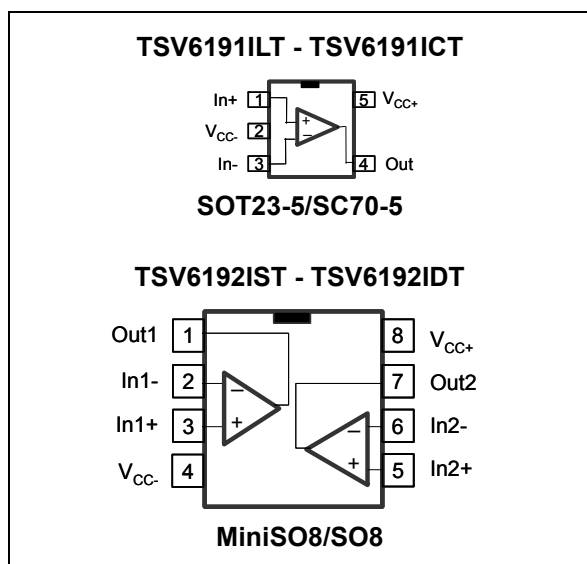




## Description

The TSV619x 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 TSV619x have a gain bandwidth product of 450 kHz while consuming only 10  $\mu$ A at 5 V. They must be used in a gain configuration (equal or above 4 or -3).

These features make the TSV619x 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: 450 kHz typ
- Stable when used in gain configuration
- Low input offset voltage: 800  $\mu$ V max (A version)
- Low input bias current: 1 pA typ
- Temperature range: -40 to 85  $^{\circ}$ C

## Applications

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

## Contents

|          |                                                          |           |
|----------|----------------------------------------------------------|-----------|
| <b>1</b> | <b>Absolute maximum ratings and operating conditions</b> | <b>3</b>  |
| <b>2</b> | <b>Electrical characteristics</b>                        | <b>4</b>  |
| <b>3</b> | <b>Application information</b>                           | <b>9</b>  |
| 3.1      | Operating voltages                                       | 9         |
| 3.2      | Rail-to-rail input                                       | 9         |
| 3.3      | Rail-to-rail output                                      | 9         |
| 3.4      | PCB layouts                                              | 9         |
| 3.5      | Macromodel                                               | 10        |
| <b>4</b> | <b>Package information</b>                               | <b>11</b> |
| 4.1      | SOT23-5 package information                              | 12        |
| 4.2      | SC70-5 (SOT323-5) package information                    | 13        |
| 4.3      | SO8 package information                                  | 14        |
| 4.4      | MiniSO8 package information                              | 15        |
| <b>5</b> | <b>Ordering information</b>                              | <b>16</b> |
| <b>6</b> | <b>Revision history</b>                                  | <b>17</b> |

# 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) (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   |

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.  $V_{CC}$ - $V_{in}$  must not exceed 6 V.
4. Short-circuits can cause excessive heating and destructive dissipation.
5.  $R_{th}$  are typical values.
6. 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.
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  $\Omega$ ), 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 $(V_{CC+}) + 0.1$ |      |
| $T_{oper}$ | 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                   |
|----------------------|--------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------|--------|------|-------------------|------------------------|
| DC performance       |                                                                                      |                                                                                                                                     |        |      |                   |                        |
| V <sub>io</sub>      | Offset voltage                                                                       | TSV619x<br>TSV619xA                                                                                                                 |        |      | 4<br>0.8          | mV                     |
|                      |                                                                                      | T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub> TSV619x<br>T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub> TSV619xA |        |      | 5<br>2            |                        |
| ΔV <sub>io</sub> /ΔT | Input offset voltage drift                                                           |                                                                                                                                     |        | 2    |                   | μV/°C                  |
| I <sub>io</sub>      | Input offset current<br>(V <sub>out</sub> = V <sub>cc</sub> /2)                      |                                                                                                                                     |        | 1    | 10 <sup>(1)</sup> | pA                     |
|                      |                                                                                      | T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub>                                                                             |        | 1    | 25                |                        |
| I <sub>ib</sub>      | Input bias current<br>(V <sub>out</sub> = V <sub>cc</sub> /2)                        |                                                                                                                                     |        | 1    | 10 <sup>(1)</sup> |                        |
|                      |                                                                                      | T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub>                                                                             |        | 1    | 25                |                        |
| CMR                  | Common mode rejection ratio<br>20 log (ΔV <sub>ic</sub> /ΔV <sub>io</sub> )          | 0 V to 1.8 V, V <sub>out</sub> = 0.9 V                                                                                              | 55     | 71   |                   | dB                     |
|                      |                                                                                      | T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub>                                                                             | 53     |      |                   |                        |
| A <sub>vd</sub>      | Large signal voltage gain                                                            | R <sub>L</sub> = 10 kΩ, Vout = 0.5 V to 1.3 V                                                                                       | 78     | 83   |                   |                        |
|                      |                                                                                      | T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub>                                                                             | 74     |      |                   |                        |
| V <sub>OH</sub>      | High level output voltage<br>(V <sub>OH</sub> = V <sub>CC</sub> - V <sub>out</sub> ) | R <sub>L</sub> = 10 kΩ<br>T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub>                                                   |        | 4    | 35<br>50          | mV                     |
| V <sub>OL</sub>      | Low level output voltage                                                             | R <sub>L</sub> = 10 kΩ<br>T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub>                                                   |        | 7    | 35<br>50          |                        |
| I <sub>out</sub>     | Isink                                                                                | V <sub>o</sub> = 1.8 V<br>T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub>                                                   | 9<br>9 | 13   |                   | mA                     |
|                      | Isource                                                                              | V <sub>o</sub> = 0 V<br>T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub>                                                     | 8<br>8 | 10   |                   |                        |
| I <sub>CC</sub>      | Supply current (per operator)                                                        | No load, V <sub>out</sub> = V <sub>cc</sub> /2                                                                                      | 6.5    | 9    | 12                | μA                     |
|                      |                                                                                      | T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub>                                                                             | 6      |      | 12.5              |                        |
| AC performance       |                                                                                      |                                                                                                                                     |        |      |                   |                        |
| GBP                  | Gain bandwidth product                                                               | R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 20 pF                                                                                      |        | 380  |                   | kHz                    |
| Gain                 | Minimum gain for stability                                                           | Phase margin = 60 °, R <sub>f</sub> = 10kΩ<br>R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 20 pF, T <sub>op</sub> = 25 °C               |        | 5    |                   | V/V                    |
| SR                   | Slew rate                                                                            | R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 20 pF,<br>V <sub>out</sub> = 0.5V to 1.3V                                                  |        | 0.06 |                   | V/μs                   |
| e <sub>n</sub>       | Equivalent input noise voltage                                                       | f = 1 kHz                                                                                                                           |        | 110  |                   | $\frac{nV}{\sqrt{Hz}}$ |
| THD+N                | Total harmonic distortion + noise                                                    | F <sub>in</sub> = 1 kHz, Av = 5, V <sub>out</sub> = 1 V <sub>pp</sub> ,<br>R <sub>L</sub> = 100 kΩ, BW = 22 kHz                     |        | 0.1  |                   | %                      |

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)**

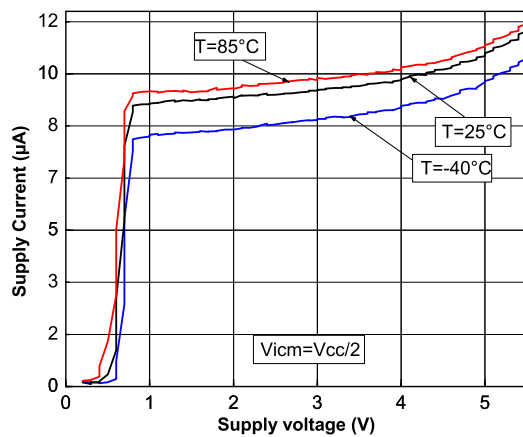
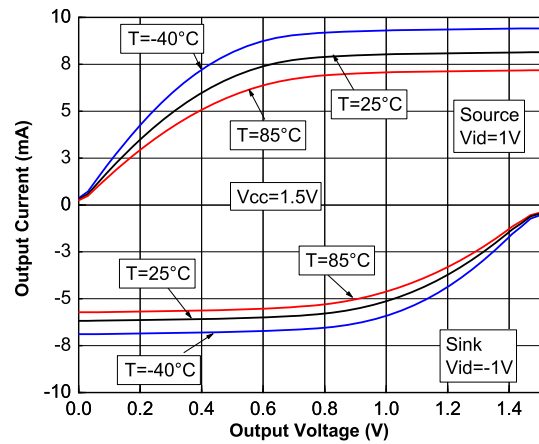
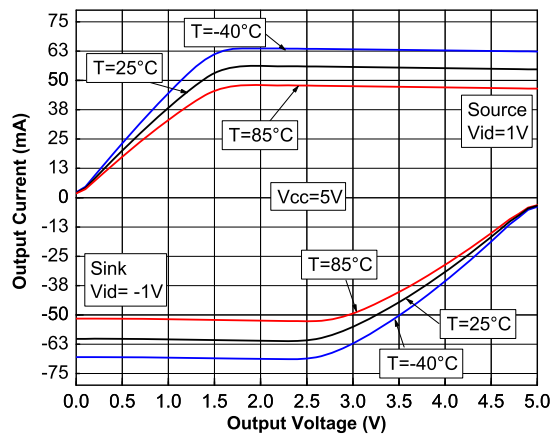
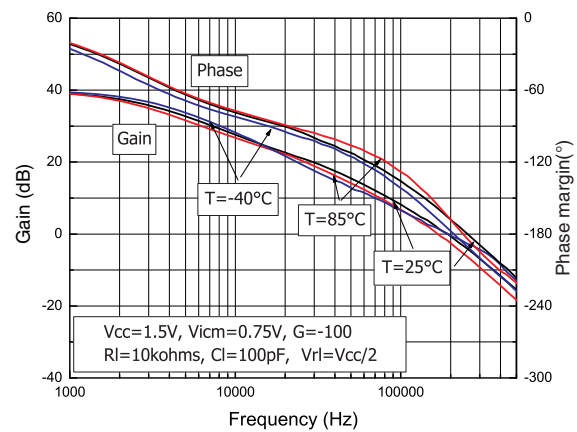
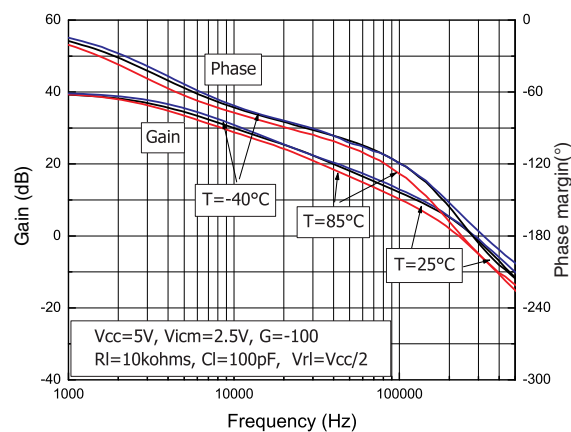
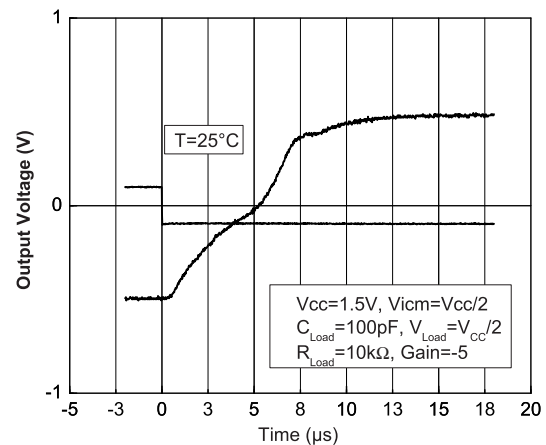
| Symbol               | Parameter                                                                            |                                                                                                                       | Min.     | Typ. | Max.              | Unit                   |
|----------------------|--------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------|----------|------|-------------------|------------------------|
| DC performance       |                                                                                      |                                                                                                                       |          |      |                   |                        |
| V <sub>io</sub>      | Offset voltage                                                                       | TSV619x                                                                                                               |          |      | 4                 | mV                     |
|                      |                                                                                      | TSV619xA                                                                                                              |          |      | 0.8               |                        |
|                      |                                                                                      | T <sub>min</sub> <T <sub>op</sub> <T <sub>max</sub> TSV619x                                                           |          |      | 5                 |                        |
|                      |                                                                                      | T <sub>min</sub> <T <sub>op</sub> <T <sub>max</sub> TSV619xA                                                          |          |      | 2                 |                        |
| ΔV <sub>io</sub> /ΔT | Input offset voltage drift                                                           |                                                                                                                       |          | 2    |                   | μV/°C                  |
| I <sub>io</sub>      | Input offset current                                                                 |                                                                                                                       |          | 1    | 10 <sup>(1)</sup> | pA                     |
|                      |                                                                                      | T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub>                                                               |          | 1    | 25                |                        |
| I <sub>ib</sub>      | Input bias current                                                                   |                                                                                                                       |          | 1    | 10 <sup>(1)</sup> |                        |
|                      |                                                                                      | T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub>                                                               |          | 1    | 25                |                        |
| CMR                  | Common mode rejection ratio<br>20 log (ΔV <sub>ic</sub> /ΔV <sub>io</sub> )          | 0 V to 3.3 V, V <sub>out</sub> = 1.75 V                                                                               | 61       | 76   |                   | dB                     |
|                      |                                                                                      | T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub>                                                               | 58       |      |                   |                        |
| A <sub>vd</sub>      | Large signal voltage gain                                                            | R <sub>L</sub> = 10 kΩ, V <sub>out</sub> = 0.5 V to 2.8 V                                                             | 85       | 92   |                   |                        |
|                      |                                                                                      | T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub>                                                               | 83       |      |                   |                        |
| V <sub>OH</sub>      | High level output voltage<br>(V <sub>OH</sub> = V <sub>CC</sub> - V <sub>out</sub> ) | R <sub>L</sub> = 10 kΩ<br>T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub>                                     |          | 5    | 35<br>50          | mV                     |
| V <sub>OL</sub>      | Low level output voltage                                                             | R <sub>L</sub> = 10 kΩ<br>T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub>                                     |          | 10   | 35<br>50          |                        |
| I <sub>out</sub>     | Isink                                                                                | V <sub>o</sub> = V <sub>CC</sub><br>T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub>                           | 37<br>35 | 44   |                   | mA                     |
|                      | Isource                                                                              | V <sub>o</sub> = 0 V<br>T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub>                                       | 32<br>30 | 38   |                   |                        |
| I <sub>CC</sub>      | Supply current (per operator)                                                        | No load, V <sub>out</sub> = V <sub>CC</sub> /2                                                                        | 6.5      | 9.5  | 12.5              | μA                     |
|                      |                                                                                      | T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub>                                                               | 6        |      | 13                |                        |
| AC performance       |                                                                                      |                                                                                                                       |          |      |                   |                        |
| GBP                  | Gain bandwidth product                                                               | R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 20 pF                                                                        |          | 400  |                   | kHz                    |
| Gain                 | Minimum gain for stability                                                           | Phase margin = 60 °, R <sub>f</sub> = 10kΩ<br>R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 20 pF, T <sub>op</sub> = 25 °C |          | 5    |                   | V/V                    |
| SR                   | Slew rate                                                                            | R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 20 pF,<br>V <sub>out</sub> = 0.5V to 2.8V                                    |          | 0.07 |                   | V/μs                   |
| e <sub>n</sub>       | Equivalent input noise voltage                                                       | f = 1 kHz                                                                                                             |          | 110  |                   | $\frac{nV}{\sqrt{Hz}}$ |

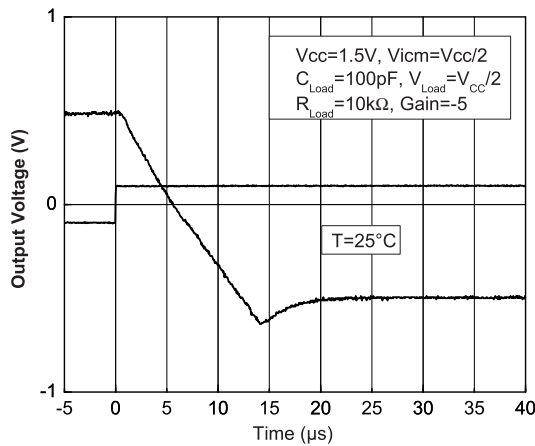
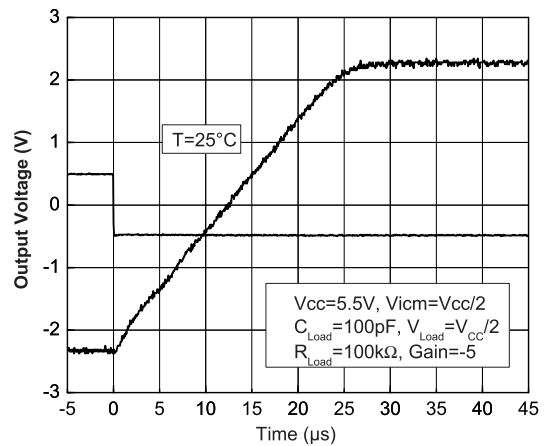
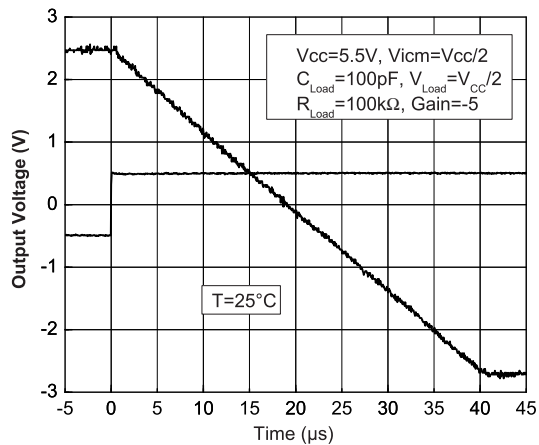
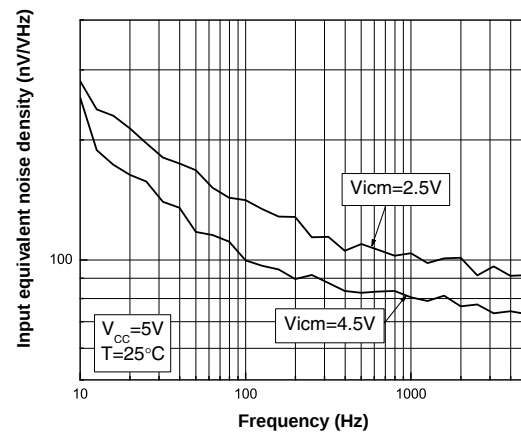
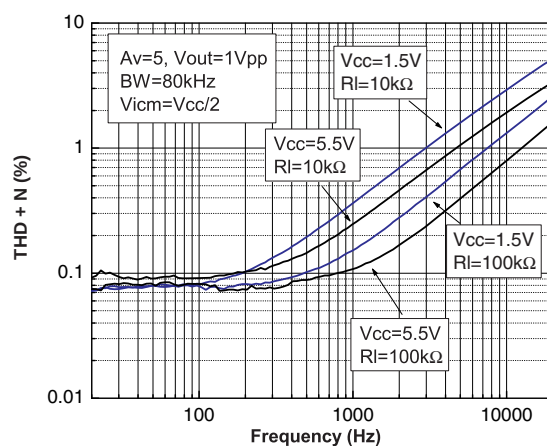
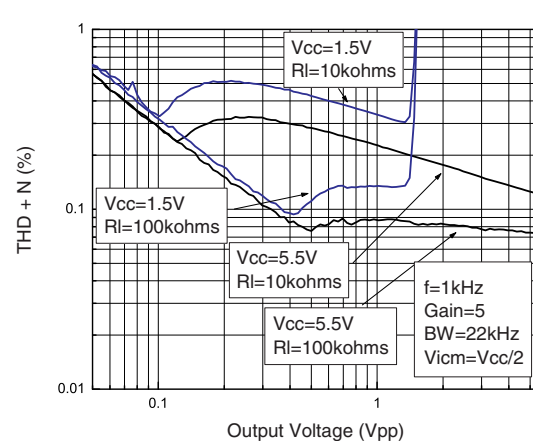
1. Guaranteed by design.

**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                   |
|----------------------|--------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------|----------|------|-------------------|------------------------|
| DC performance       |                                                                                      |                                                                                                                           |          |      |                   |                        |
| V <sub>io</sub>      | Offset voltage                                                                       | TSV619x                                                                                                                   |          |      | 4                 | mV                     |
|                      |                                                                                      | TSV619xA                                                                                                                  |          |      | 0.8               |                        |
|                      |                                                                                      | T <sub>min</sub> <T <sub>op</sub> <T <sub>max</sub> TSV619x                                                               |          |      | 5                 |                        |
|                      |                                                                                      | T <sub>min</sub> <T <sub>op</sub> <T <sub>max</sub> TSV619xA                                                              |          |      | 2                 |                        |
| ΔV <sub>io</sub> /ΔT | Input offset voltage drift                                                           |                                                                                                                           |          | 2    |                   | μV/°C                  |
| I <sub>io</sub>      | Input offset current                                                                 |                                                                                                                           |          | 1    | 10 <sup>(1)</sup> | pA                     |
|                      |                                                                                      | T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub>                                                                   |          | 1    | 25                |                        |
| I <sub>ib</sub>      | Input bias current                                                                   |                                                                                                                           |          | 1    | 10 <sup>(1)</sup> | pA                     |
|                      |                                                                                      | T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub>                                                                   |          | 1    | 25                |                        |
| CMR                  | Common mode rejection ratio<br>20 log (ΔV <sub>ic</sub> /ΔV <sub>io</sub> )          | 0 V to 5 V, V <sub>out</sub> = 2.5 V                                                                                      | 64       | 80   |                   | dB                     |
|                      |                                                                                      | T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub>                                                                   | 63       |      |                   |                        |
| SVR                  | Supply voltage rejection ratio 20<br>log (ΔV <sub>cc</sub> /ΔV <sub>io</sub> )       | V <sub>cc</sub> = 1.8 to 5 V                                                                                              | 76       | 93   |                   |                        |
|                      |                                                                                      | T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub>                                                                   | 74       |      |                   |                        |
| A <sub>vd</sub>      | Large signal voltage gain                                                            | R <sub>L</sub> = 10 kΩ, V <sub>out</sub> = 0.5 V to 4.5 V                                                                 | 88       | 93   |                   |                        |
|                      |                                                                                      | T <sub>min</sub> <T <sub>op</sub> <T <sub>max</sub>                                                                       | 85       |      |                   |                        |
| V <sub>OH</sub>      | High level output voltage<br>(V <sub>OH</sub> = V <sub>CC</sub> - V <sub>out</sub> ) | R <sub>L</sub> = 10 kΩ<br>T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub>                                         |          | 7    | 35<br>50          | mV                     |
| V <sub>OL</sub>      | Low level output voltage                                                             | R <sub>L</sub> = 10 kΩ<br>T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub>                                         |          | 16   | 35<br>50          |                        |
| I <sub>out</sub>     | Isink                                                                                | V <sub>o</sub> = V <sub>CC</sub><br>T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub>                               | 52<br>42 | 57   |                   | mA                     |
|                      | Isource                                                                              | V <sub>o</sub> = 0 V<br>T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub>                                           | 58<br>49 | 63   |                   |                        |
| I <sub>CC</sub>      | Supply current (per operator)                                                        | No load, V <sub>out</sub> = V <sub>CC</sub> /2                                                                            | 7.5      | 10.5 | 14                | μA                     |
|                      |                                                                                      | T <sub>min.</sub> < T <sub>op</sub> < T <sub>max.</sub>                                                                   | 7        |      | 15                |                        |
| AC performance       |                                                                                      |                                                                                                                           |          |      |                   |                        |
| GBP                  | Gain bandwidth product                                                               | R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 20 pF                                                                            |          | 450  |                   | kHz                    |
| Gain                 | Minimum gain for stability                                                           | Phase margin = 60 °, R <sub>f</sub> = 10kΩ,<br>R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 20 pF, T <sub>op</sub> = 25 °C    |          | 5    |                   | V/V                    |
| SR                   | Slew rate                                                                            | R <sub>L</sub> = 10 kΩ, C <sub>L</sub> = 20 pF,<br>V <sub>out</sub> = 0.5V to 4.5V                                        |          | 0.08 |                   | V/μs                   |
| e <sub>n</sub>       | Equivalent input noise voltage                                                       | f = 1 kHz                                                                                                                 |          | 105  |                   | $\frac{nV}{\sqrt{Hz}}$ |
| THD+N                | Total harmonic distortion + noise                                                    | F <sub>in</sub> = 1 kHz, A <sub>v</sub> = 5, V <sub>out</sub> = 1 V <sub>pp</sub> ,<br>R <sub>L</sub> = 100 kΩ BW = 22kHz |          | 0.1  |                   | %                      |

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. Positive slew rate vs. time at  $V_{CC} = 1.5V$** 

**Figure 7. Negative slew rate vs. time at  $V_{CC} = 1.5\text{ V}$** **Figure 8. Positive slew rate vs. time at  $V_{CC} = 5.5\text{ V}$** **Figure 9. Negative slew rate vs. time,  $V_{CC} = 5.5\text{ V}$ ,  $C_{Load} = 100\text{ pF}$ ,  $R_{Load} = 100\text{ k}\Omega$** **Figure 10. Noise vs. frequency at  $V_{CC} = 5\text{ V}$ ,  $T = 25^\circ\text{C}$** **Figure 11. Distortion + noise vs. frequency****Figure 12. Distortion + noise vs. output voltage**

### 3 Application information

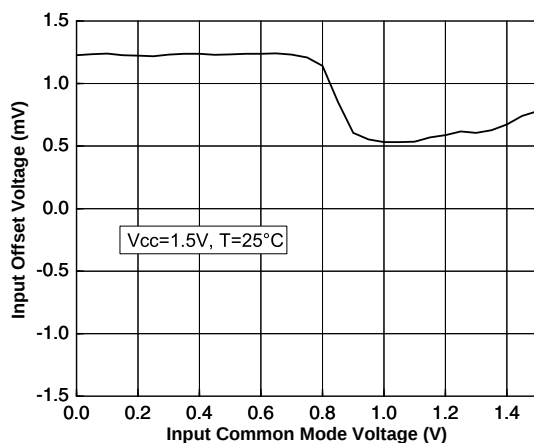
#### 3.1 Operating voltages

The TSV619x 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 TSV619x characteristics at 1.5 V. Additionally, the main specifications are guaranteed in extended temperature ranges from  $-40\text{ }^{\circ}\text{C}$  to  $85\text{ }^{\circ}\text{C}$ .

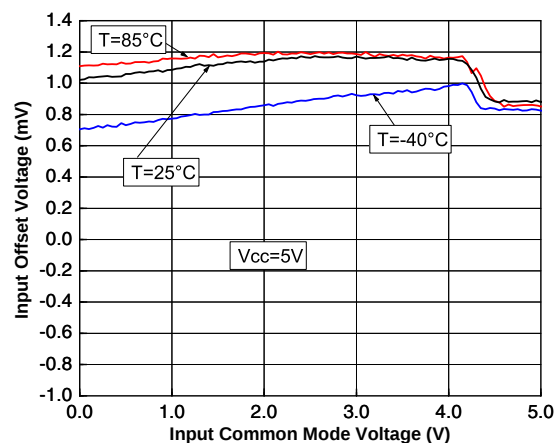
#### 3.2 Rail-to-rail input

The TSV619x 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 13](#) and [Figure 14](#) for  $V_{io}$  vs.  $V_{icm}$ ).

**Figure 13. Input offset voltage vs input common mode at  $V_{CC} = 1.5\text{ V}$**



**Figure 14. Input offset voltage vs input common mode at  $V_{CC} = 5\text{ V}$**



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  $10\text{ k}\Omega$  load to  $V_{CC}/2$ .

#### 3.4 PCB layouts

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

### 3.5 Macromodel

An accurate macromodel of the TSV619x 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 TSV619x 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 15. SOT23-5 package outline

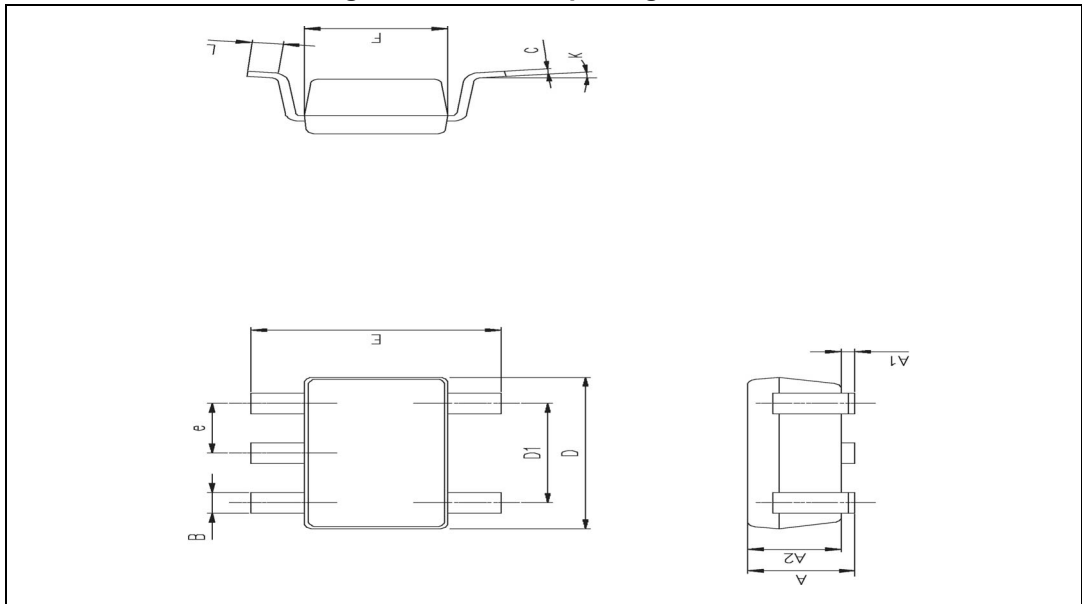


Table 6. SOT23-5 mechanical data

| 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 16. SC70-5 (SOT323-5) package outline

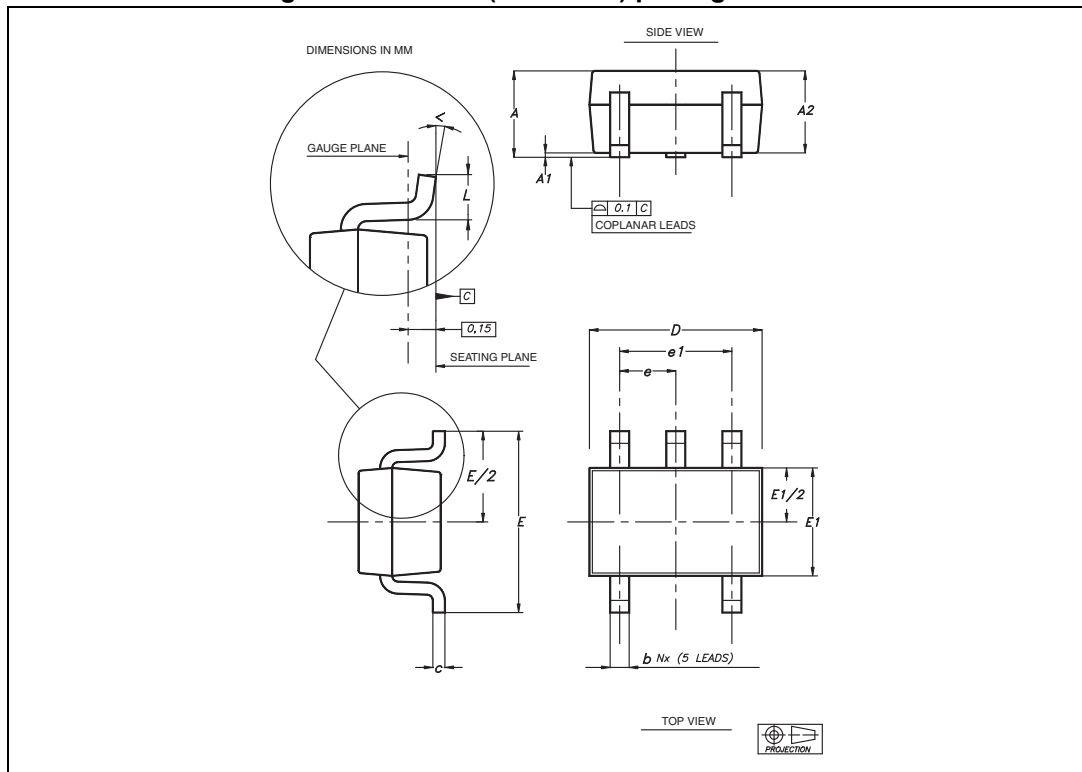


Table 7. SC70-5 (SOT323-5) mechanical data

| 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 17. SO8 package outline

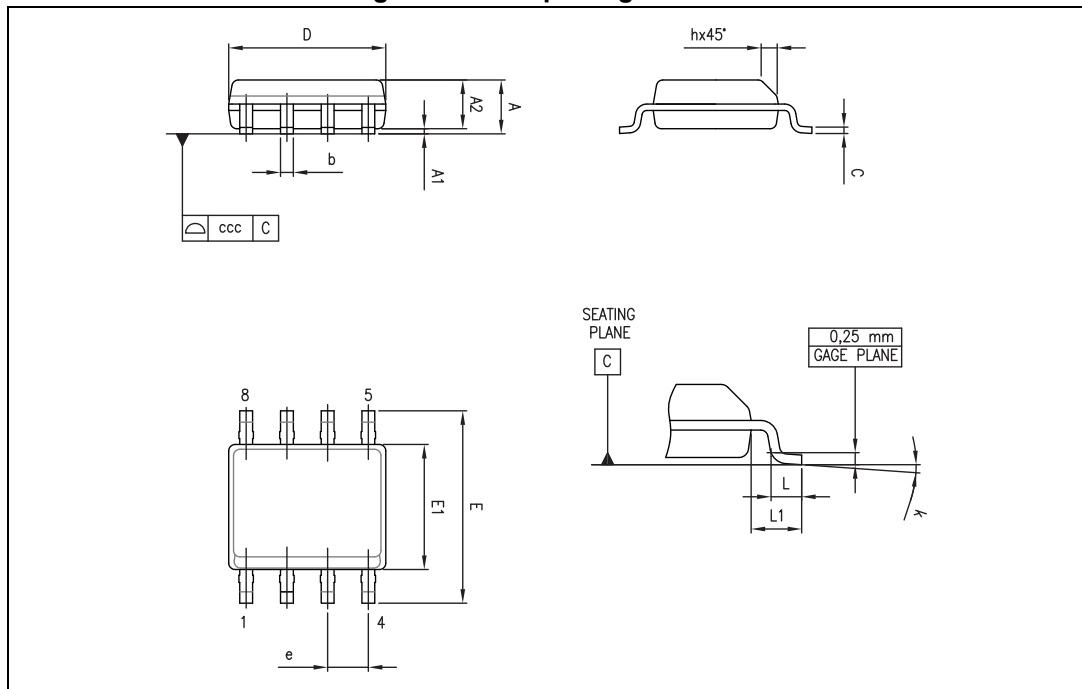


Table 8. SO8 mechanical data

| 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 18. MiniSO8 package outline

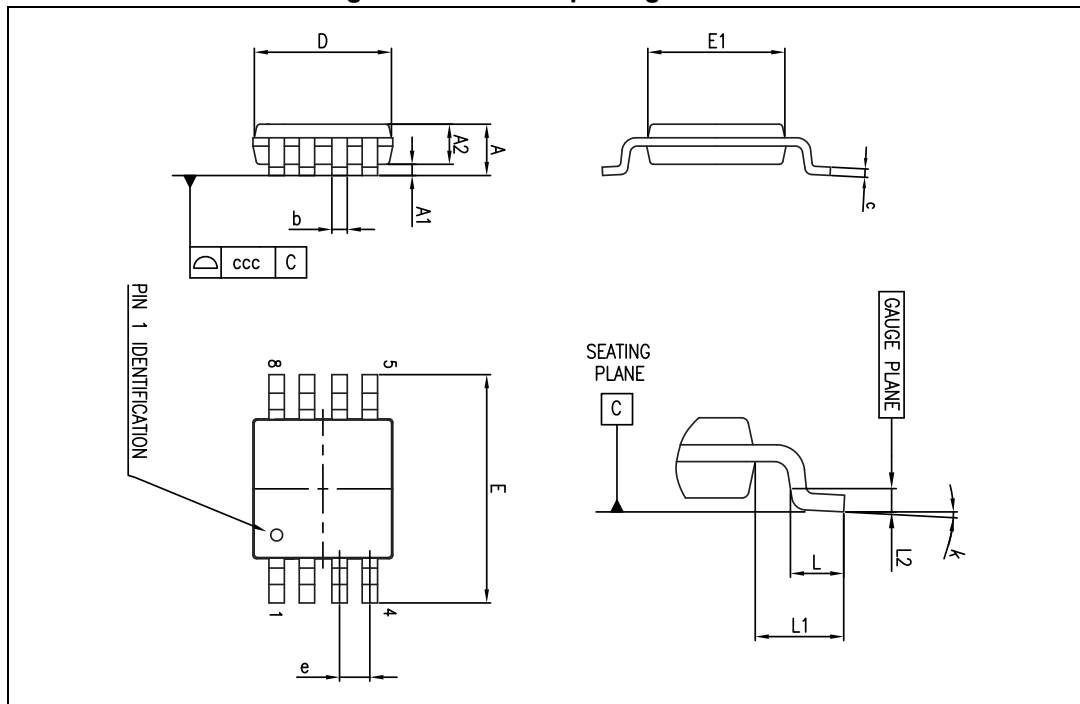


Table 9. MiniSO8 mechanical data

| 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 |
|-------------|-------------------|----------|---------------|---------|
| TSV6191ILT  | -40 °C to 85 °C   | SOT23-5  | Tape and reel | K110    |
| TSV6191AILT |                   |          |               | K115    |
| TSV6191ICT  |                   | SC70-5   |               | K10     |
| TSV6191AICT |                   |          |               | K13     |
| TSV6192IDT  |                   | SO-8     |               | V6192I  |
| TSV6192AIDT |                   |          |               | V6192AI |
| TSV6192IST  |                   | MiniSO-8 |               | K130    |
| TSV6192AIST |                   |          |               | K129    |

## 6 Revision history

**Table 11. Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                                                     |
|-------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 04-Oct-2010 | 1        | Initial release.                                                                                                                                                                                                                                                                                                                                            |
| 16-May-2017 | 2        | <a href="#">Table 3</a> , <a href="#">Table 4</a> , and <a href="#">Table 5</a> : changed “DV <sub>IO</sub> to $\Delta V_{IO}/\Delta T$ , updated V <sub>OH</sub> parameter information, changed min. values for V <sub>OH</sub> parameter to max. values.<br><a href="#">Table 10: Order codes</a> : removed obsolete order codes TSV6192ID and TSV6192AID |

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