

1.8 V input/output, rail-to-rail, low power operational amplifiers

Features

- Operating range from $V_{CC} = 1.8$ to 6 V
- Rail-to-rail input and output
- Extended V_{icm} ($V_{CC-} - 0.2$ V to $V_{CC+} + 0.2$ V)
- Low supply current (120 μ A)
- Good accuracy (1 mV max for A version)
- Gain bandwidth product (530 kHz)
- High unity gain stability (able to drive 500 pF)
- ESD tolerance (2 kV)
- Latch-up immunity
- Available in SOT23-5 micropackage

Applications

- Two-cell battery-powered systems
- Battery-powered electronic equipment
- Cordless phones
- Cellular phones
- Laptops
- PDAs

Description

The TS185x (single, dual and quad) can operate with voltages as low as 1.8 V. They feature both input and output rail-to-rail (1.71 at $V_{CC} = 1.8$ V, $R_L = 2$ k Ω), 120 μ A current consumption and 530 kHz gain bandwidth product.

With this low consumption and a sufficient GBP for many applications, these operational amplifiers are well-suited to all kinds of battery supplied and portable applications.

The TS1851 is housed in the space-saving 5-pin SOT23-5 package, which simplifies board design (outside dimensions are 2.8 mm x 2.9 mm).

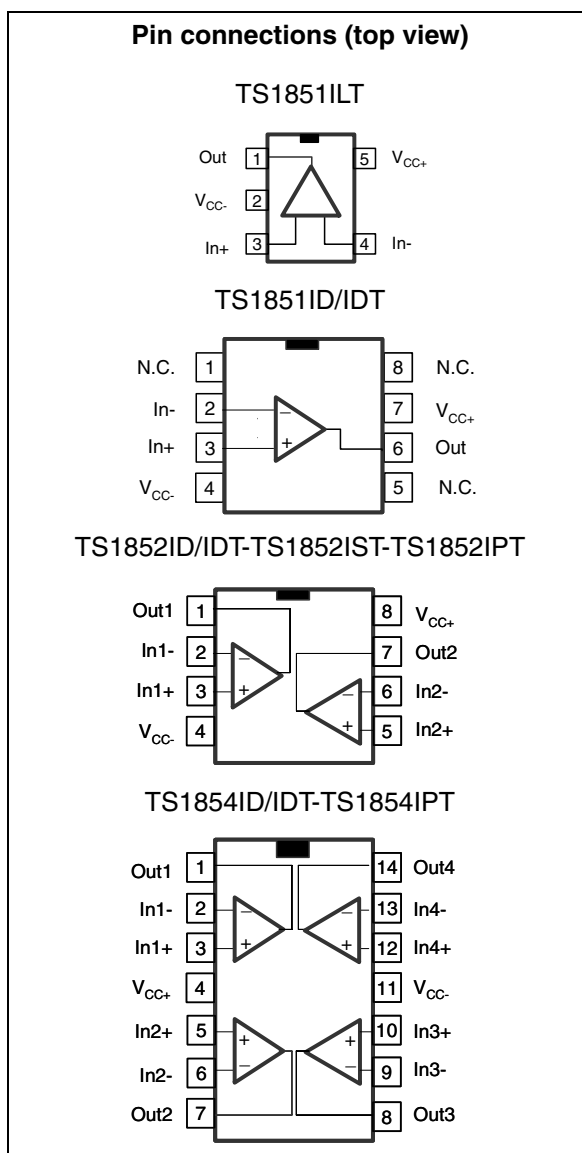


Table 1. Device summary

| Reference | Single version | Dual version | Quad version |
|-----------|----------------|--------------|--------------|
| TS185x | TS1851 | TS1852 | TS1854 |
| TS185xA | TS1851A | TS1852A | TS1854A |

Contents

| | | |
|----------|--|-----------|
| 1 | Absolute maximum ratings and operating conditions | 3 |
| 2 | Electrical characteristics | 5 |
| 3 | Package information | 15 |
| 3.1 | SO-8 package information | 16 |
| 3.2 | TSSOP8 package information | 17 |
| 3.3 | MiniSO-8 package information | 18 |
| 3.4 | SO-14 package information | 19 |
| 3.5 | TSSOP14 package information | 20 |
| 3.6 | SOT23-5 package information | 21 |
| 4 | Ordering information | 22 |
| 5 | Revision history | 23 |

1 Absolute maximum ratings and operating conditions

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|------------|---|------------------------------------|------|
| V_{CC} | Supply voltage ⁽¹⁾ | 7 | V |
| V_{id} | Differential input voltage ⁽²⁾ | ± 1 | V |
| V_i | Input voltage | $V_{CC-} - 0.3$ to $V_{CC+} + 0.3$ | V |
| T_{oper} | Operating free-air temperature range | -40 to + 125 | °C |
| T_{stg} | Storage temperature | -65 to +150 | °C |
| T_j | Maximum junction temperature | 150 | °C |
| R_{thja} | Thermal resistance junction to ambient ⁽³⁾ | | °C/W |
| | SOT23-5 | 250 | |
| | miniSO-8 | 190 | |
| | SO-8 | 125 | |
| | SO-14 | 103 | |
| | TSSOP8 TSSOP14 | 120 100 | |
| R_{thjc} | Thermal resistance junction to case | | °C/W |
| | SOT23-5 | 81 | |
| | miniSO-8 | 39 | |
| | SO-8 | 40 | |
| | SO-14 | 31 | |
| | TSSOP8 TSSOP14 | 37 32 | |
| ESD | HBM: human body model ⁽⁴⁾ | 2 | kV |
| | MM: machine model ⁽⁵⁾ | 200 | V |
| | CDM: charged device model ⁽⁶⁾ | 1.5 | kV |
| | Lead temperature (soldering, 10sec) | 250 | °C |
| | Output short-circuit duration | See note ⁽⁷⁾ | |

- All voltage values, except differential voltages, are with respect to network terminal.
- Differential voltages are the non-inverting input terminal with respect to the inverting input terminal. If $V_{id} > \pm 1$ V, the maximum input current must not exceed ± 1 mA. When $V_{id} > \pm 1$ V, add an input series resistor to limit the input current.
- Short-circuits can cause excessive heating. Destructive dissipation can result from simultaneous short-circuits on all amplifiers.
- Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5 k Ω resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
- Machine model: a 200 pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5 Ω). This is done for all couples of connected pin combinations while the other pins are floating.
- Charged device model: all pins and package are charged together to the specified voltage and then discharged directly to ground through only one pin. This is done for all pins.
- Short-circuits from the output to V_{CC} can cause excessive heating. The maximum output current is approximately 48 mA, independent of the magnitude of V_{CC} . Destructive dissipation can result from simultaneous short-circuits on all amplifiers.

Table 3. Operating conditions

| Symbol | Parameter | Value | Unit |
|------------|--|--|--------------------|
| V_{CC} | Supply voltage | 1.8 to 6 | V |
| V_{icm} | Common-mode input voltage range $T_{op} = 25^{\circ}\text{C}$, $1.8 \leq V_{CC} \leq 6\text{ V}$ $T_{min} < T_{op} < T_{max}$, $1.8 \leq V_{CC} \leq 5.5\text{ V}$ | $V_{CC-} - 0.2$ to $V_{CC+} + 0.2$ V_{CC-} to V_{CC+} | V |
| T_{oper} | Operating free-air temperature range | -40 to + 125 | $^{\circ}\text{C}$ |

2 Electrical characteristics

Table 4. Electrical characteristics measured at $V_{CC+} = +1.8\text{ V}$, $V_{CC-} = 0\text{ V}$, with C_L and R_L connected to $V_{CC}/2$, $T_{\text{amb}} = 25^\circ\text{C}$ (unless otherwise specified) ⁽¹⁾

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|-----------------|--|---|----------------------------|-------------|------------------------|------------------------------|
| V_{io} | Input offset voltage | TS1851/2/4 $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$ TS1851A/2A/4A $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$ | | 0.1 | 3 6 1 1.5 | mV |
| ΔV_{io} | Input offset voltage drift | | | 2 | | $\mu\text{V}/^\circ\text{C}$ |
| I_{io} | Input offset current | $V_{\text{icm}} = V_{\text{out}} = V_{CC}/2$ ⁽²⁾ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$ | | 1 | 9 25 | nA |
| I_{ib} | Input bias current | $V_{\text{icm}} = V_{\text{out}} = V_{CC}/2$ ⁽²⁾ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$ | | 10 | 50 80 | nA |
| CMR | Common mode rejection ratio $20 \log (\Delta V_{ic}/\Delta V_{io})$ | $0 \leq V_{\text{icm}} \leq V_{CC}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$ | 55 52 | 85 | | dB |
| A_{vd} | Large signal voltage gain | $V_{\text{out}} = 0.5$ to 1.3 V $R_L = 10\text{ k}\Omega$ $R_L = 2\text{ k}\Omega$ | 80 70 | 100 100 | | dB |
| V_{OH} | High level output voltage | $V_{id} = 100\text{ mV}$ $R_L = 10\text{ k}\Omega$ $R_L = 2\text{ k}\Omega$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$, $R_L = 10\text{ k}\Omega$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$, $R_L = 2\text{ k}\Omega$ | 1.7 1.65 1.7 1.65 | 1.77 1.7 | | V |
| V_{OL} | Low level output voltage | $V_{id} = -100\text{ mV}$ $R_L = 10\text{ k}\Omega$ $R_L = 2\text{ k}\Omega$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$, $R_L = 10\text{ k}\Omega$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$, $R_L = 2\text{ k}\Omega$ | | 40 62 | 70 90 100 120 | mV |
| I_o | Output source current | $V_{id} = 100\text{ mV}$, $V_O = V_{CC-}$ at T_{amb} at $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$ | 15 5 | 29 5 | | mA |
| | Output sink current | $V_{id} = -100\text{ mV}$, $V_O = V_{CC+}$, at T_{amb} at $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$ | 15 5 | 46 | | |
| I_{CC} | Supply current (per amplifier) | $V_{\text{out}} = V_{CC}/2$ $A_{VCL} = 1$, no load $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$ | | 120 | 170 200 | μA |
| GBP | Gain bandwidth product | $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$, $f = 100\text{ kHz}$ | 300 | 530 | | kHz |
| SR | Slew rate | $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$, $A_V = 1$ | 0.1 | 0.18 | | $\text{V}/\mu\text{s}$ |
| ϕ_m | Phase margin | $C_L = 100\text{ pF}$ | | 60 | | Degrees |
| e_n | Input voltage noise | $f = 1\text{ kHz}$ | | 40 | | $\text{nV}/\sqrt{\text{Hz}}$ |
| THD | Total harmonic distortion | | | 0.01 | | % |

1. All parameter limits at temperatures other than 25°C are guaranteed by correlation.
2. Maximum values include unavoidable inaccuracies of the industrial tests.

Table 5. Electrical characteristics measured at $V_{CC+} = +3\text{ V}$, $V_{CC-} = 0\text{ V}$, with C_L and R_L connected to $V_{CC}/2$, $T_{amb} = 25^\circ\text{C}$ (unless otherwise specified) ⁽¹⁾

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|-----------------|--|---|----------------------------|--------------|-------------------------|------------------------------|
| V_{io} | Input offset voltage | $V_{icm} = V_{out} = V_{CC}/2$ TS1851/2/4 $T_{min} \leq T_{amb} \leq T_{max}$ TS1851A/2A/4A $T_{min} \leq T_{amb} \leq T_{max}$ | | 0.1 | 3 6 1 1.5 | mV |
| ΔV_{io} | Input offset voltage drift | | | 2 | | $\mu\text{V}/^\circ\text{C}$ |
| I_{io} | Input offset current | $V_{icm} = V_{out} = V_{CC}/2$ ⁽²⁾ $T_{min} \leq T_{amb} \leq T_{max}$ | | 1 | 9 25 | nA |
| I_{ib} | Input bias current | $V_{icm} = V_{out} = V_{CC}/2$ ⁽²⁾ $T_{min} \leq T_{amb} \leq T_{max}$ | | 10 | 55 85 | nA |
| CMR | Common mode rejection ratio $20 \log (\Delta V_{ic}/\Delta V_{io})$ | $0 \leq V_{icm} \leq V_{CC}$ $T_{min} \leq T_{amb} \leq T_{max}$ | 60 57 | 90 | | dB |
| A_{vd} | Large signal voltage gain | $V_{out} = 0.5 \text{ to } 2.5\text{ V}$ $R_L = 10\text{ k}\Omega$ $R_L = 2\text{ k}\Omega$ | 83 74 | 102 102 | | dB |
| V_{OH} | High level output voltage | $V_{id} = 100\text{ mV}$ $R_L = 10\text{ k}\Omega$ $R_L = 2\text{ k}\Omega$ $T_{min} \leq T_{amb} \leq T_{max}$, $R_L = 10\text{ k}\Omega$ $T_{min} \leq T_{amb} \leq T_{max}$, $R_L = 2\text{ k}\Omega$ | 2.9 2.85 2.9 2.85 | 2.96 2.94 | | V |
| V_{OL} | Low level output voltage | $V_{id} = -100\text{ mV}$ $R_L = 10\text{ k}\Omega$ $R_L = 2\text{ k}\Omega$ $T_{min} \leq T_{amb} \leq T_{max}$, $R_L = 10\text{ k}\Omega$ $T_{min} \leq T_{amb} \leq T_{max}$, $R_L = 2\text{ k}\Omega$ | | 10 46 | 90 100 120 130 | mV |
| I_o | Output source current | $V_{id} = 100\text{ mV}$, $V_O = V_{CC-}$, at T_{amb} | 15 | 47 | | mA |
| | | At $T_{min} \leq T_{amb} \leq T_{max}$ | 5 | | | |
| | Output sink current | $V_{id} = -100\text{ mV}$, $V_O = V_{CC+}$, at T_{amb} | 15 | 47 | | mA |
| | | At $T_{min} \leq T_{amb} \leq T_{max}$ | 5 | | | |
| I_{CC} | Supply current (per amplifier) | $V_{out} = V_{CC}/2$ $A_{VCL} = 1$, no load $T_{min} \leq T_{amb} \leq T_{max}$ | | 150 | 200 230 | μA |
| GBP | Gain bandwidth product | $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$, $f = 100\text{ kHz}$ | 370 | 600 | | kHz |
| SR | Slew rate | $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$, $A_V = 1$ | 0.12 | 0.2 | | $\text{V}/\mu\text{s}$ |
| ϕ_m | Phase margin | $C_L = 100\text{ pF}$ | | 60 | | Degrees |
| e_n | Input voltage noise | $f = 1\text{ kHz}$ | | 40 | | $\text{nV}/\sqrt{\text{Hz}}$ |
| THD | Total harmonic distortion | $V_{out} = 2\text{ V}_{pk-pk}$, $A_V = -1$, $f = 1\text{ kHz}$ | | 0.005 | | % |

1. All parameter limits at temperatures other than 25°C are guaranteed by correlation.
2. Maximum values include unavoidable inaccuracies of the industrial tests.

Table 6. Electrical characteristics measured at $V_{CC+} = +5\text{ V}$, $V_{CC-} = 0\text{ V}$, with C_L and R_L connected to $V_{CC}/2$, $T_{amb} = 25^\circ\text{C}$ (unless otherwise specified) ⁽¹⁾

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|-----------------|---|---|----------------------------|--------------|--------------------------|------------------------------|
| V_{io} | Input offset voltage | $V_{icm} = V_{out} = V_{CC}/2$ TS1851/2/4 $T_{min} \leq T_{amb} \leq T_{max}$ TS1851A/2A/4A $T_{min} \leq T_{amb} \leq T_{max}$ | | 0.1 | 3 6 1 1.5 | mV |
| ΔV_{io} | Input offset voltage drift | | | 2 | | $\mu\text{V}/^\circ\text{C}$ |
| I_{io} | Input offset current | $V_{icm} = V_{out} = V_{CC}/2^{(2)}$ $T_{min} \leq T_{amb} \leq T_{max}$ | | 1 | 9 25 | nA |
| I_{ib} | Input bias current | $V_{icm} = V_{out} = V_{CC}/2^{(2)}$ $T_{min} \leq T_{amb} \leq T_{max}$ | | 16 | 63 93 | nA |
| CMR | Common mode rejection ratio $20 \log (\Delta V_{ic}/\Delta V_{io})$ | $0 \leq V_{icm} \leq V_{CC}$ $T_{min} \leq T_{amb} \leq T_{max}$ | 65 62 | 95 | | dB |
| SVR | Supply voltage rejection ratio $20 \log (\Delta V_{CC}/\Delta V_{io})$ | $V_{CC} = 1.8 \text{ to } 5\text{ V}$ | 70 | 90 | | dB |
| A_{vd} | Large signal voltage gain | $V_{out} = 0.5 \text{ to } 4\text{ V}$ $R_L = 10\text{ k}\Omega$ $R_L = 2\text{ k}\Omega$ | 85 77 | 104 104 | | dB |
| V_{OH} | High level output voltage | $V_{id} = 100\text{ mV}$ $R_L = 10\text{ k}\Omega$ $R_L = 2\text{ k}\Omega$ $T_{min} \leq T_{amb} \leq T_{max}, R_L = 10\text{ k}\Omega$ $T_{min} \leq T_{amb} \leq T_{max}, R_L = 2\text{ k}\Omega$ | 4.85 4.8 4.85 4.8 | 4.95 4.91 | | V |
| V_{OL} | Low level output voltage | $V_{id} = -100\text{ mV}$ $R_L = 10\text{ k}\Omega$ $R_L = 2\text{ k}\Omega$ $T_{min} \leq T_{amb} \leq T_{max}, R_L = 10\text{ k}\Omega$ $T_{min} \leq T_{amb} \leq T_{max}, R_L = 2\text{ k}\Omega$ | | 40 80 | 180 200 180 200 | mV |
| I_o | Output source current | $V_{id} = 100\text{ mV}, V_O = V_{CC-}$, at T_{amb} at $T_{min} \leq T_{amb} \leq T_{max}$ | 15 | 48 | | mA |
| | Output sink current | $V_{id} = -100\text{ mV}, V_O = V_{CC+}$, at T_{amb} at $T_{min} \leq T_{amb} \leq T_{max}$ | 15 | 48 | | |
| I_{CC} | Supply current (per amplifier) | $V_{out} = V_{CC}/2$ $A_{VCL} = 1$, no load $T_{min} \leq T_{amb} \leq T_{max}$ | | 162 | 220 250 | μA |
| GBP | Gain bandwidth product | $R_L = 10\text{ k}\Omega, C_L = 100\text{ pF}, f = 100\text{ kHz}$ | 380 | 656 | | kHz |
| SR | Slew rate | $R_L = 10\text{ k}\Omega, C_L = 100\text{ pF}, A_V = 1$ | 0.13 | 0.25 | | V/ μs |
| ϕ_m | Phase margin | $C_L = 100\text{ pF}$ | | 60 | | Degrees |
| e_n | Input voltage noise | $f = 1\text{ kHz}$ | | 40 | | nV/ $\sqrt{\text{Hz}}$ |
| THD | Total harmonic distortion | $V_{out} = 2\text{ V}_{pk-pk}, A_V = -1, f = 1\text{ kHz}$ | | 0.01 | | % |

1. All parameter limits at temperatures other than 25°C are guaranteed by correlation.
2. Maximum values include unavoidable inaccuracies of the industrial tests.



Figure 1. Input offset voltage distribution

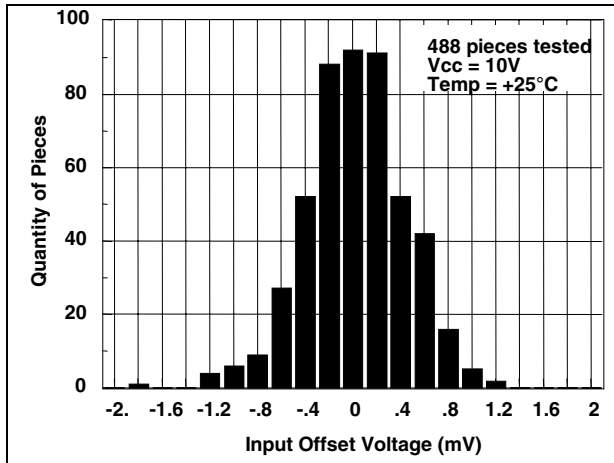


Figure 2. Input offset voltage vs. temperature

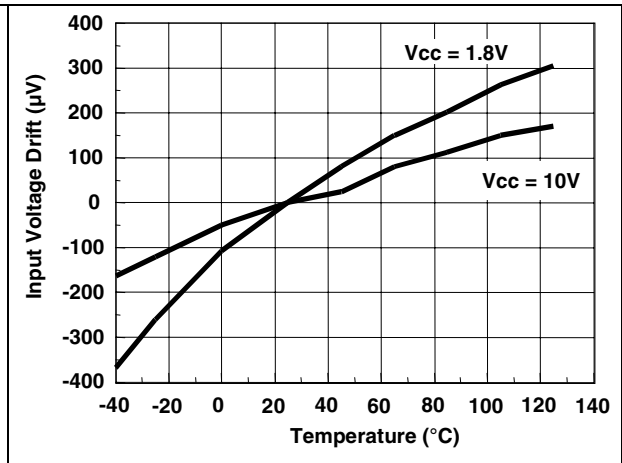


Figure 3. Input bias current vs. temperature at Vcc = 1.8 V

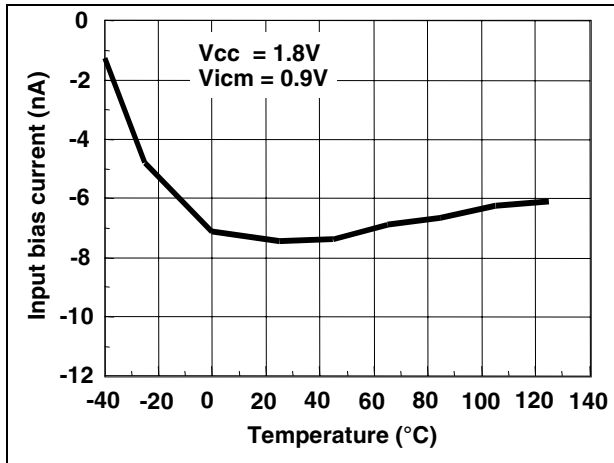


Figure 4. Input bias current vs. temperature at Vcc = 3 V

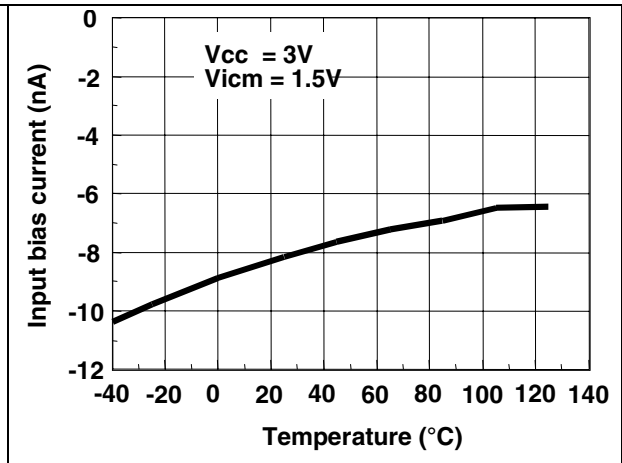


Figure 5. Input bias current vs. temperature at Vcc = 5 V

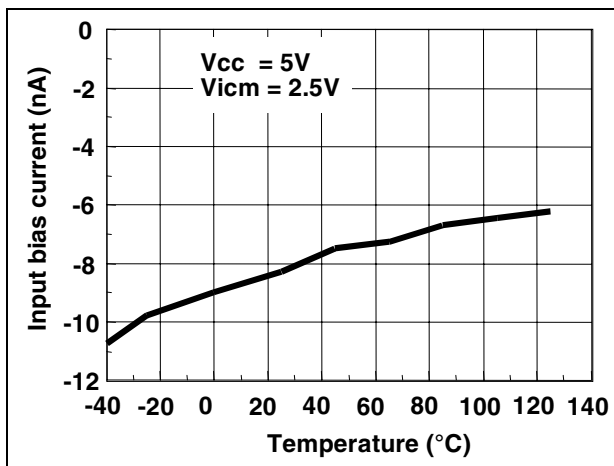


Figure 6. Supply current/amplifier vs. supply voltage

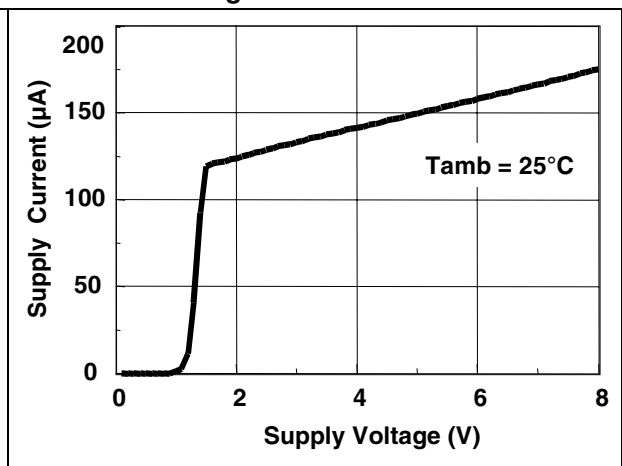


Figure 7. Supply current/amplifier vs. temperature

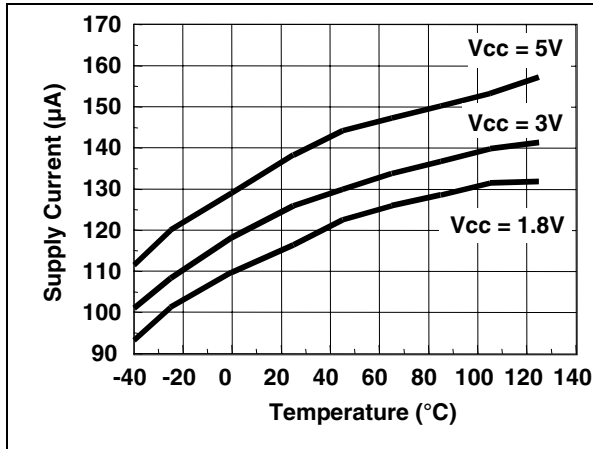


Figure 8. Common mode rejection vs. temperature at V_{CC} = 1.8 V

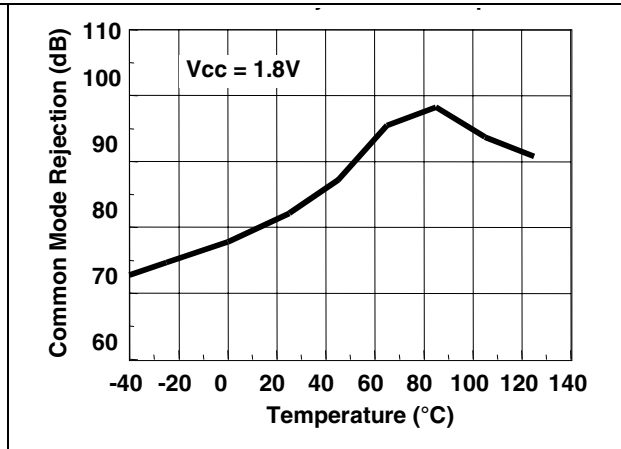


Figure 9. Common mode rejection vs. temperature at V_{CC} = 3 V

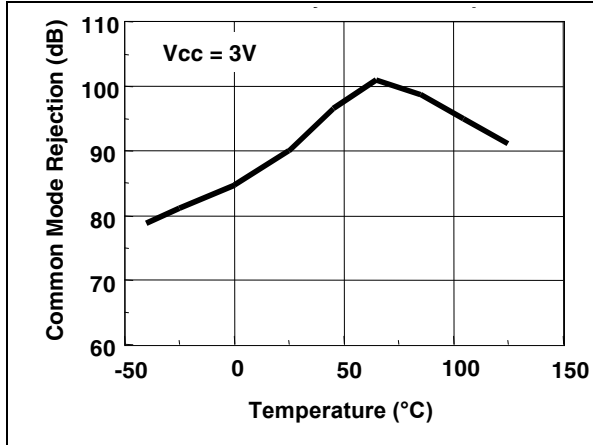


Figure 10. Common mode rejection vs. temperature at V_{CC} = 5 V

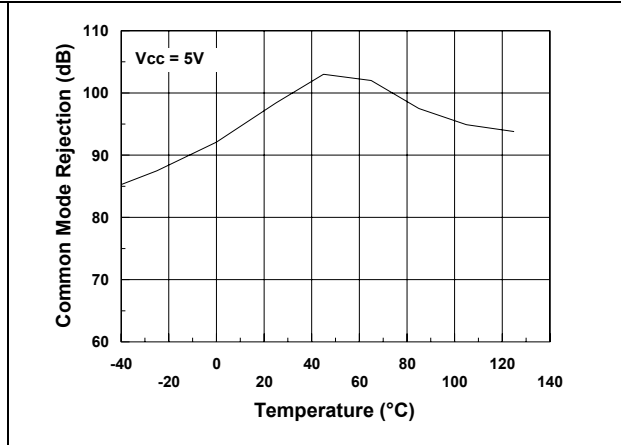


Figure 11. Supply voltage rejection vs. temperature at V_{CC} = 2 V

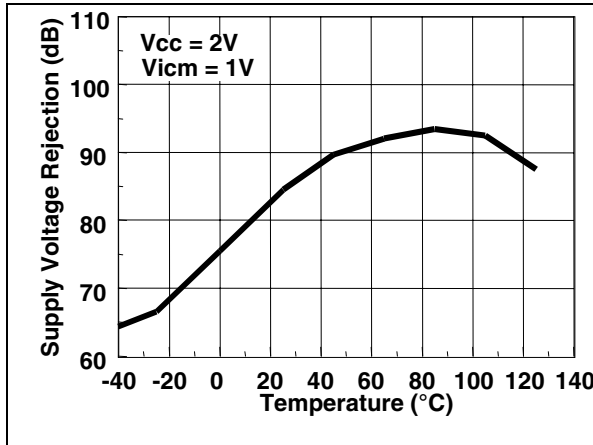


Figure 12. Supply voltage rejection vs. temperature at V_{CC} = 3 V

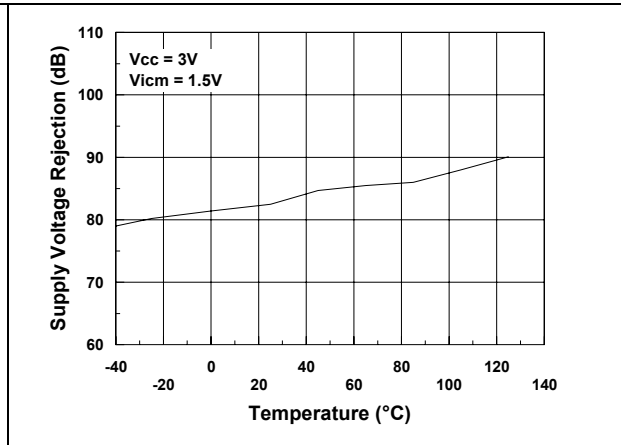


Figure 13. Supply voltage rejection vs. temperature at $V_{CC} = 5\text{ V}$

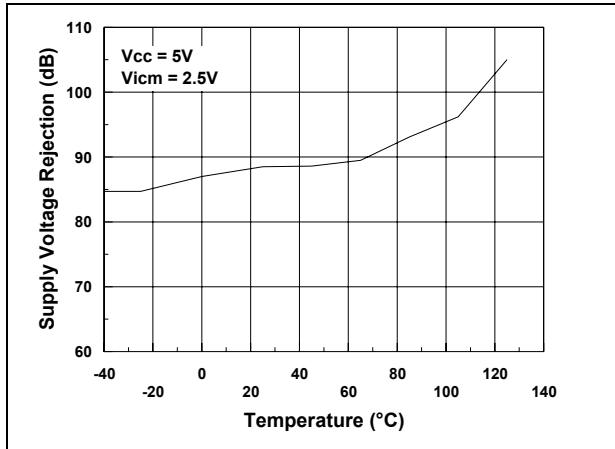


Figure 14. Open loop gain vs. temperature at $V_{CC} = 1.8\text{ V}$

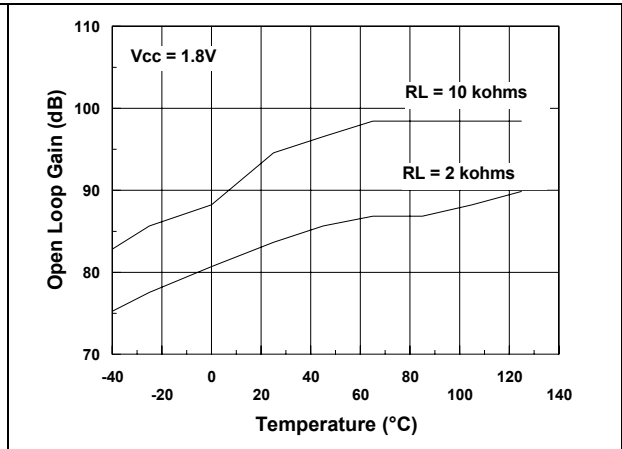


Figure 15. Open loop gain vs. temperature at $V_{CC} = 3\text{ V}$

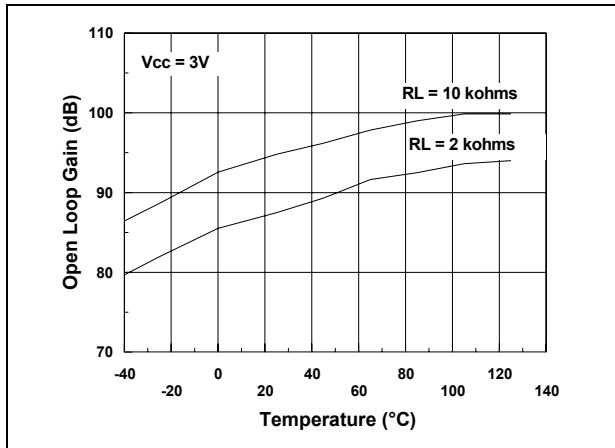


Figure 16. Open loop gain vs. temperature at $V_{CC} = 5\text{ V}$

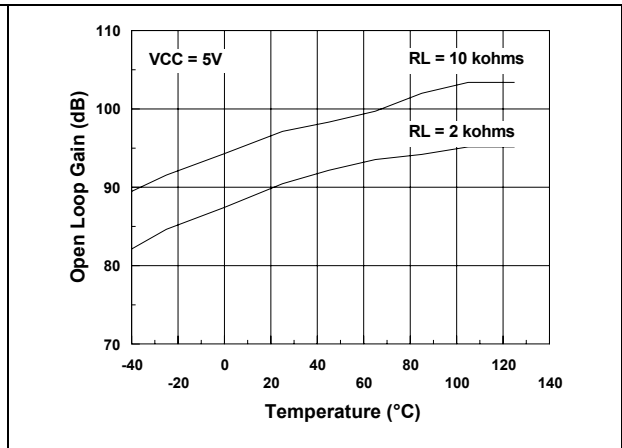


Figure 17. High level output voltage vs. temperature, $R_L = 10\text{ k}\Omega$

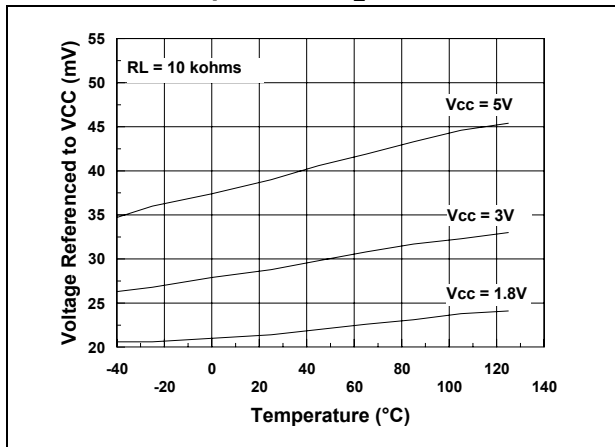


Figure 18. Low level output voltage vs. temperature, $R_L = 10\text{ k}\Omega$

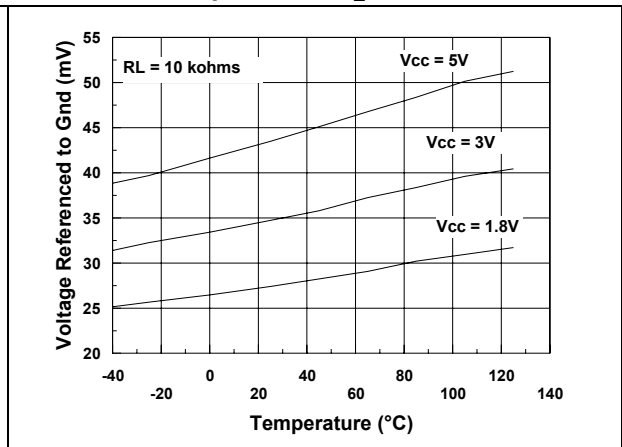


Figure 19. High level output voltage vs. temperature, $R_L = 2\text{ k}\Omega$

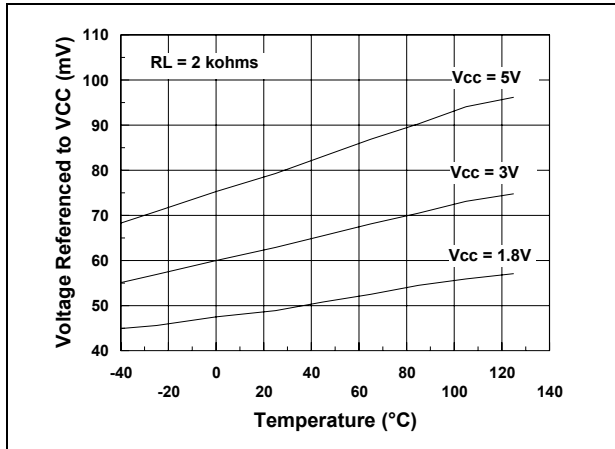


Figure 20. Low level output voltage vs. temperature, $R_L = 2\text{ k}\Omega$

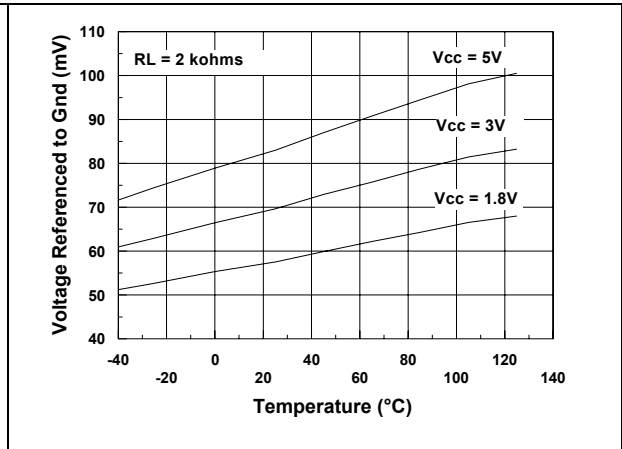


Figure 21. Output current vs. temperature

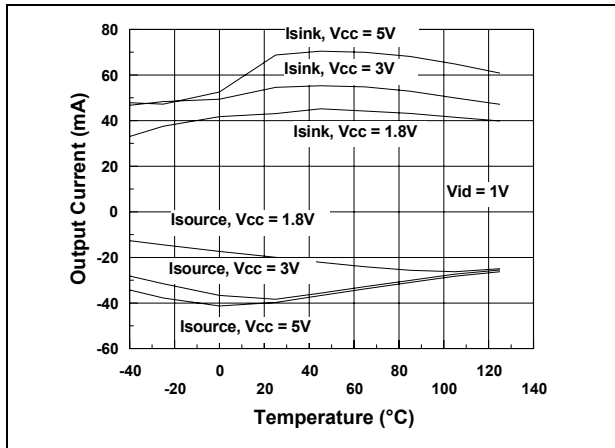


Figure 22. Output current vs. output voltage at $V_{CC} = 1.8\text{ V}$

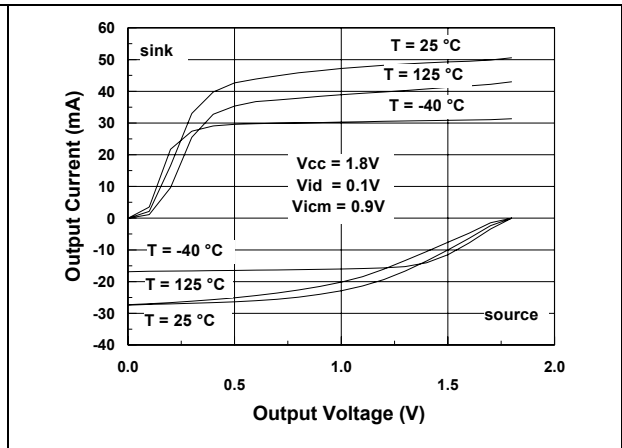


Figure 23. Output current vs. output voltage at $V_{CC} = 3\text{ V}$

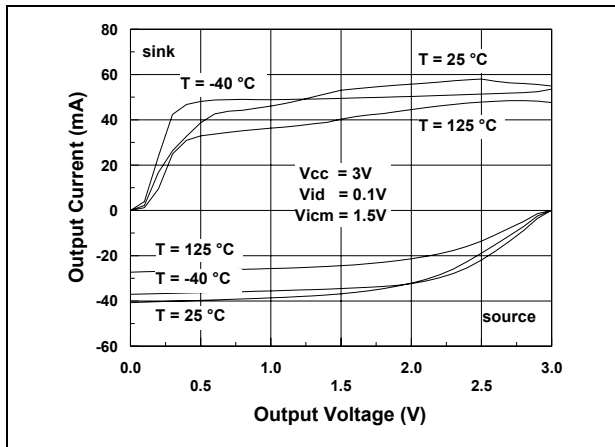


Figure 24. Output current vs. output voltage at $V_{CC} = 5\text{ V}$

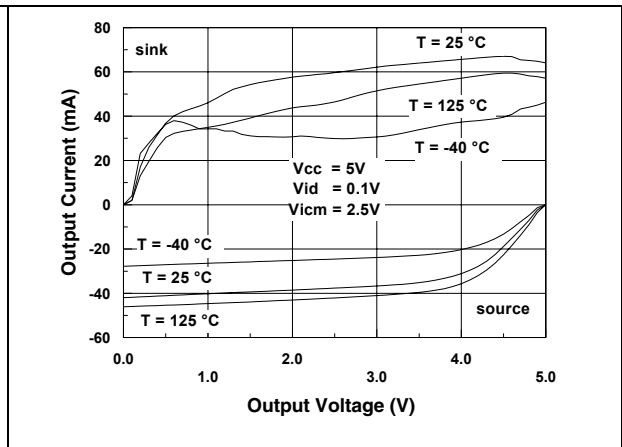


Figure 25. Gain and phase vs. frequency at $V_{CC} = 1.8\text{ V}$

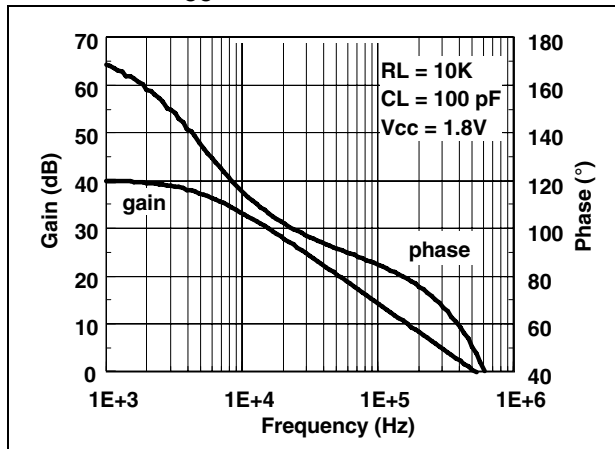


Figure 26. Gain and phase vs. frequency at $V_{CC} = 5\text{ V}$

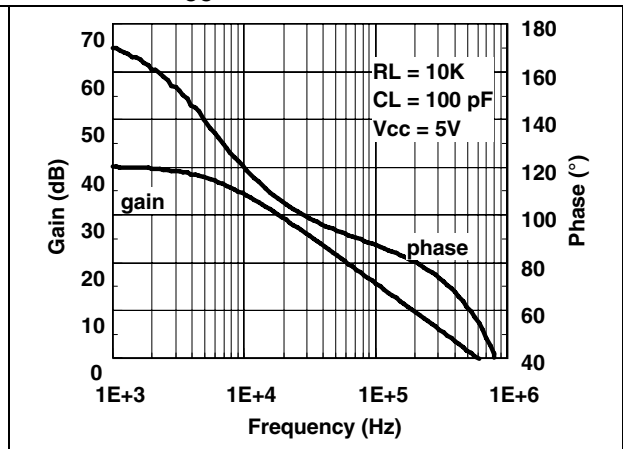


Figure 27. Gain bandwidth product vs. temperature

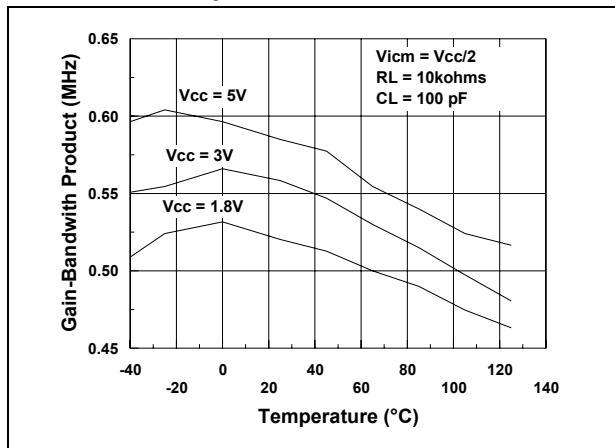


Figure 28. Gain bandwidth product vs. supply voltage

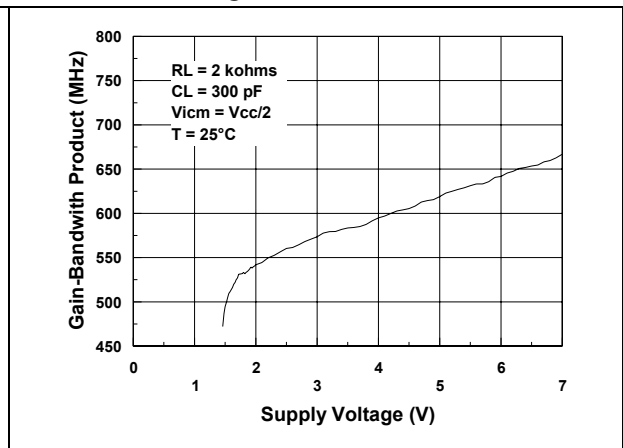


Figure 29. Slew rate vs. temperature at $V_{CC} = 1.8\text{ V}$

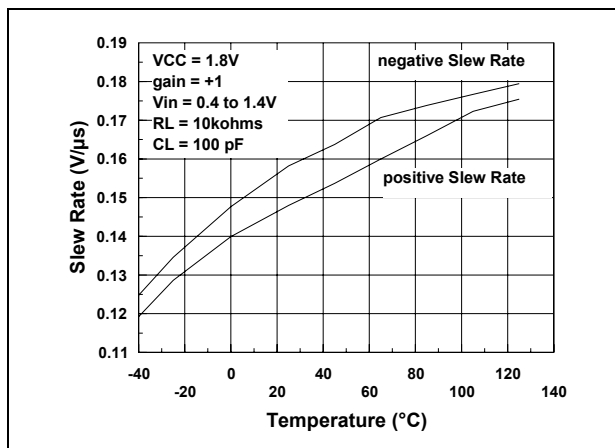


Figure 30. Slew rate vs. temperature at $V_{CC} = 3\text{ V}$

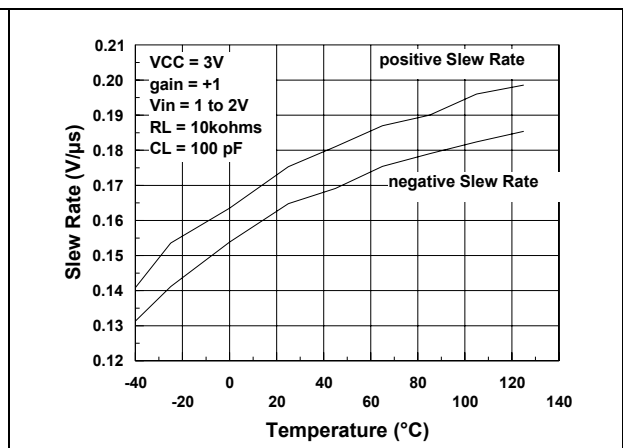


Figure 31. Slew rate vs. temperature at $V_{CC} = 5\text{ V}$

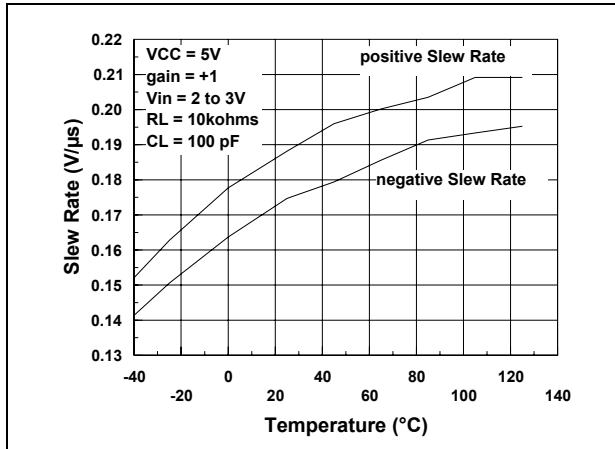


Figure 32. Phase margin vs. load capacitor

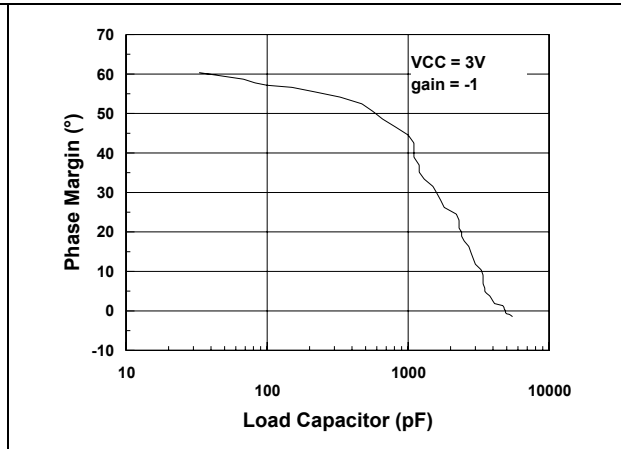


Figure 33. Phase margin vs. output current

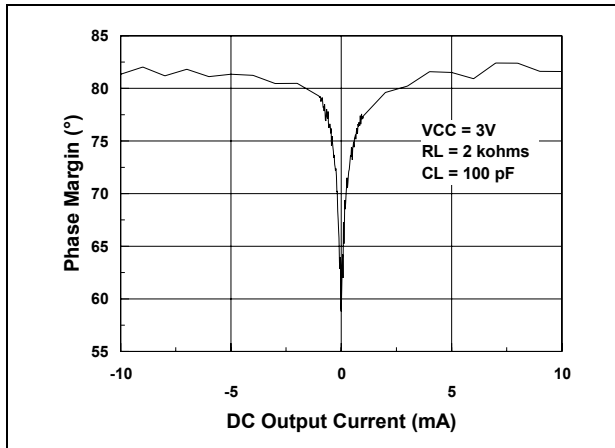


Figure 34. Equivalent input noise vs. frequency

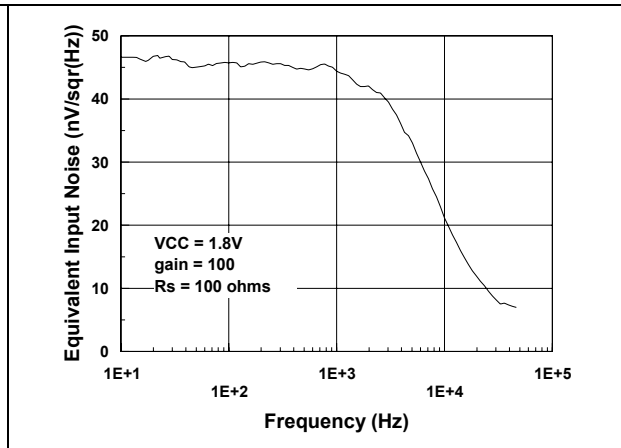


Figure 35. Distortion vs. output voltage at $V_{CC} = 1.8\text{ V}$

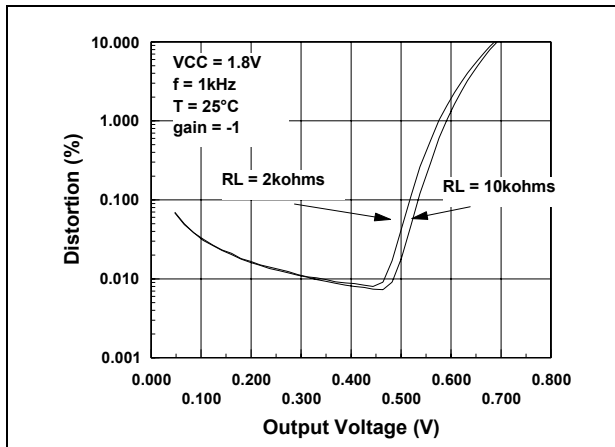


Figure 36. Distortion vs. output voltage at $V_{CC} = 3\text{ V}$

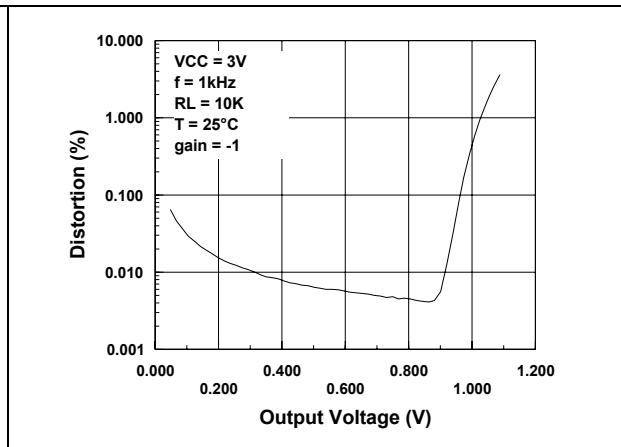


Figure 37. Distortion vs. output voltage at $V_{CC} = 5\text{ V}$

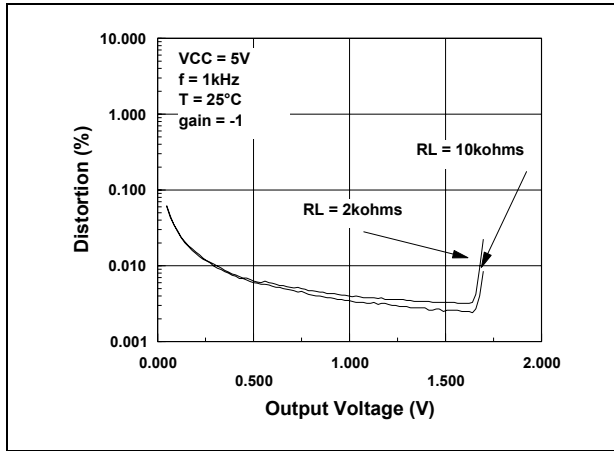
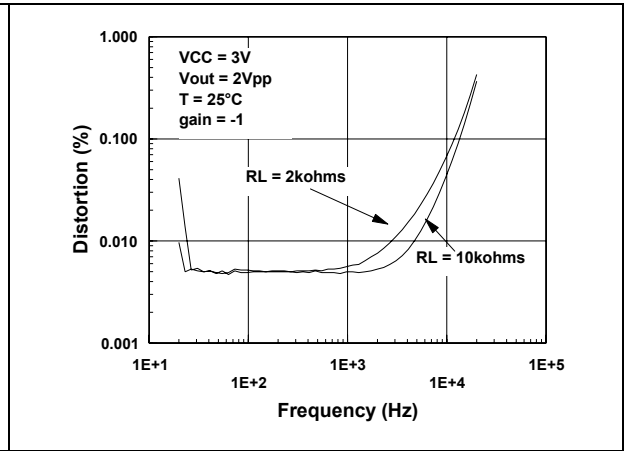


Figure 38. Distortion vs. frequency



3 Package information

In order to meet environmental requirements, ST offers these devices in different grades of ECOPACK[®] packages, depending on their level of environmental compliance. ECOPACK[®] specifications, grade definitions and product status are available at: www.st.com. ECOPACK[®] is an ST trademark.

3.1 SO-8 package information

Figure 39. SO-8 package mechanical drawing

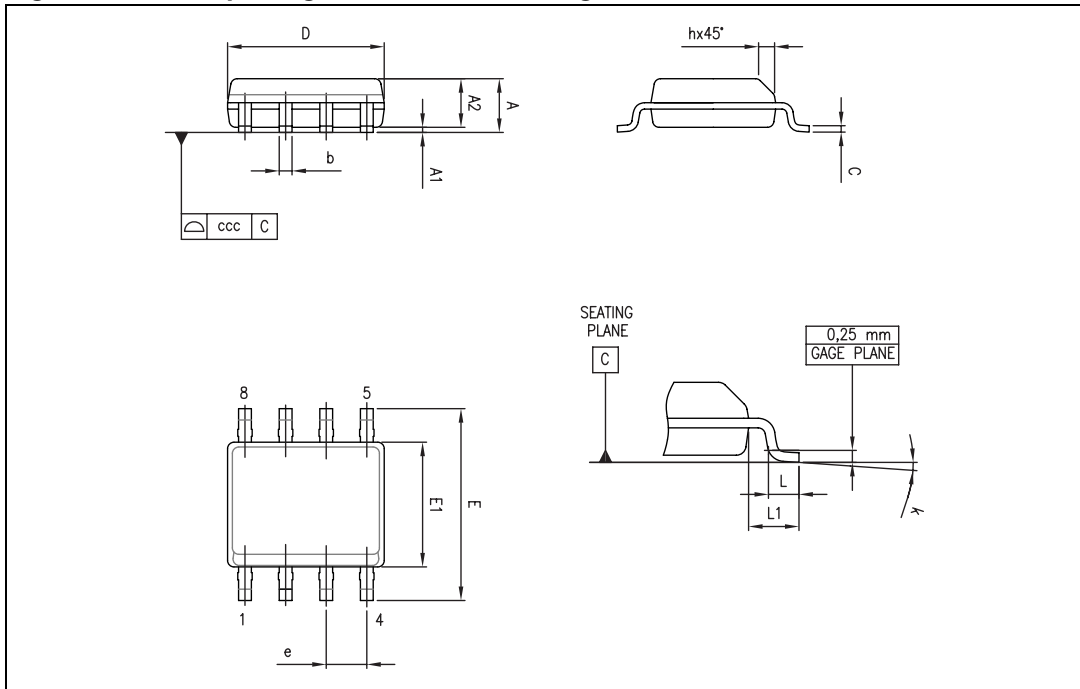


Table 7. SO-8 package mechanical data

| 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 |

3.2 TSSOP8 package information

Figure 40. TSSOP8 package mechanical drawing

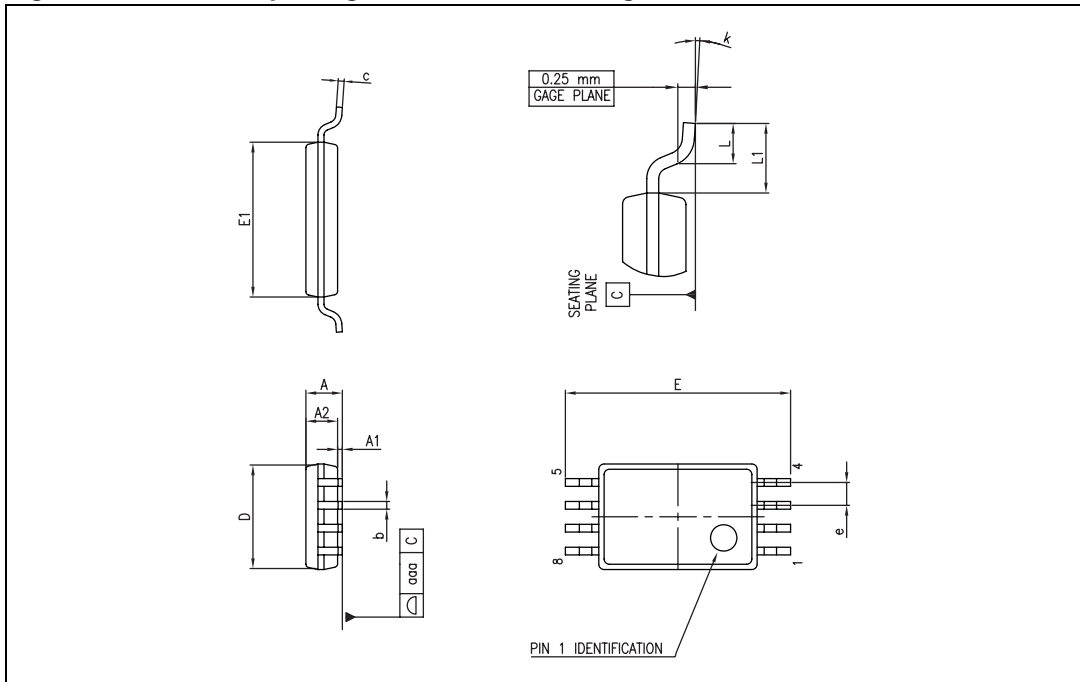


Table 8. TSSOP8 package mechanical data

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

3.3 MiniSO-8 package information

Figure 41. MiniSO-8 package mechanical drawing

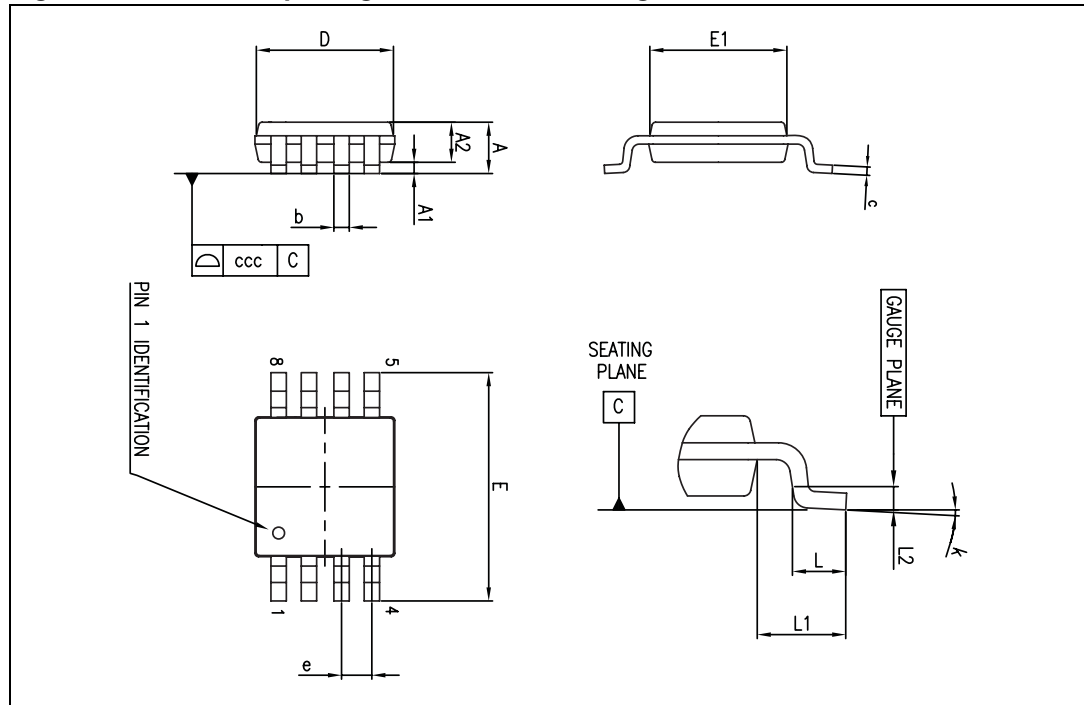


Table 9. MiniSO-8 package mechanical data

| 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 |

3.4 SO-14 package information

Figure 42. SO-14 package mechanical drawing

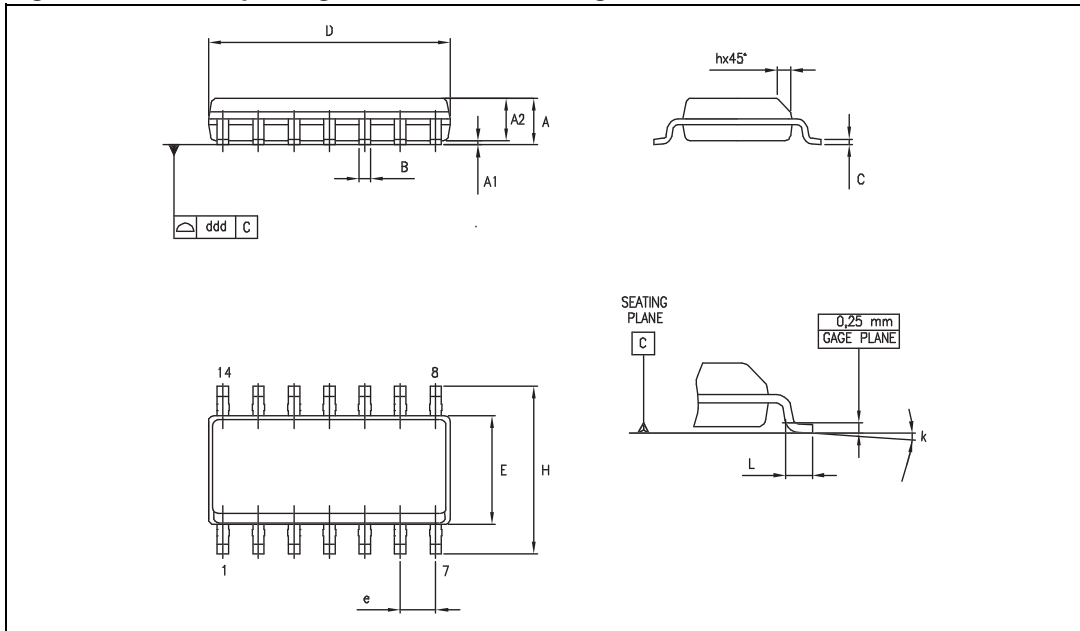


Table 10. SO-14 package mechanical data

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

3.5 TSSOP14 package information

Figure 43. TSSOP14 package mechanical drawing

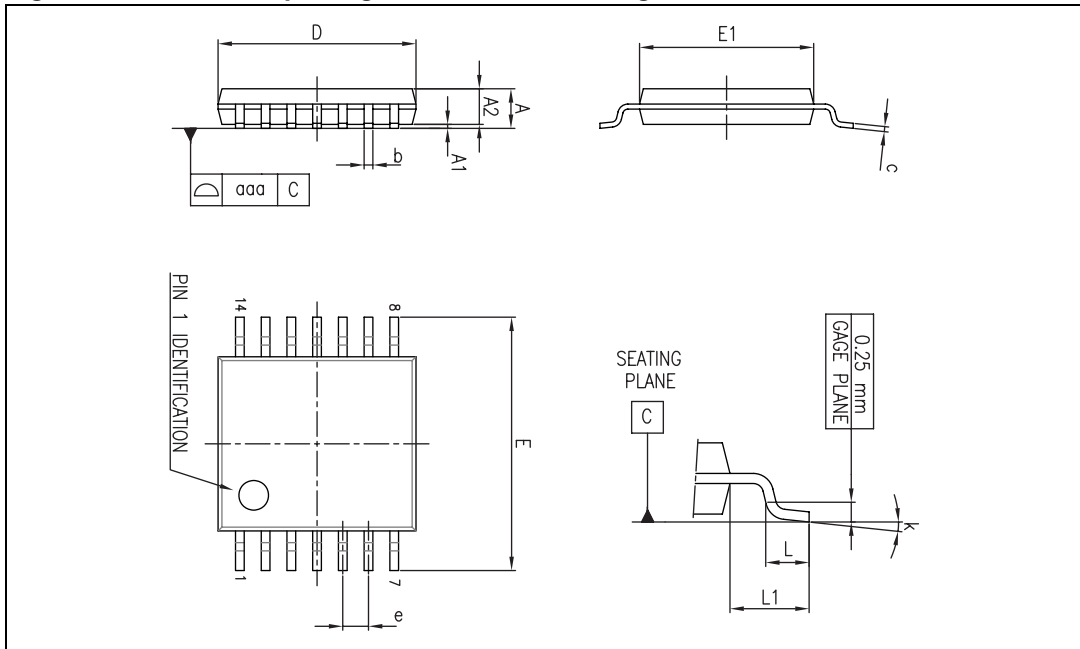


Table 11. TSSOP14 package mechanical data

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

3.6 SOT23-5 package information

Figure 44. SOT23-5L package mechanical drawing

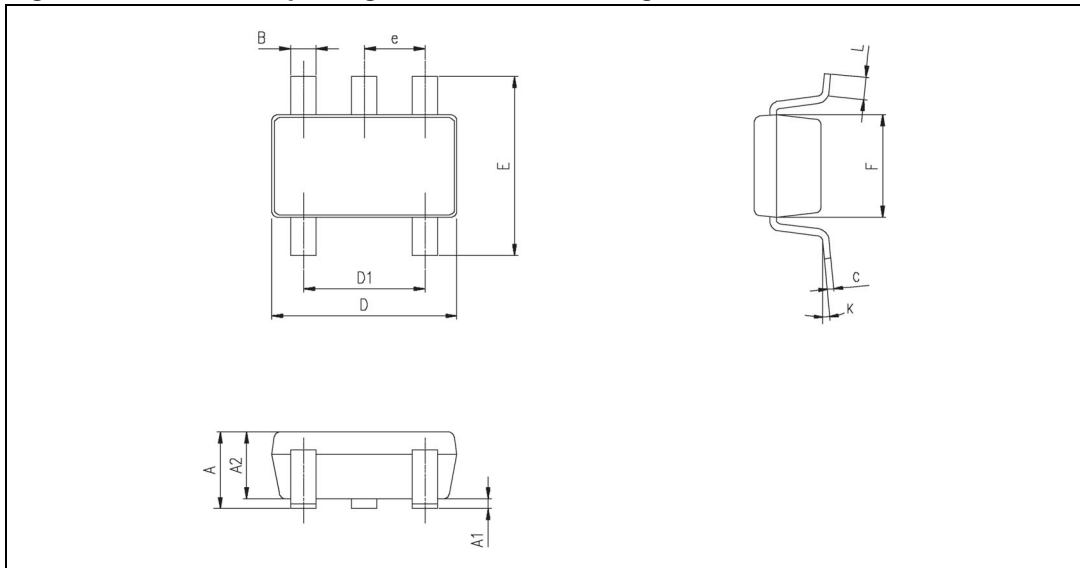


Table 12. SOT23-5L package mechanical data

| 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° | | 10° | | | |

4 Ordering information

Table 13. Order codes

| Order code | Temperature range | Package | Packing | Marking |
|----------------|-------------------|--|---------------------|---------|
| TS1851ID/IDT | -40°C to +125°C | SO-8 | Tube or tape & reel | 1851I |
| TS1851AID/AIDT | | | | 1851AI |
| TS1851ILT | | SOT23-5L | Tape & reel | K161 |
| TS1851AILT | | | | K162 |
| TS1852ID/IDT | | SO-8 | Tube or tape & reel | 1852I |
| TS1852AID/AIDT | | | | 1852AI |
| TS1852IPT | | TSSOP8 (Thin shrink outline package) | Tape & reel | 1852I |
| TS1852AIPT | | | | 1852A |
| TS1852IST | | MiniSO-8 | Tape & reel | K161 |
| TS1852AIST | | | | K162 |
| TS1854ID/IDT | | SO-14 | Tube or tape & reel | 1854I |
| TS1854AID/AIDT | | | | 1854AI |
| TS1854IPT | | TSSOP14 (Thin shrink outline package) | Tape & reel | 1854I |
| TS1854AIPT | | | | 1854A |

5 Revision history

Table 14. Document revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 01-Feb-2002 | 1 | First release. |
| 01-May-2005 | 2 | Modifications on AMR Table 2 on page 3 (explanation of V_{id} and V_i limits) |
| 22-May-2007 | 3 | Added limits in temperature in Table 4 , Table 5 , and Table 6 . Added SVR in Table 6 (SVR parameter removed from Table 4 and Table 5). Added equivalent input voltage noise in Table 4 , Table 5 , and Table 6 . Added R_{thjc} values in Table 2 on page 3 . Updated Table 13: Order codes . |
| 12-Mar-2010 | 4 | Updated document format. Modified headings, added root part number TS185xA and added Table 1: Device summary on cover page. Modified Iout parameters in temperature, added limits at Tamb and improved typical values of A_{vd} in Table 4 , Table 5 and Table 6 . Updated package information in Chapter 3 . Removed order codes for DIP package from Table 13 . |

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