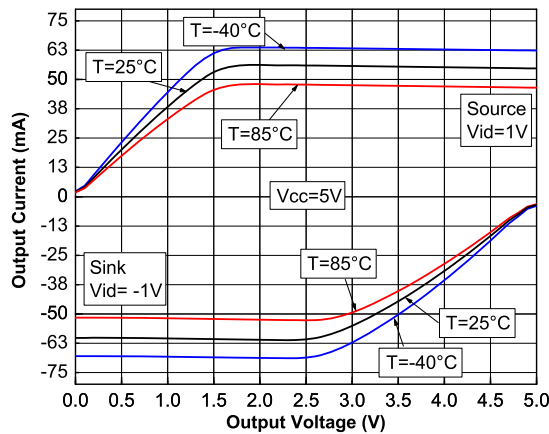
**Figure 1. Supply current vs. supply voltage at  $V_{icm} = V_{CC}/2$**



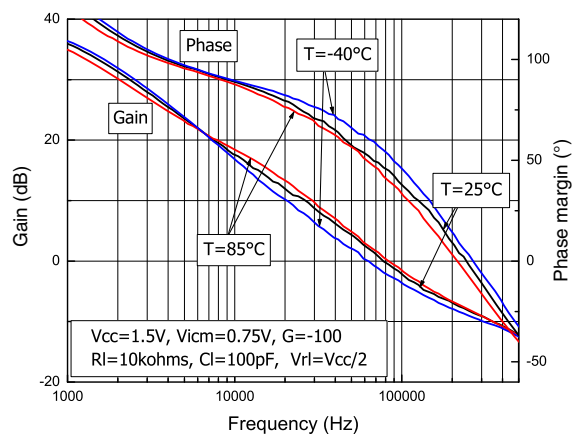
**Figure 2. Output current vs. output voltage at  $V_{CC} = 1.5V$**



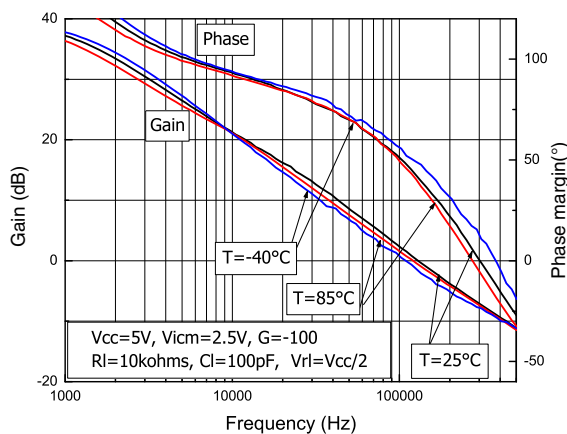
**Figure 3. Output current vs. output voltage at  $V_{CC} = 5V$**



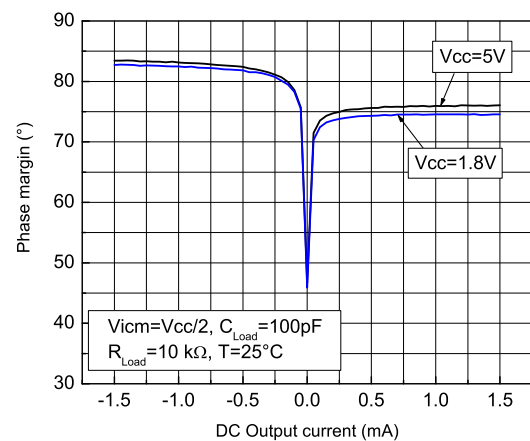
**Figure 4. Voltage gain and phase vs. frequency at  $V_{CC} = 1.5V$**



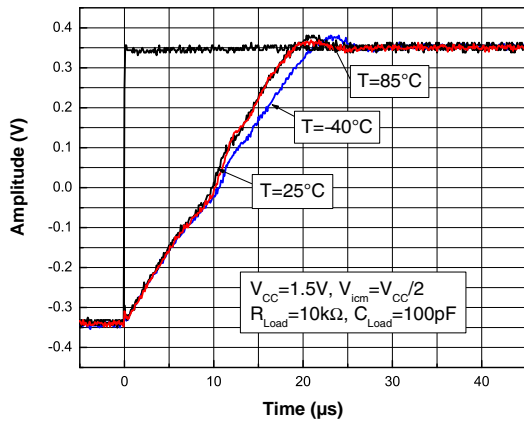
**Figure 5. Voltage gain and phase vs. frequency at  $V_{CC} = 5V$**



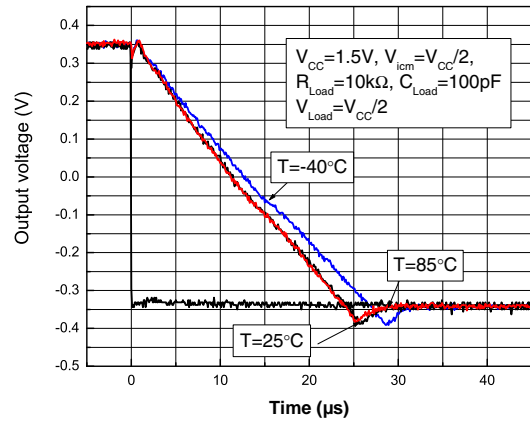
**Figure 6. Phase margin vs. output current**



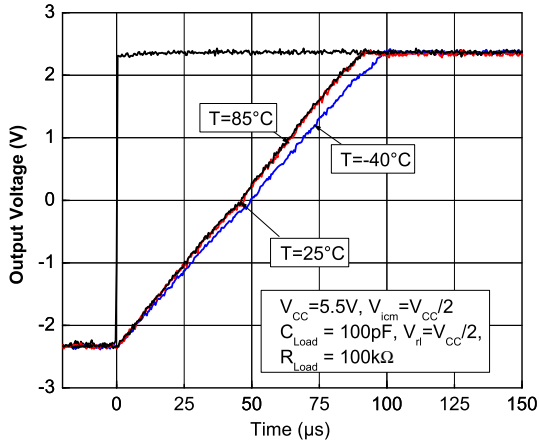
**Figure 7. Positive slew rate vs. time,  $V_{CC} = 1.5\text{ V}$ ,  $C_{Load} = 100\text{ pF}$ ,  $R_{Load} = 10\text{ k}\Omega$**



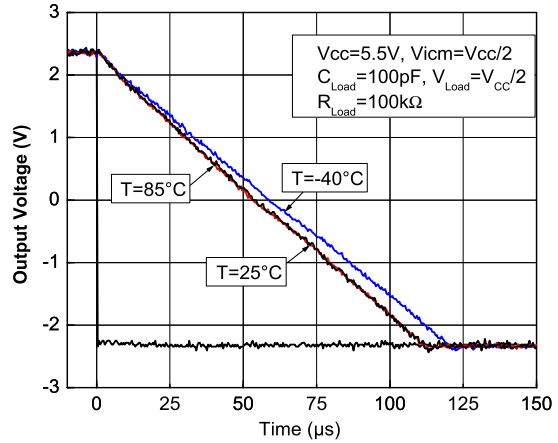
**Figure 8. Negative slew rate vs. time,  $V_{CC} = 1.5\text{ V}$ ,  $C_{Load} = 100\text{ pF}$ ,  $R_{Load} = 10\text{ k}\Omega$**



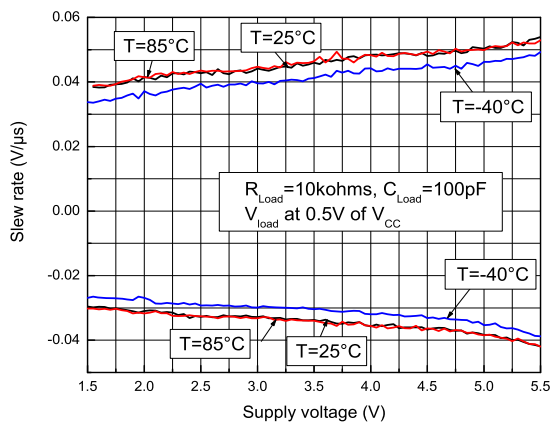
**Figure 9. Positive slew rate vs. time,  $V_{CC} = 5.5\text{ V}$ ,  $C_{Load} = 100\text{ pF}$ ,  $R_{Load} = 100\text{ k}\Omega$**



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



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



**Figure 12. Noise vs. frequency at  $V_{CC} = 5\text{ V}$**

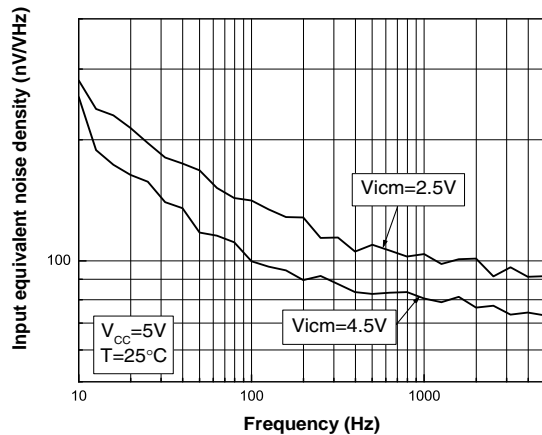


Figure 13. Distortion + noise vs. frequency

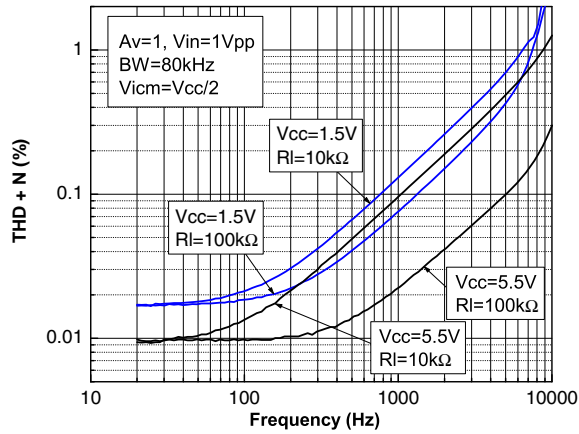


Figure 14. Distortion + noise vs. output voltage

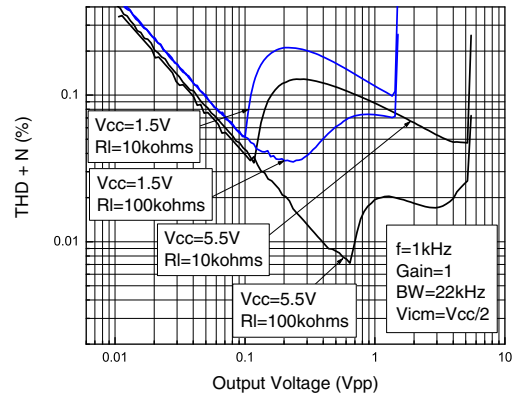


Figure 15. Voltage gain and phase vs. frequency at  $V_{CC} = 1.8 V$  (based on simulation results)

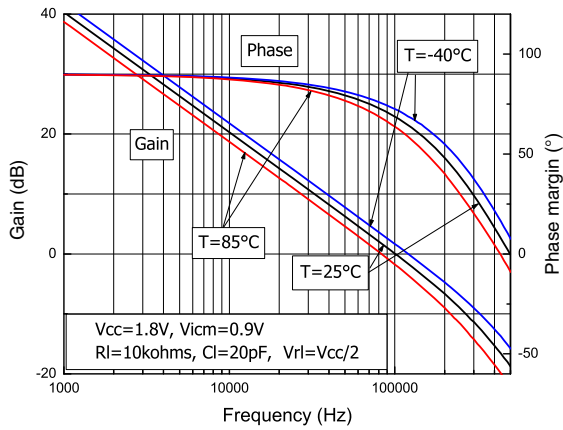
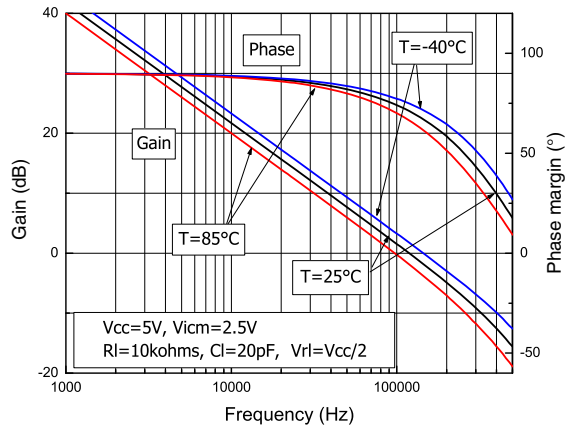


Figure 16. Voltage gain and phase vs. frequency at  $V_{CC} = 5 V$  (based on simulation results)



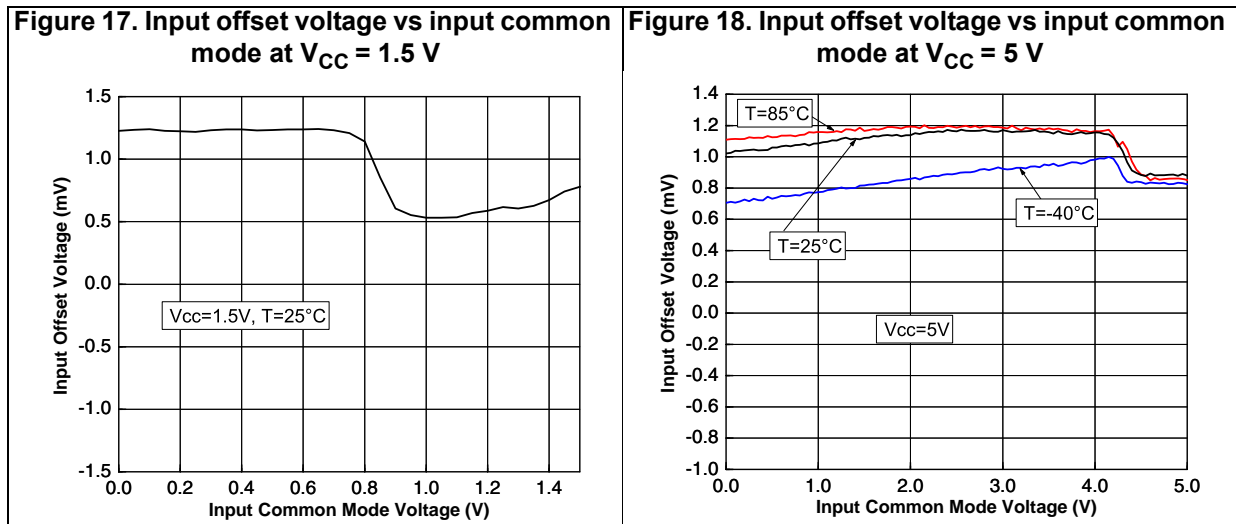
### 3 Application information

#### 3.1 Operating voltages

The TSV61x can operate from 1.5 to 5.5 V. The 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  $-40\text{ }^{\circ}\text{C}$  to  $85\text{ }^{\circ}\text{C}$ .

#### 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  $(V_{CC-}) - 0.1\text{ V}$  to  $(V_{CC+}) + 0.1\text{ V}$ . The transition between the two pairs appears at  $(V_{CC+}) - 0.7\text{ V}$ . 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.  $V_{ICM}$ ).



The device is guaranteed without phase reversal.

#### 3.3 Rail-to-rail output

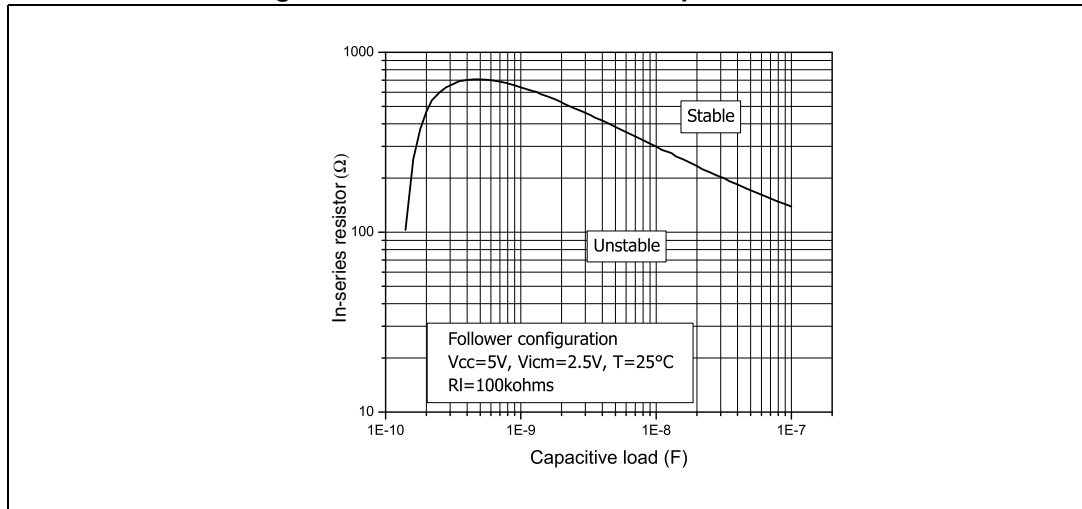
The operational amplifiers' output levels can go close to the rails: less than 35 mV above GND rail and less than 35 mV below  $V_{CC}$  rail when connected to  $10\text{ k}\Omega$  load to  $V_{CC}/2$ .

### 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 k $\Omega$ . 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](http://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<sup>®</sup> packages, depending on their level of environmental compliance. ECOPACK<sup>®</sup> specifications, grade definitions and product status are available at: [www.st.com](http://www.st.com). ECOPACK<sup>®</sup> is an ST trademark.

### 4.1 SOT23-5 package information

Figure 20. SOT23-5 package outline

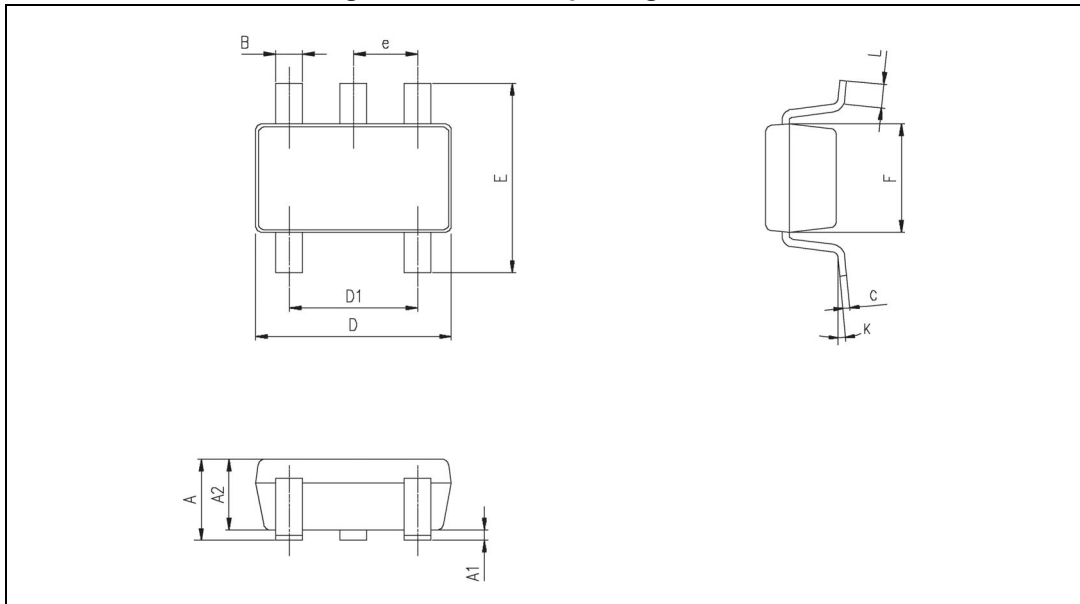


Table 6. SOT23-5 mechanical data

| 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 outline

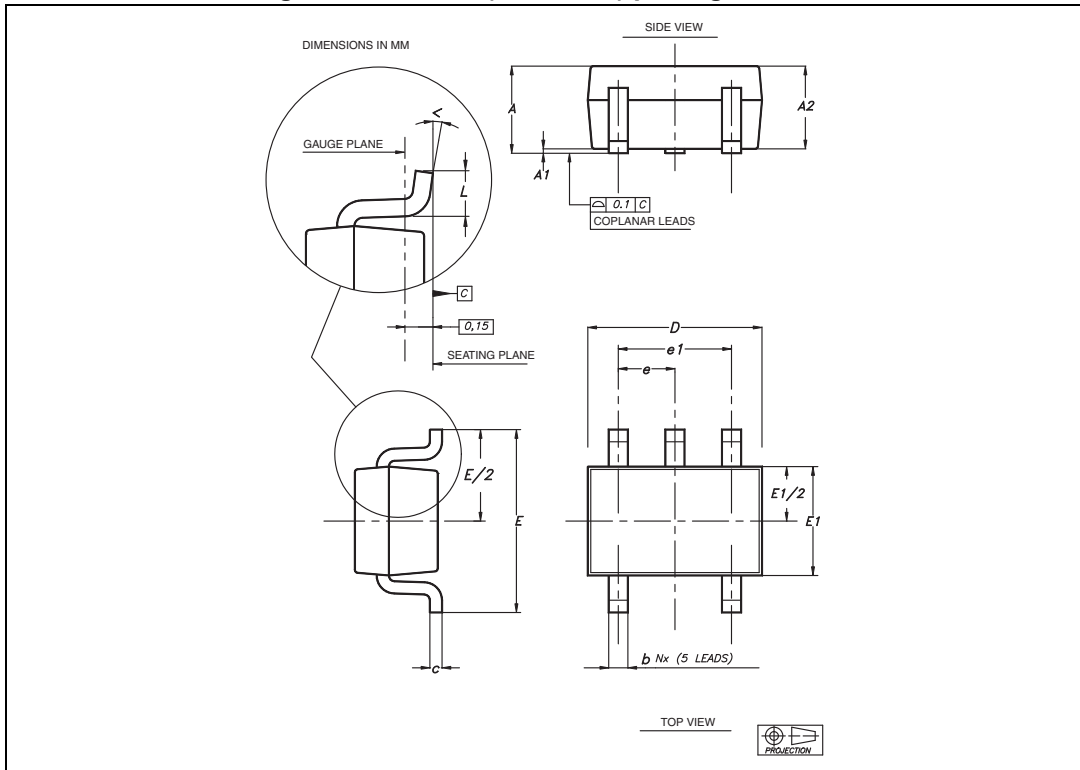


Table 7. SC70-5 (SOT323-5) mechanical data

| 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 SO8 package information

Figure 22. SO8 package outline

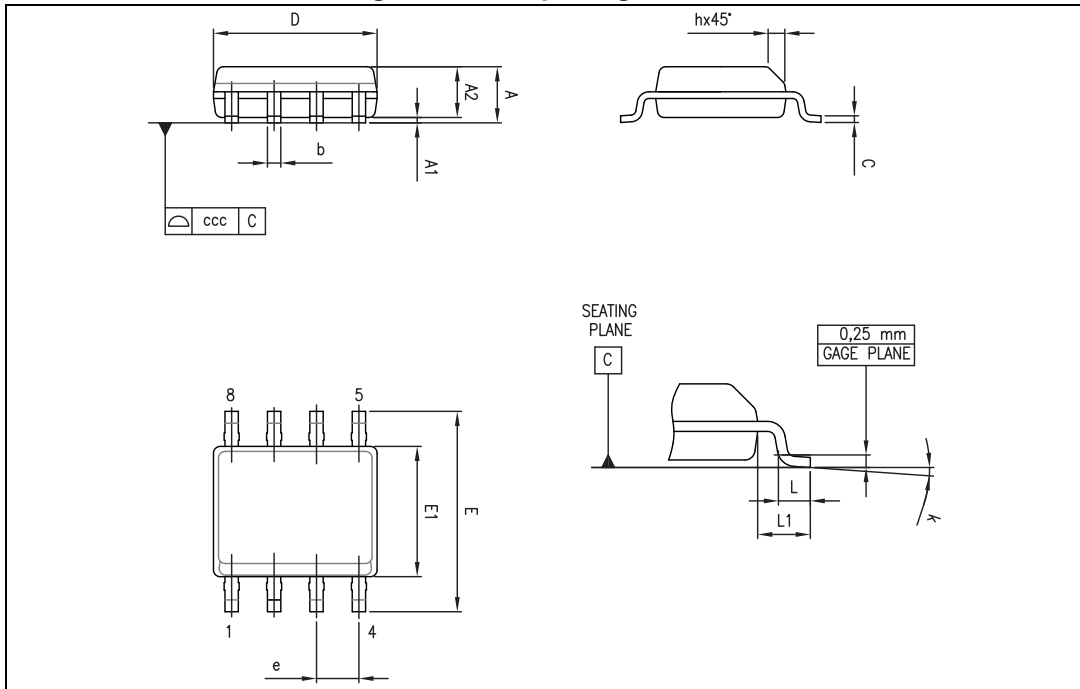


Table 8. SO8 mechanical data

| 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 MiniSO8 package information

Figure 23. MiniSO8 package outline

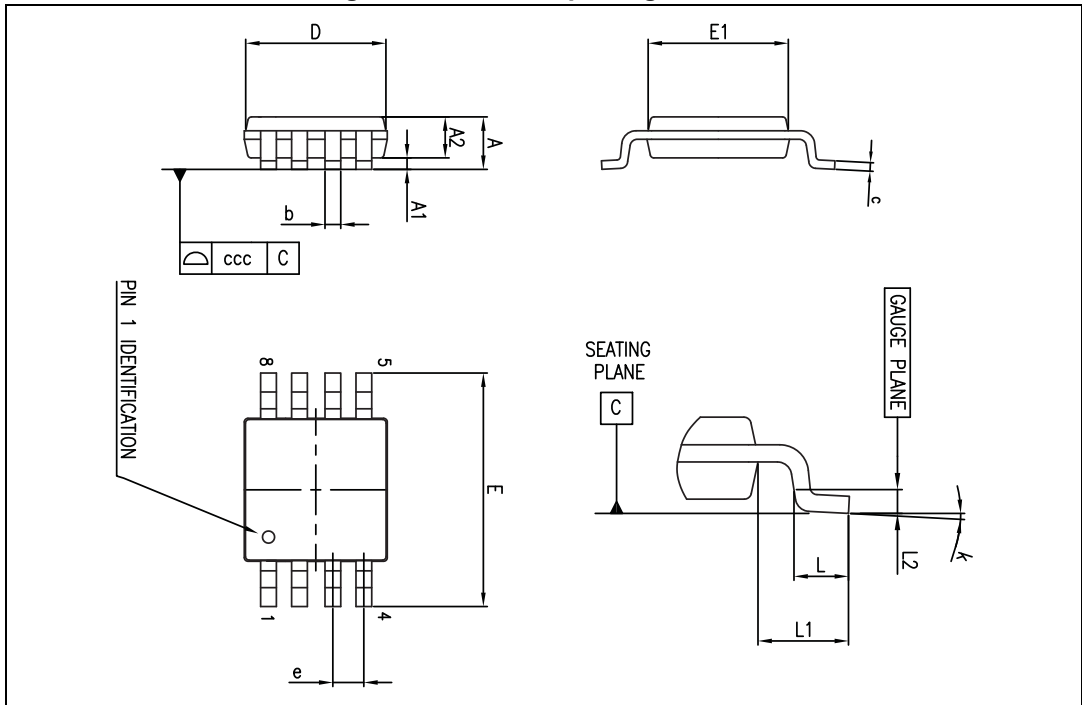


Table 9. MiniSO8 mechanical data

| 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

| Order code | Temperature range | Package  | Packing       | Marking |
|------------|-------------------|----------|---------------|---------|
| TSV611ILT  | -40 °C to 85 °C   | SOT23-5  | Tape and reel | K12     |
| TSV611AILT |                   |          |               | K11     |
| TSV611ICT  |                   | SC70-5   |               | K12     |
| TSV611AICT |                   |          |               | K11     |
| TSV612IDT  |                   | SO-8     |               | V612I   |
| TSV612AIDT |                   |          |               | V612AI  |
| TSV612IST  |                   | MiniSO-8 |               | K113    |
| TSV612AIST |                   |          |               | K115    |

## 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.   |
| 11-May-2017 | 3        | <i>Table 3, Table 4, and Table 5</i> : changed “ $DV_{io}$ to $\Delta V_{io}/\Delta T$ ”, updated $V_{OH}$ parameter information, changed min. values of $V_{OH}$ parameter to max. values.<br><i>Table 10: Order codes</i> : removed obsolete order codes TSV612ID and TSV612AID |

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