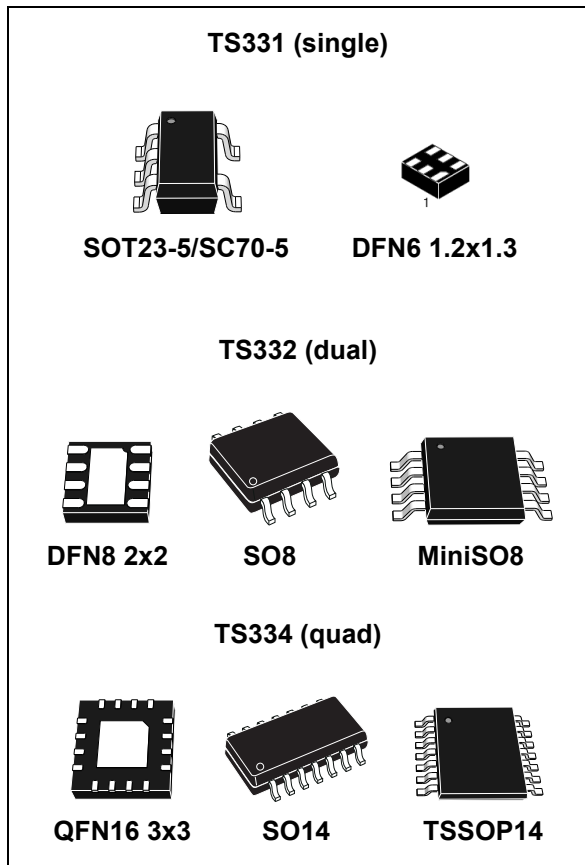


Micropower low-voltage, rail-to-rail comparators

Datasheet - production data

**Applications**

- Mobile phones
- Notebooks and PDAs
- Battery-supplied electronics
- General-purpose portable devices
- General-purpose low voltage applications

Description

The TS331, TS332 and TS334 are single, dual and quad micropower and low-voltage comparators. They can operate with a supply voltage ranging from 1.6 V to 5 V with a typical current consumption as low as 20 μ A. In addition, rail-to-rail inputs make them a perfect choice for low-voltage applications.

Their availability in tiny packages is a real advantage for overcoming space constraints.

The TS33x are specified for temperatures between -40 °C to +125 °C, making them ideal for a wide range of applications.

Features

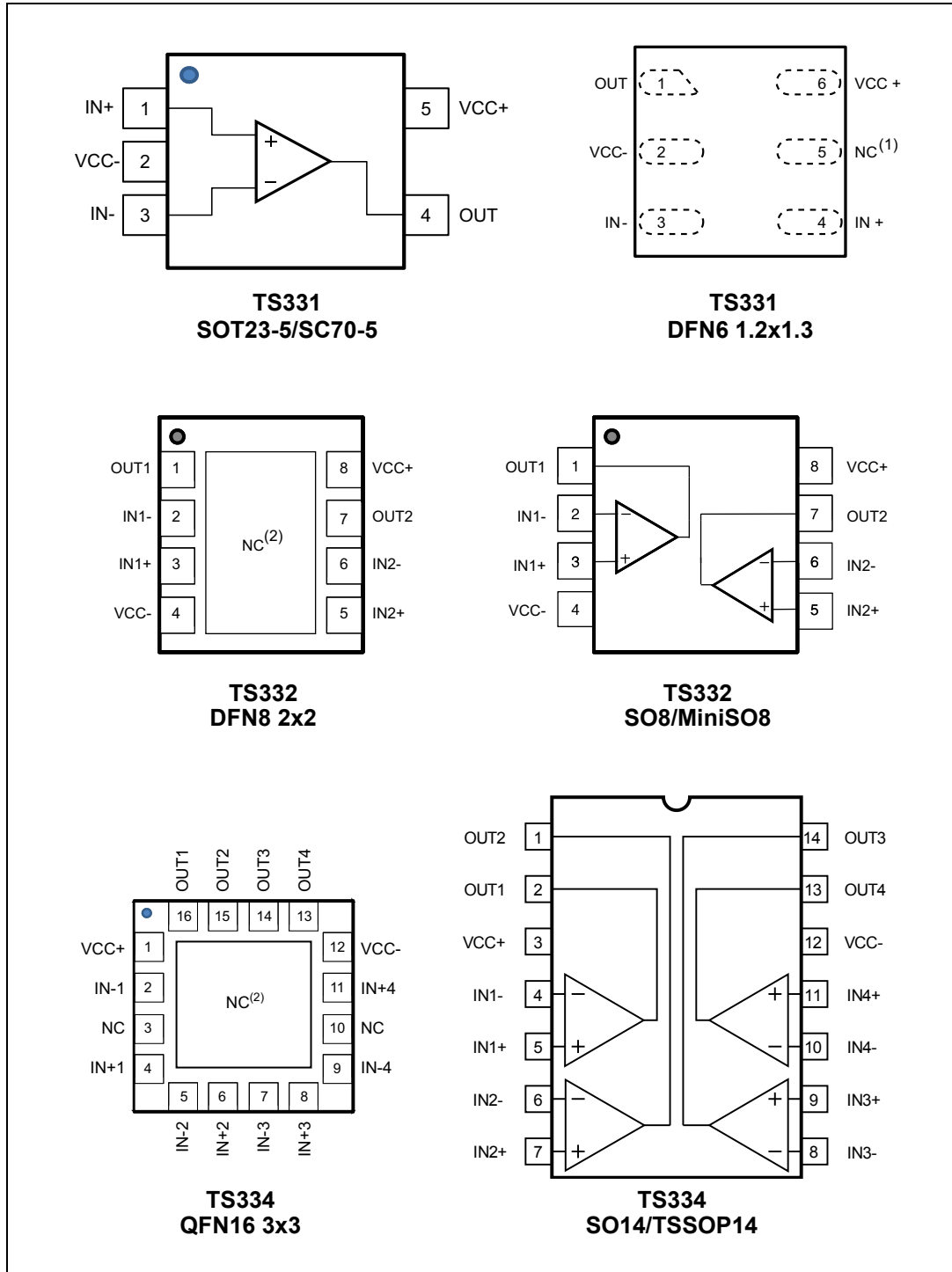
- Supply operation from 1.6 V to 5 V
- Low current consumption: 20 μ A
- Rail-to-rail inputs
- Wide temperature range: -40 °C to +125 °C
- Low output saturation voltage
- Low propagation delay: 210 ns
- Open-drain output
- ESD tolerance: 2 kV HBM/200 V MM
- SMD packages
- Automotive qualified

Contents

| | | |
|----------|--|-----------|
| 1 | Package pin connections | 3 |
| 2 | Absolute maximum ratings and operating conditions | 4 |
| 3 | Electrical characteristics | 6 |
| 4 | Package information | 13 |
| 4.1 | SOT23-5 package information | 14 |
| 4.2 | SC70-5 (SOT323-5) package information | 15 |
| 4.3 | DFN6 1.2x1.3 package information | 16 |
| 4.4 | DFN8 2x2 package information | 17 |
| 4.5 | SO8 package information | 19 |
| 4.6 | MiniSO8 package information | 20 |
| 4.7 | QFN16 3x3 package information | 21 |
| 4.8 | SO14 package information | 23 |
| 4.9 | TSSOP14 package information | 24 |
| 5 | Ordering information | 25 |
| 6 | Revision history | 26 |

1 Package pin connections

Figure 1. Pin connections for each package (top view)



1. NC = not connected
2. The exposed pads of the DFN8 2x2 and the QFN16 3x3 can be connected to VCC- or left floating.

2 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|------------|---|--|------|
| V_{CC} | Supply voltage ⁽¹⁾ | 5.5 | V |
| V_{ID} | Differential input voltage | ± 5.5 | |
| V_{IN} | Input voltage range | $(V_{CC-}) - 0.3$ to $(V_{CC+}) + 0.3$ | |
| V_{out} | Output voltage ⁽¹⁾ | 5.5 | |
| R_{thja} | Thermal resistance junction to ambient ⁽²⁾ | | °C/W |
| | SOT23-5 | 250 | |
| | SC70-5 | 205 | |
| | DFN6 1.2x1.3 | 40 | |
| | DFN8 2x2 | 57 | |
| | SO8 | 125 | |
| | MiniSO8 | 190 | |
| | QFN16 3x3 | 39 | |
| SO14 | 105 | | |
| TSSOP14 | 100 | | |
| R_{thjc} | Thermal resistance junction to case ⁽²⁾ | | |
| | SOT23-5 | 81 | |
| | SC70-5 | 172 | |
| | SO8 | 40 | |
| | MiniSO8 | 39 | |
| | QFN16 3x3 | 5 | |
| | SO14 | 31 | |
| TSSOP14 | 32 | | |
| T_{stg} | Storage temperature | -65 to +150 | °C |
| T_j | Junction temperature | 150 | |
| T_{LEAD} | Lead temperature (soldering 10 seconds) | 260 | |
| ESD | Human body model (HBM) ⁽³⁾ | 2000 | V |
| | Machine model (MM) ⁽⁴⁾ | 200 | |
| | Charged device model (CDM) ⁽⁵⁾ | 1500 | |
| | Latchup immunity | 200 | mA |

1. All voltage values, except differential voltage, are referenced to V_{CC-}
2. Short-circuits can cause excessive heating. These values are typical
3. According to JEDEC standard JESD22-A114F.
4. According to JEDEC standard JESD22-A115A.
5. According to ANSI/ESD STM5.3.1.

Table 2. Operating conditions

| Symbol | Parameter | Value | Unit |
|------------|--|--|------|
| T_{oper} | Operating temperature range | -40 to +125 | °C |
| V_{CC} | Supply voltage (V_{CC+}) - (V_{CC-}) $-40^{\circ}\text{C} < T_{amb} < +125^{\circ}\text{C}$ | 1.6 to 5.0 | V |
| V_{ICM} | Common mode input voltage range $T_{amb} = +25^{\circ}\text{C}$ $-40^{\circ}\text{C} < T_{amb} < +125^{\circ}\text{C}$ | $(V_{CC-}) - 0.2$ to $(V_{CC+}) + 0.2$ (V_{CC-}) to (V_{CC+}) | |

3 Electrical characteristics

Table 3. $V_{CC+} = +1.8\text{ V}$, $V_{CC-} = 0\text{ V}$, $T_{amb} = +25^\circ\text{C}$ (unless otherwise specified)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------------------------|--|--|------|------|------|------------------------------|
| V_{IO} | Input offset voltage | | | 0.5 | 5 | mV |
| | | $-40^\circ\text{C} < T_{amb} < +125^\circ\text{C}$ | | | 6 | |
| $\Delta V_{IO}/\Delta T$ | Input offset voltage drift | $-40^\circ\text{C} < T_{amb} < +125^\circ\text{C}$ | | 4.5 | | $\mu\text{V}/^\circ\text{C}$ |
| I_{IB} | Input bias current ⁽¹⁾ | | | 25 | 40 | nA |
| | | $-40^\circ\text{C} < T_{amb} < +125^\circ\text{C}$ | | | 100 | |
| I_{IO} | Input offset current ⁽¹⁾ | | | 1 | 10 | nA |
| | | $-40^\circ\text{C} < T_{amb} < +125^\circ\text{C}$ | | | 100 | |
| I_{CC} | Supply current | No load, output low, $V_{ICM} = 0\text{ V}$ | | 20 | 26 | μA |
| | | $-40^\circ\text{C} < T_{amb} < +125^\circ\text{C}$ | | | 30 | |
| | | No load, output high, $V_{ICM} = 0\text{ V}$ | | 22 | 29 | |
| | | $-40^\circ\text{C} < T_{amb} < +125^\circ\text{C}$ | | | 33 | |
| I_{OH} | Output current leakage | $V_{OUT} = V_{CC+}$ | | 1 | 10 | nA |
| | | $-40^\circ\text{C} < T_{amb} < +125^\circ\text{C}$ | | | 500 | |
| V_{OL} | Output voltage low | $I_{SINK} = 1\text{ mA}$ | | 24 | 30 | mV |
| | | $-40^\circ\text{C} < T_{amb} < +125^\circ\text{C}$ | | | 50 | |
| I_{SINK} | Output sink current | $V_{OUT} = 1.5\text{ V}$ | 20 | 22 | | mA |
| | | $-40^\circ\text{C} < T_{amb} < +125^\circ\text{C}$ | 15 | | | |
| CMRR | Common mode rejection ratio | $0 < V_{ICM} < 1.8\text{ V}$ | 50 | 68 | | dB |
| TP_{HL} | Propagation delay ⁽²⁾ High to low output level | $V_{ICM} = 0\text{ V}$, $R_L = 5.1\text{ k}\Omega$, $C_L = 50\text{ pF}$, overdrive = 10 mV | | 300 | | ns |
| | | $V_{ICM} = 0\text{ V}$, $R_L = 5.1\text{ k}\Omega$, $C_L = 50\text{ pF}$, overdrive = 100 mV | | 210 | 310 | |
| TP_{LH} | Propagation delay ⁽³⁾ Low to high output level | $V_{ICM} = 0\text{ V}$, $R_L = 5.1\text{ k}\Omega$, $C_L = 50\text{ pF}$, overdrive = 10 mV | | 540 | | ns |
| | | $V_{ICM} = 0\text{ V}$, $R_L = 5.1\text{ k}\Omega$, $C_L = 50\text{ pF}$, overdrive = 100 mV | | 420 | 620 | |

1. Maximum values include unavoidable inaccuracies of the industrial tests.
2. TP_{HL} is measured when the output signal crosses a voltage level at 50% of V_{CC} with the following conditions: inverting input voltage (IN^-) = V_{ICM} and non-inverting input voltage (IN^+) moving from $V_{ICM} + 100\text{ mV}$ to $V_{ICM} - \text{overdrive}$.
3. TP_{LH} is measured when the output signal crosses a voltage level at 50% of V_{CC} with the following conditions: inverting input voltage (IN^-) = V_{ICM} and non-inverting input voltage (IN^+) moving from $V_{ICM} - 100\text{ mV}$ to $V_{ICM} + \text{overdrive}$.

Table 4. $V_{CC+} = +2.7\text{ V}$, $V_{CC-} = 0\text{ V}$, $T_{amb} = +25^{\circ}\text{C}$ (unless otherwise specified)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------------------------|--|--|------|------|------|--------------------------------|
| V_{IO} | Input offset voltage | | | 0.5 | 5 | mV |
| | | $-40^{\circ}\text{C} < T_{amb} < +125^{\circ}\text{C}$ | | | 6 | |
| $\Delta V_{IO}/\Delta T$ | Input offset voltage drift | $-40^{\circ}\text{C} < T_{amb} < +125^{\circ}\text{C}$ | | 3.3 | | $\mu\text{V}/^{\circ}\text{C}$ |
| I_{IB} | Input bias current ⁽¹⁾ | | | 25 | 40 | nA |
| | | $-40^{\circ}\text{C} < T_{amb} < +125^{\circ}\text{C}$ | | | 100 | |
| I_{IO} | Input offset current ⁽¹⁾ | | | 1 | 10 | nA |
| | | $-40^{\circ}\text{C} < T_{amb} < +125^{\circ}\text{C}$ | | | 100 | |
| I_{CC} | Supply current | No load, output low, $V_{ICM} = 0\text{ V}$ | | 21 | 27 | μA |
| | | $-40^{\circ}\text{C} < T_{amb} < +125^{\circ}\text{C}$ | | | 31 | |
| | | No load, output high, $V_{ICM} = 0\text{ V}$ | | 23 | 30 | |
| | | $-40^{\circ}\text{C} < T_{amb} < +125^{\circ}\text{C}$ | | | 34 | |
| I_{OH} | Output current leakage | $V_{OUT} = V_{CC+}$ | | 1 | 10 | nA |
| | | $-40^{\circ}\text{C} < T_{amb} < +125^{\circ}\text{C}$ | | | 500 | |
| V_{OL} | Output voltage low | $I_{SINK} = 1\text{ mA}$ | | 17 | 30 | mV |
| | | $-40^{\circ}\text{C} < T_{amb} < +125^{\circ}\text{C}$ | | | 50 | |
| I_{SINK} | Output sink current | $V_{OUT} = 1.5\text{ V}$ | 40 | 47 | | mA |
| | | $-40^{\circ}\text{C} < T_{amb} < +125^{\circ}\text{C}$ | 30 | | | |
| CMRR | Common mode rejection ratio | $0 < V_{ICM} < 2.7\text{ V}$ | 54 | 74 | | dB |
| | | $-40^{\circ}\text{C} < T_{amb} < +125^{\circ}\text{C}$ | 53 | | | |
| TP_{HL} | Propagation delay ⁽²⁾ High to low output level | $V_{ICM} = 0\text{ V}$, $R_L = 5.1\text{ k}\Omega$, $C_L = 50\text{ pF}$, overdrive = 10 mV | | 320 | | ns |
| | | $V_{ICM} = 0\text{ V}$, $R_L = 5.1\text{ k}\Omega$, $C_L = 50\text{ pF}$, overdrive = 100 mV | | 220 | 320 | |
| TP_{LH} | Propagation delay ⁽³⁾ Low to high output level | $V_{ICM} = 0\text{ V}$, $R_L = 5.1\text{ k}\Omega$, $C_L = 50\text{ pF}$, overdrive = 10 mV | | 550 | | ns |
| | | $V_{ICM} = 0\text{ V}$, $R_L = 5.1\text{ k}\Omega$, $C_L = 50\text{ pF}$, overdrive = 100 mV | | 420 | 640 | |

1. Maximum values include unavoidable inaccuracies of the industrial tests.
2. TP_{HL} is measured when the output signal crosses a voltage level at 50% of V_{CC} with the following conditions: Inverting input voltage (IN-) = V_{ICM} and non-inverting input voltage (IN+) moving from $V_{ICM} + 100\text{ mV}$ to $V_{ICM} - \text{overdrive}$.
3. TP_{LH} is measured when the output signal crosses a voltage level at 50% of V_{CC} with the following conditions: Inverting input voltage (IN-) = V_{ICM} and non-inverting input voltage (IN+) moving from $V_{ICM} - 100\text{ mV}$ to $V_{ICM} + \text{overdrive}$.

Table 5. $V_{CC+} = +5\text{ V}$, $V_{CC-} = 0\text{ V}$, $T_{amb} = +25^\circ\text{C}$ (unless otherwise specified)

| Symbol | Parameter | Test conditions | Min. | Typ. | Max. | Unit |
|--------------------------|--|--|------|------|------|------------------------------|
| V_{IO} | Input offset voltage | | | 0.5 | 5 | mV |
| | | $-40^\circ\text{C} < T_{amb} < +125^\circ\text{C}$ | | | 6 | |
| $\Delta V_{IO}/\Delta T$ | Input offset voltage drift | $-40^\circ\text{C} < T_{amb} < +125^\circ\text{C}$ | | 1.3 | | $\mu\text{V}/^\circ\text{C}$ |
| I_{IB} | Input bias current ⁽¹⁾ | | | 30 | 40 | nA |
| | | $-40^\circ\text{C} < T_{amb} < +125^\circ\text{C}$ | | | 100 | |
| I_{IO} | Input offset current ⁽¹⁾ | | | 1 | 10 | nA |
| | | $-40^\circ\text{C} < T_{amb} < +125^\circ\text{C}$ | | | 100 | |
| I_{CC} | Supply current | No load, output low, $V_{ICM} = 0\text{ V}$ | | 23 | 30 | μA |
| | | $-40^\circ\text{C} < T_{amb} < +125^\circ\text{C}$ | | | 34 | |
| | | No load, output high, $V_{ICM} = 0\text{ V}$ | | 26 | 34 | |
| | | $-40^\circ\text{C} < T_{amb} < +125^\circ\text{C}$ | | | 38 | |
| I_{OH} | Output current leakage | $V_{OUT} = V_{CC+}$ | | 1 | 10 | nA |
| | | $-40^\circ\text{C} < T_{amb} < +125^\circ\text{C}$ | | | 600 | |
| V_{OL} | Output voltage low | $I_{SINK} = 4\text{ mA}$ | | 48 | 60 | mV |
| | | $-40^\circ\text{C} < T_{amb} < +125^\circ\text{C}$ | | | 80 | |
| I_{SINK} | Output sink current | $V_{OUT} = 1.5\text{ V}$ | 82 | 93 | | mA |
| | | $-40^\circ\text{C} < T_{amb} < +125^\circ\text{C}$ | 60 | | | |
| A_V | Voltage gain | | 40 | 100 | | V/mV |
| CMRR | Common mode rejection ratio | $0 < V_{ICM} < 5\text{ V}$ | 60 | 79 | | dB |
| | | $-40^\circ\text{C} < T_{amb} < +125^\circ\text{C}$ | 58 | | | |
| SVR | Supply voltage rejection | $\Delta V_{CC} = 1.8\text{ to }5\text{ V}$ | 56 | 75 | | dB |
| | | $-40^\circ\text{C} < T_{amb} < +125^\circ\text{C}$ | 56 | | | |
| TP_{HL} | Propagation delay ⁽²⁾ High to low output level | $V_{ICM} = 0\text{ V}$, $R_L = 5.1\text{ k}\Omega$, $C_L = 50\text{ pF}$, overdrive = 10 mV | | 380 | | ns |
| | | $V_{ICM} = 0\text{ V}$, $R_L = 5.1\text{ k}\Omega$, $C_L = 50\text{ pF}$, overdrive = 100 mV | | 270 | 430 | |
| TP_{LH} | Propagation delay ⁽³⁾ Low to high output level | $V_{ICM} = 0\text{ V}$, $R_L = 5.1\text{ k}\Omega$, $C_L = 50\text{ pF}$, overdrive = 10 mV | | 570 | | ns |
| | | $V_{ICM} = 0\text{ V}$, $R_L = 5.1\text{ k}\Omega$, $C_L = 50\text{ pF}$, overdrive = 100 mV | | 450 | 720 | |

1. Maximum values include unavoidable inaccuracies of the industrial tests.
2. TP_{HL} is measured when the output signal crosses a voltage level at 50% of V_{CC} with the following conditions: Inverting input voltage (IN-) = V_{ICM} and non-inverting input voltage (IN+) moving from $V_{ICM} + 100\text{ mV}$ to $V_{ICM} - \text{overdrive}$.
3. TP_{LH} is measured when the output signal crosses a voltage level at 50% of V_{CC} with the following conditions: Inverting input voltage (IN-) = V_{ICM} and non-inverting input voltage (IN+) moving from $V_{ICM} - 100\text{ mV}$ to $V_{ICM} + \text{overdrive}$.

Figure 2. Supply current versus supply voltage with output high, $V_{ICM} = 0\text{ V}$

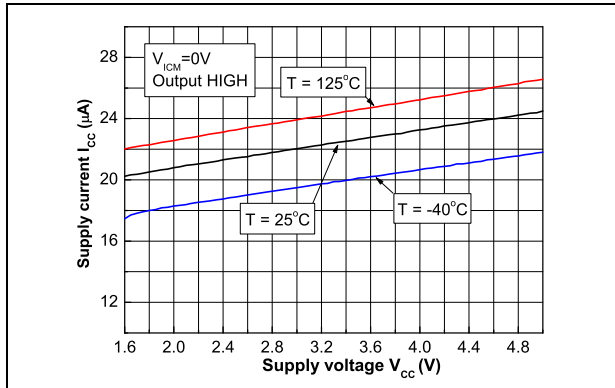


Figure 3. Supply current versus supply voltage with output high, $V_{ICM} = V_{CC}$

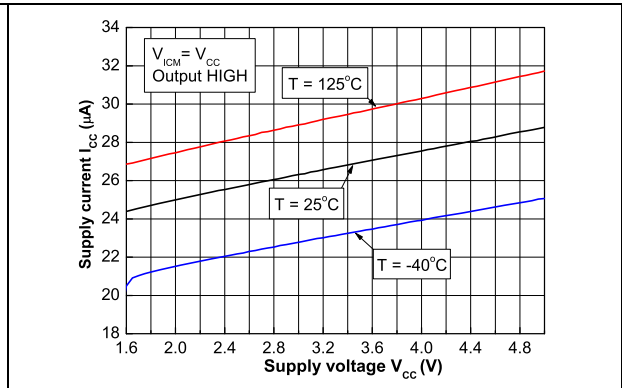


Figure 4. Supply current versus supply voltage with output low, $V_{ICM} = 0\text{ V}$

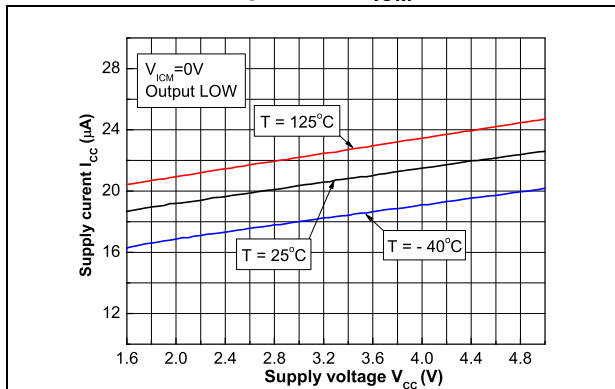


Figure 5. Supply current versus supply voltage with output low, $V_{ICM} = V_{CC}$

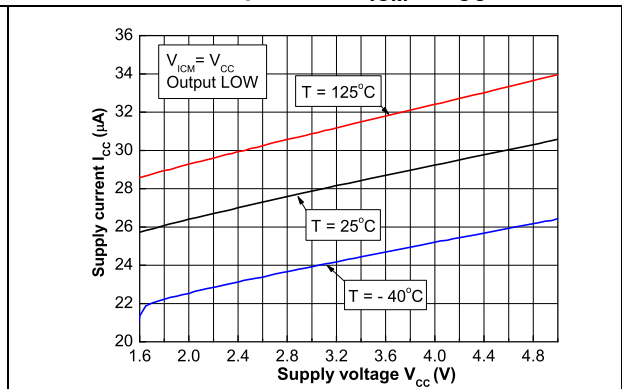


Figure 6. Supply current versus temperature

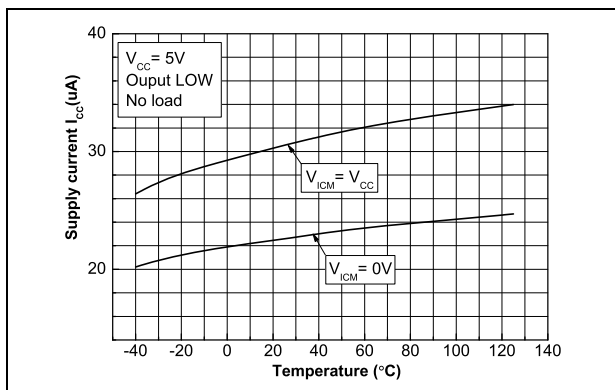


Figure 7. Input bias current versus input common-mode voltage

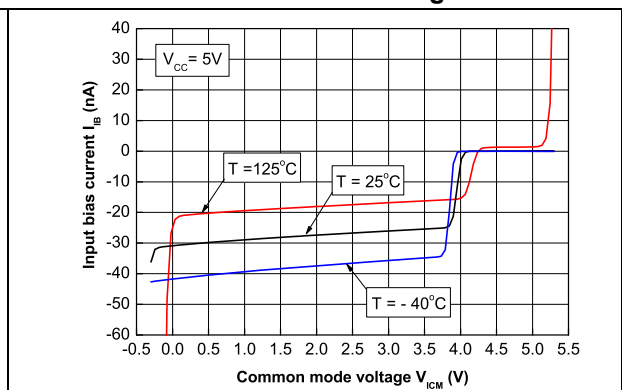


Figure 8. Input current versus differential input voltage

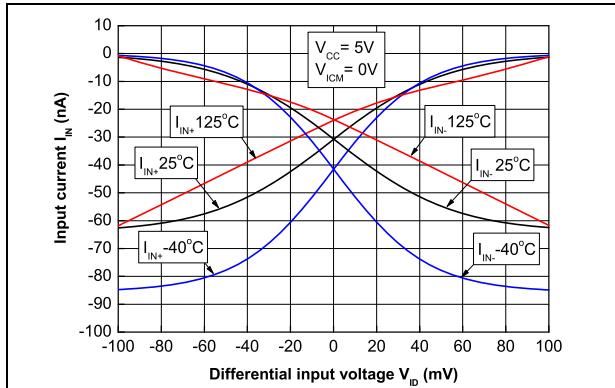


Figure 9. Input offset voltage versus temperature

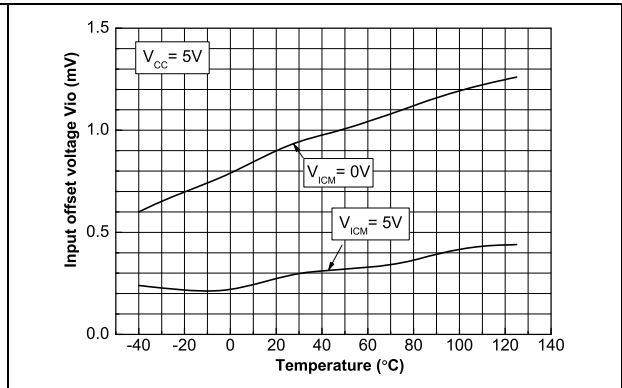


Figure 10. Output voltage versus output sink current, $V_{CC} = 1.8V$

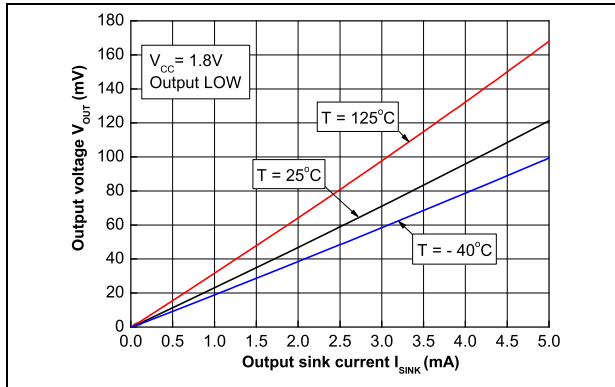


Figure 11. Output voltage versus output sink current, $V_{CC} = 2.7V$

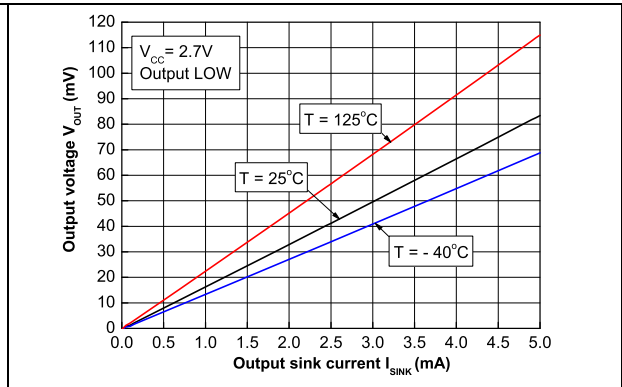


Figure 12. Output voltage versus output sink current, $V_{CC} = 5V$

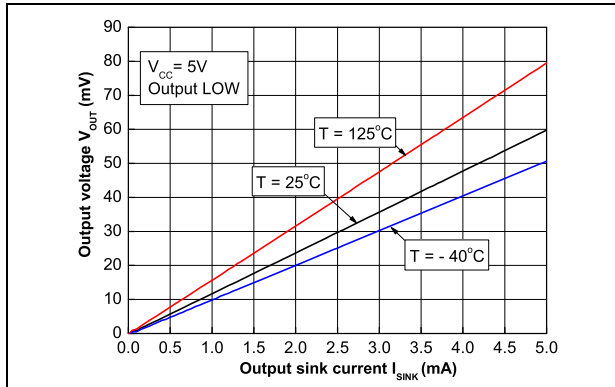


Figure 13. Output sink current versus output voltage

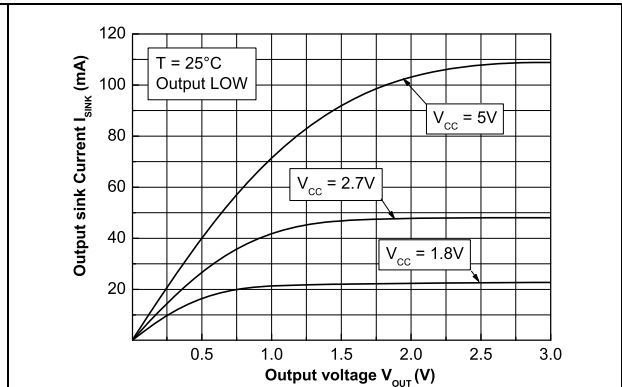


Figure 14. Output voltage versus temperature

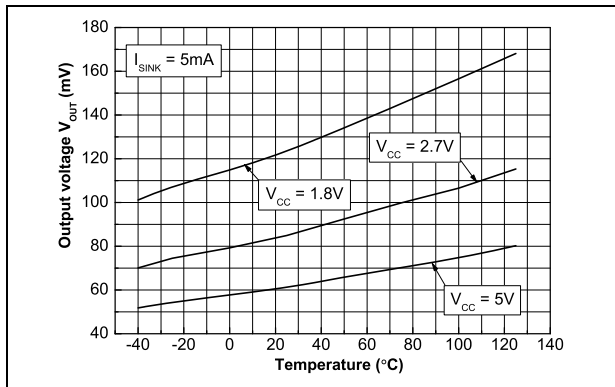


Figure 15. Propagation delay versus overdrive with negative transition, $V_{CC} = 1.8V$

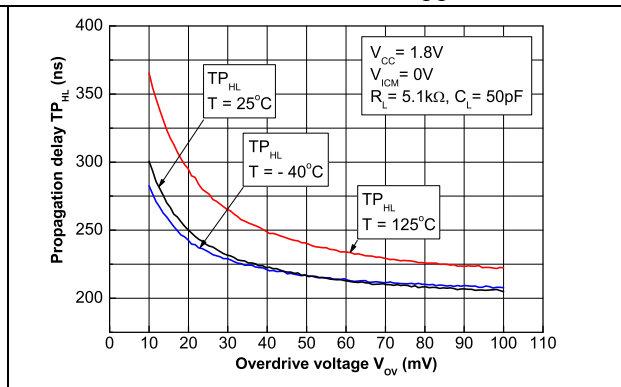


Figure 16. Propagation delay versus overdrive with positive transition, $V_{CC} = 1.8V$

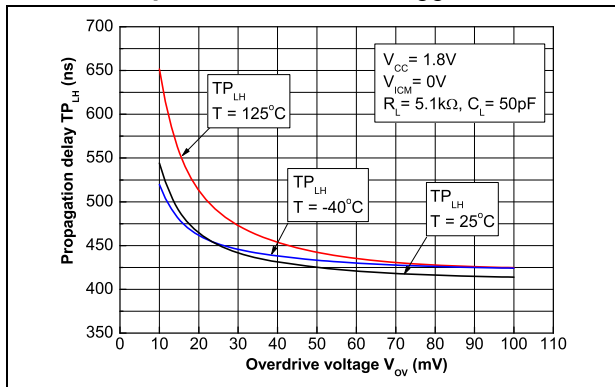


Figure 17. Propagation delay versus common mode voltage, $V_{CC} = 1.8V$

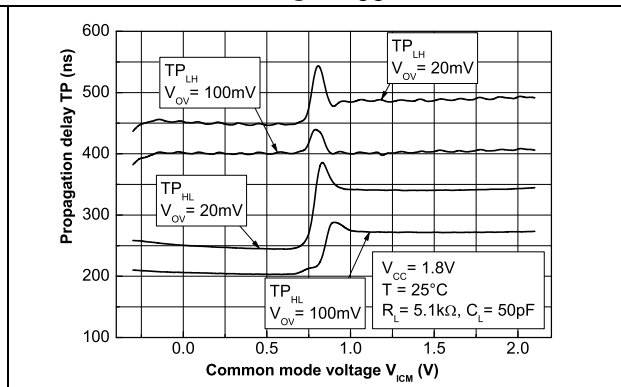


Figure 18. Propagation delay versus overdrive with negative transition, $V_{CC} = 2.7V$

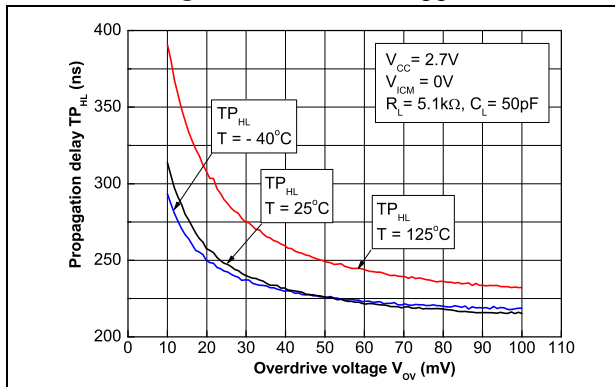


Figure 19. Propagation delay versus overdrive with positive transition, $V_{CC} = 2.7V$

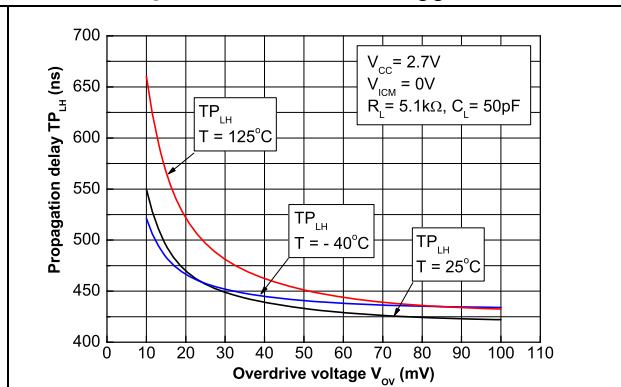


Figure 20. Propagation delay versus common mode voltage, $V_{CC} = 2.7\text{ V}$

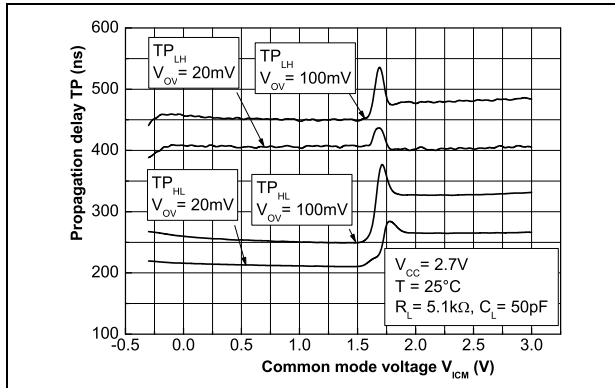


Figure 21. Propagation delay versus overdrive with negative transition, $V_{CC} = 5\text{ V}$

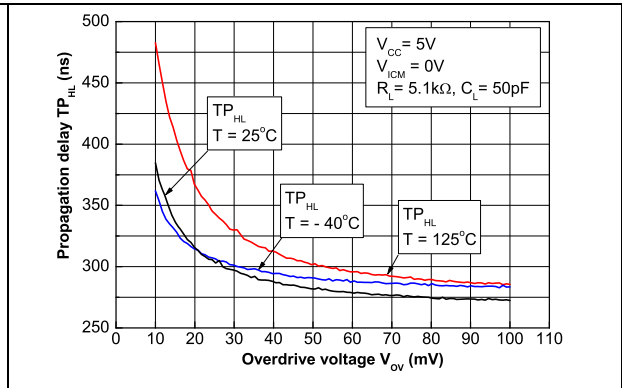


Figure 22. Propagation delay versus overdrive with positive transition, $V_{CC} = 5\text{ V}$

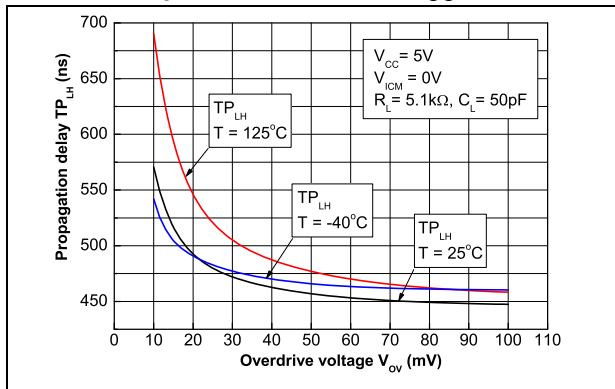


Figure 23. Propagation delay versus common mode voltage, $V_{CC} = 5\text{ V}$

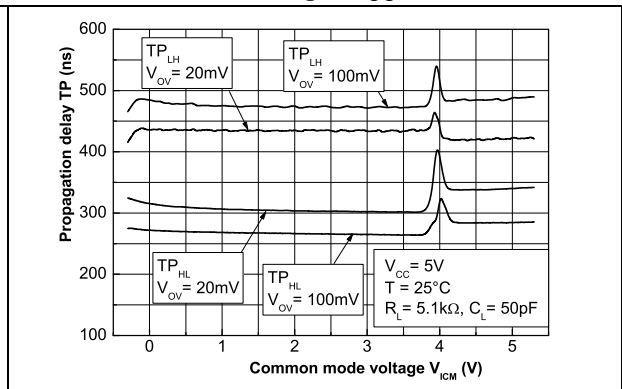


Figure 24. Propagation delay versus time with negative transition

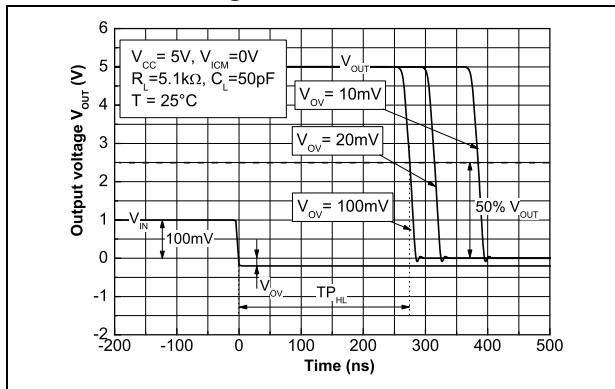
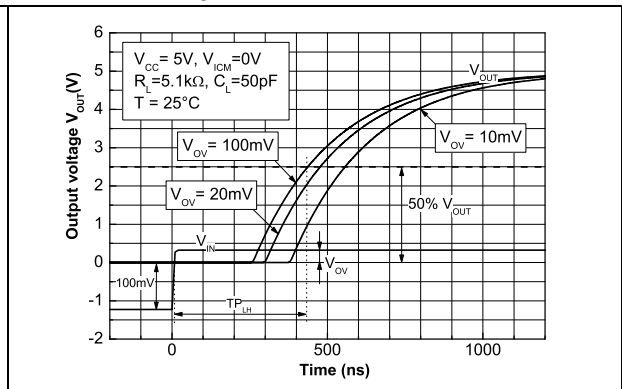


Figure 25. Propagation delay versus time with positive transition



4 Package information

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

4.1 SOT23-5 package information

Figure 26. SOT23-5 package mechanical drawing

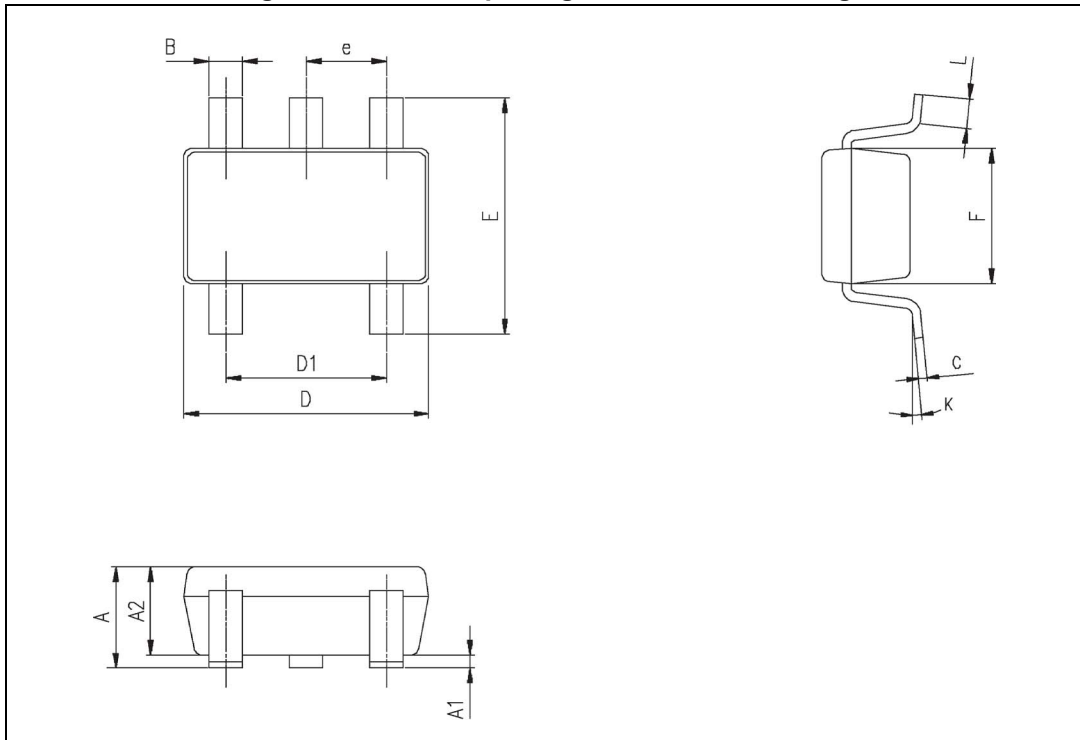


Table 6. SOT23-5 package mechanical data

| Ref. | Dimensions | | | | | |
|------|-------------|------|------|-----------------------|-------|-------|
| | Millimeters | | | Inches ⁽¹⁾ | | |
| | 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° | 0° | | 10° |

1. Values in inches are rounded to three decimal digits.

4.2 SC70-5 (SOT323-5) package information

Figure 27. SC70-5 (SOT323-5) package mechanical drawing

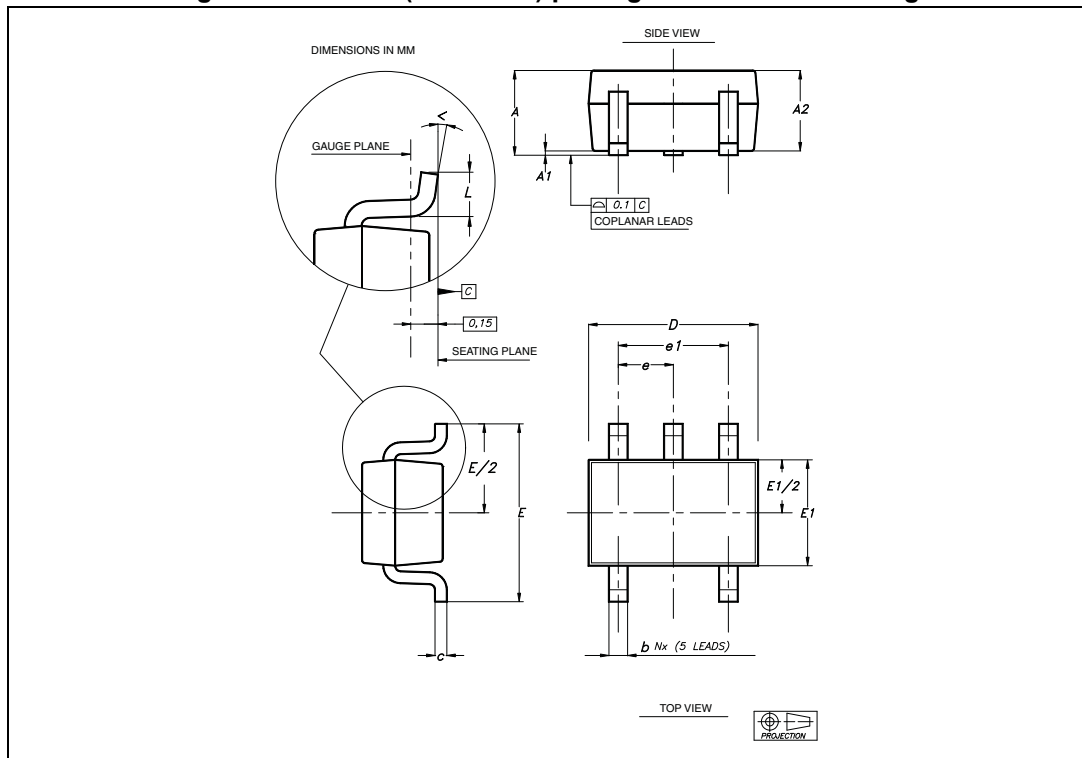


Table 7. SC70-5 (or SOT323-5) package mechanical data

| Ref | Dimensions | | | | | |
|----------|-------------|------|------|-----------------------|-------|-------|
| | Millimeters | | | Inches ⁽¹⁾ | | |
| | 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 |
| α | 0° | | 8° | 0° | | 8° |

1. Values in inches are rounded to three decimal digits.

4.3 DFN6 1.2x1.3 package information

Figure 28. DFN6 1.2x1.3 package mechanical drawing

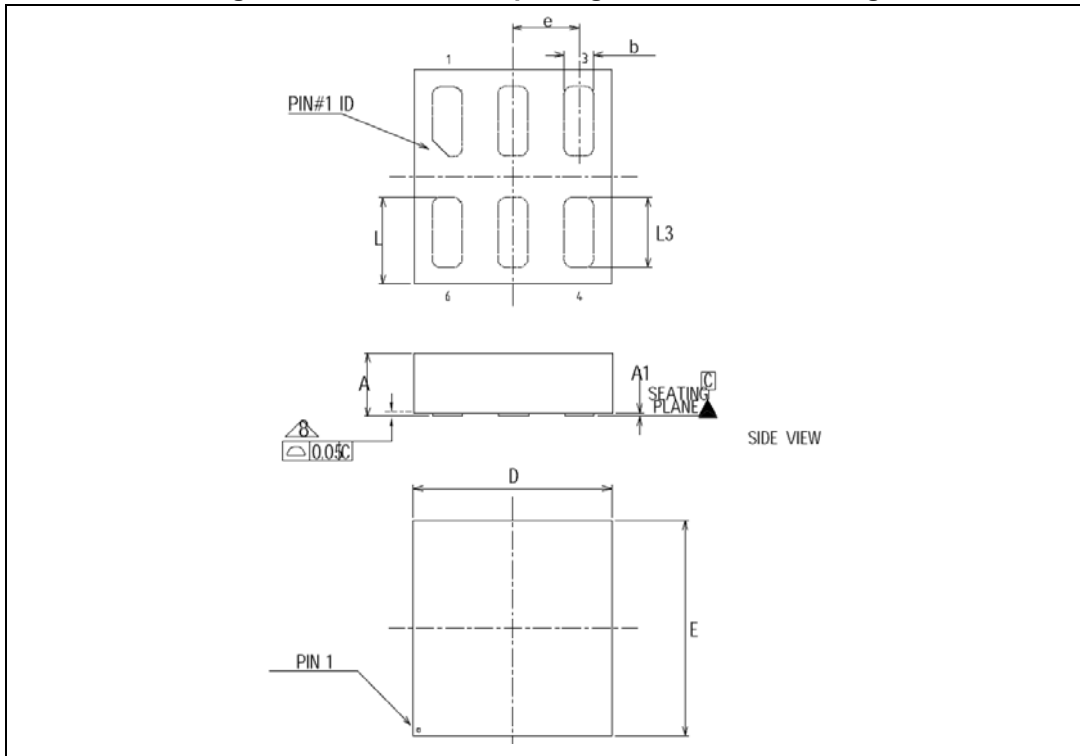


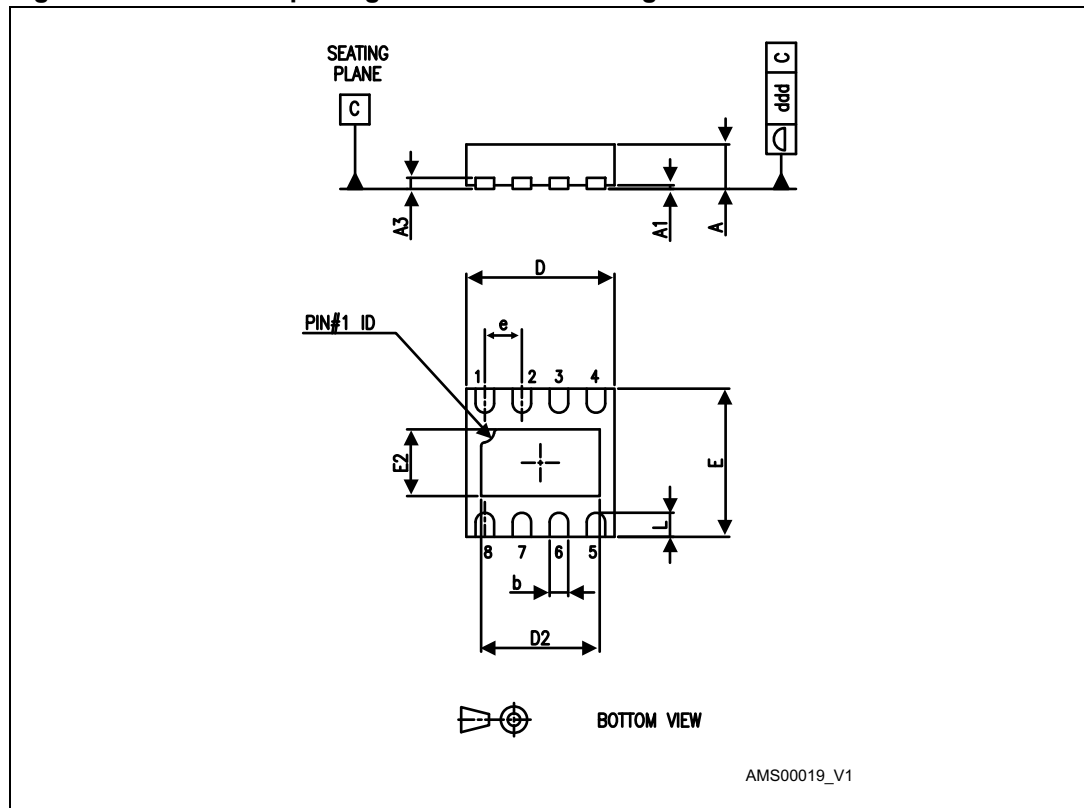
Table 8. DFN6 1.2x1.3 package mechanical data

| Ref | Dimensions | | | | | |
|-----|-------------|-------|-------|-----------------------|-------|-------|
| | Millimeters | | | Inches ⁽¹⁾ | | |
| | Min | Typ | Max | Min | Typ | Max |
| A | 0.45 | 0.50 | 0.55 | 0.018 | 0.020 | 0.022 |
| A1 | 0.00 | 0.02 | 0.05 | 0.000 | 0.001 | 0.002 |
| b | 0.15 | 0.18 | 0.25 | 0.006 | 0.007 | 0.002 |
| c | | 0.05 | | | 0.002 | |
| D | | 1.20 | | | 0.047 | |
| E | | 1.30 | | | 0.051 | |
| e | | 0.4 | | | 0.016 | |
| L | 0.475 | 0.525 | 0.575 | 0.019 | 0.021 | 0.023 |
| L3 | 0.375 | 0.425 | 0.475 | 0.015 | 0.017 | 0.019 |

1. Values in inches are rounded to three decimal digits.

4.4 DFN8 2x2 package information

Figure 29. DFN8 2x2 package mechanical drawing

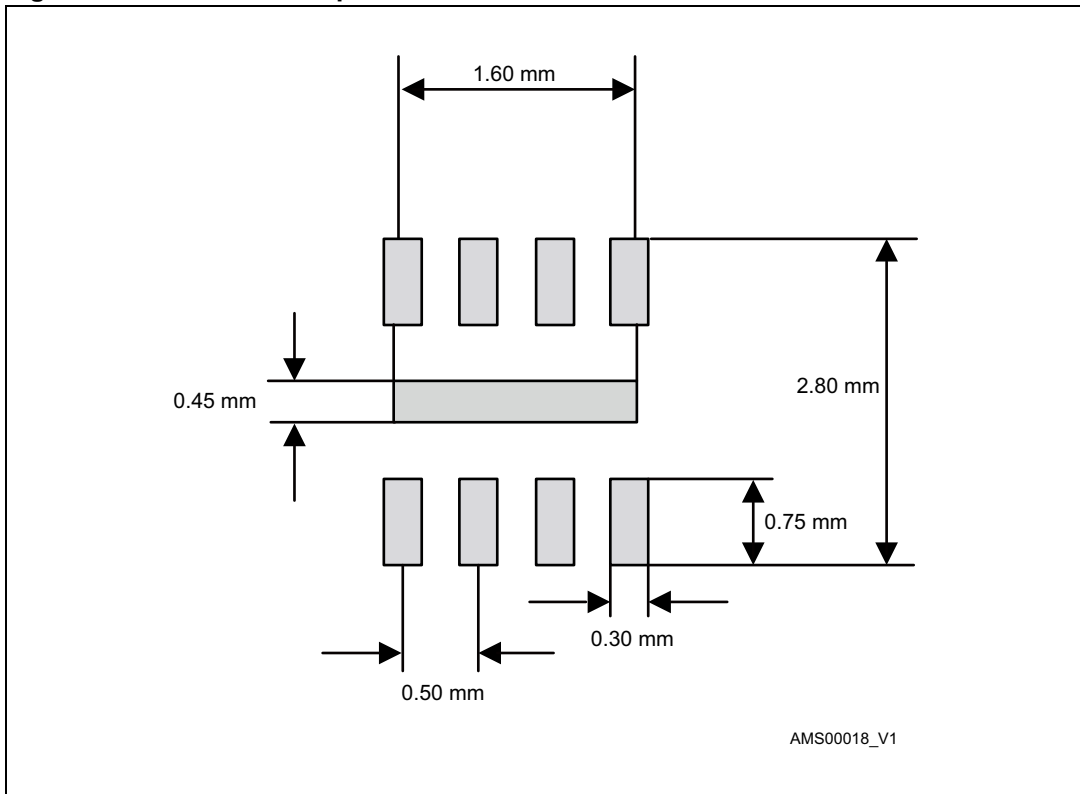


AMS00019_V1

Table 9. DFN8 2x2x0.6 mm package mechanical data (pitch 0.5 mm)

| Ref. | Dimensions | | | | | |
|------|-------------|------|-------|--------|-------|-------|
| | Millimeters | | | Inches | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | 0.51 | 0.55 | 0.60 | 0.020 | 0.022 | 0.024 |
| A1 | | | 0.05 | | | 0.002 |
| A3 | | 0.15 | | | 0.006 | |
| b | 0.18 | 0.25 | 0.30 | 0.007 | 0.010 | 0.012 |
| D | 1.85 | 2.00 | 2.15 | 0.073 | 0.079 | 0.085 |
| D2 | 1.45 | 1.60 | 1.70 | 0.057 | 0.063 | 0.067 |
| E | 1.85 | 2.00 | 2.15 | 0.073 | 0.079 | 0.085 |
| E2 | 0.75 | 0.90 | 1.00 | 0.030 | 0.035 | 0.039 |
| e | | 0.50 | | | 0.020 | |
| L | | | 0.425 | | | 0.017 |
| ddd | | | 0.08 | | | 0.003 |

Figure 30. DFN8 2x2 footprint recommendation



4.5 SO8 package information

Figure 31. SO8 package mechanical drawing

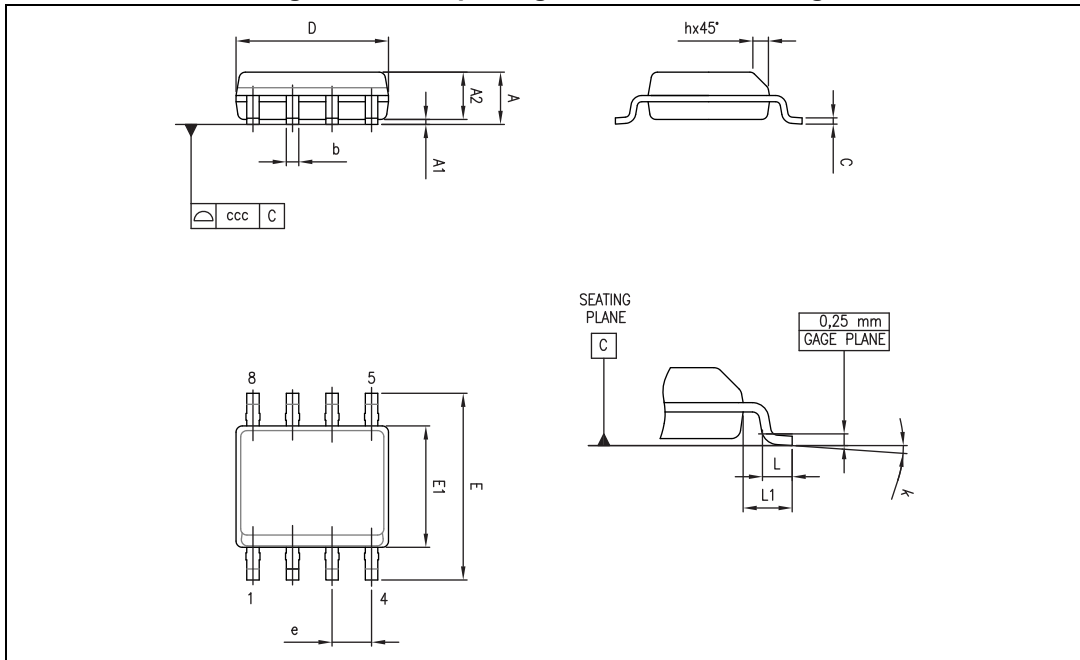


Table 10. SO8 package mechanical data

| Ref. | Dimensions | | | | | |
|------|-------------|------|------|-----------------------|-------|-------|
| | Millimeters | | | Inches ⁽¹⁾ | | |
| | 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 | 0 | | 8° | 1° | | 8° |
| ccc | | | 0.10 | | | 0.004 |

1. Values in inches are rounded to three decimal digits.

4.6 MiniSO8 package information

Figure 32. MiniSO8 package mechanical drawing

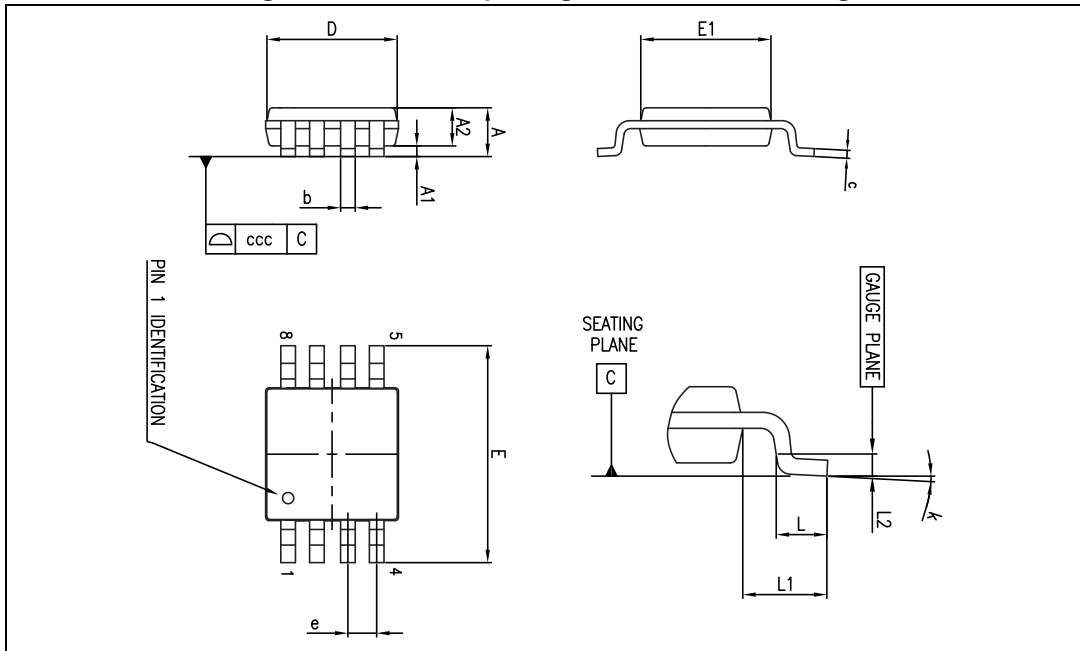


Table 11. MiniSO8 package mechanical data

| Ref. | Dimensions | | | | | |
|------|-------------|------|------|-----------------------|-------|-------|
| | Millimeters | | | Inches ⁽¹⁾ | | |
| | 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 |

1. Values in inches are rounded to three decimal digits.

4.7 QFN16 3x3 package information

Figure 33. QFN16 3 x 3 mm package mechanical drawing

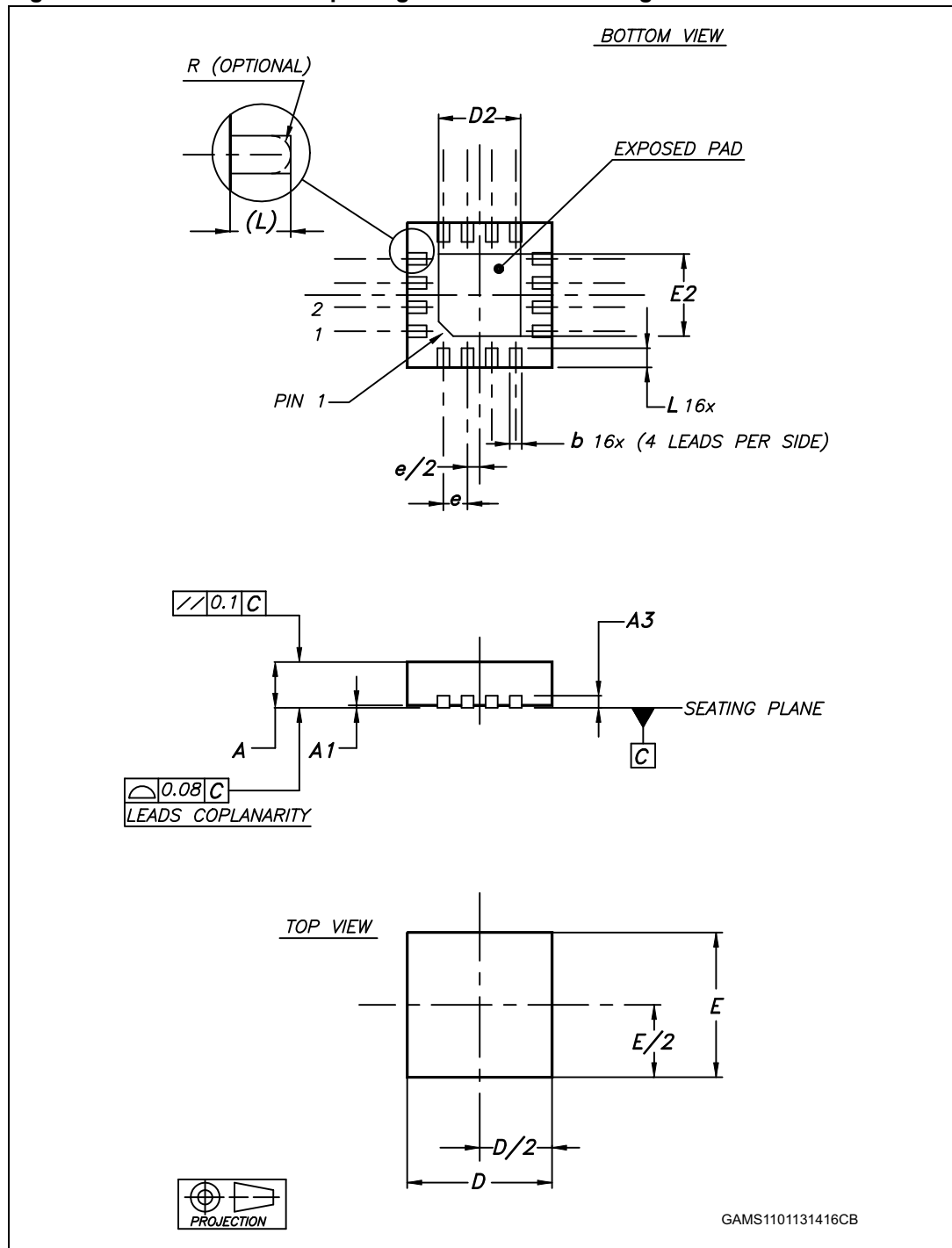
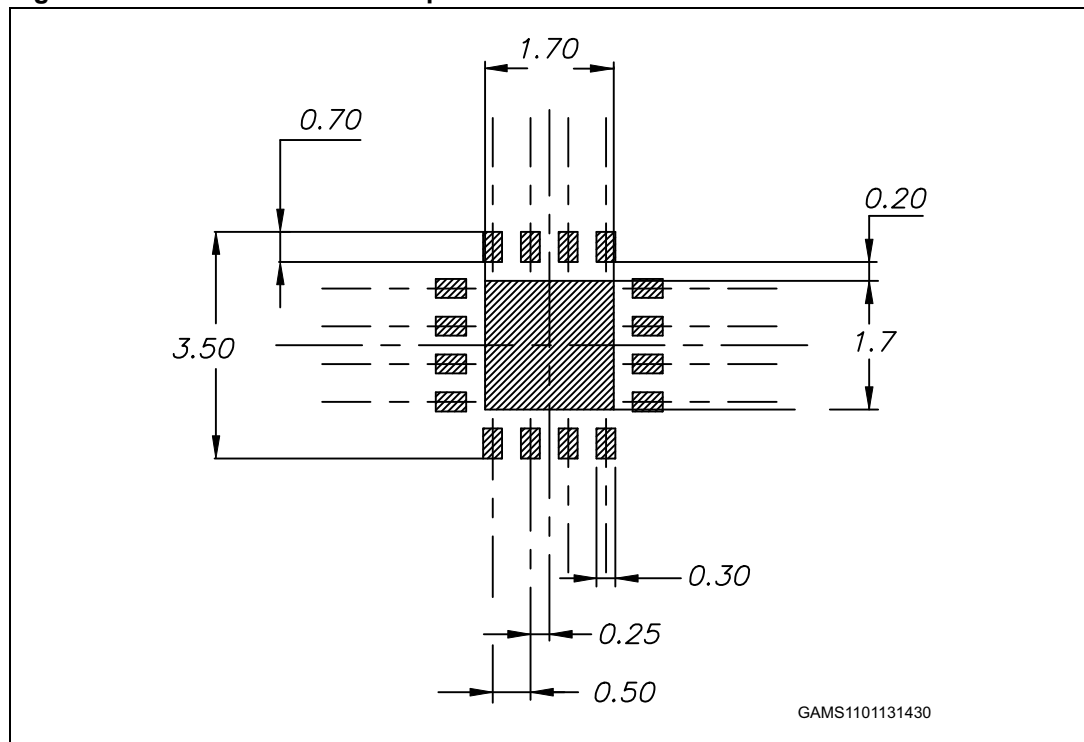


Table 12. QFN16 3 x 3 mm package mechanical data (pitch 0.5 mm)

| Ref. | Dimensions | | | | | |
|------|-------------|------|------|--------|-------|-------|
| | Millimeters | | | Inches | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | 0.80 | 0.90 | 1.00 | 0.031 | 0.035 | 0.039 |
| A1 | 0 | | 0.05 | 0 | | 0.002 |
| A3 | | 0.20 | | | 0.008 | |
| b | 0.18 | | 0.30 | 0.007 | | 0.012 |
| D | 2.90 | 3.00 | 3.10 | 0.114 | 0.118 | 0.122 |
| D2 | 1.50 | | 1.80 | 0.059 | | 0.071 |
| E | 2.90 | 3.00 | 3.10 | 0.114 | 0.118 | 0.122 |
| E2 | 1.50 | | 1.80 | 0.059 | | 0.071 |
| e | | 0.50 | | | 0.020 | |
| L | 0.30 | | 0.50 | 0.012 | | 0.020 |

Figure 34. QFN16 3 x 3 mm footprint recommendation



4.8 SO14 package information

Figure 35. SO14 package mechanical drawing

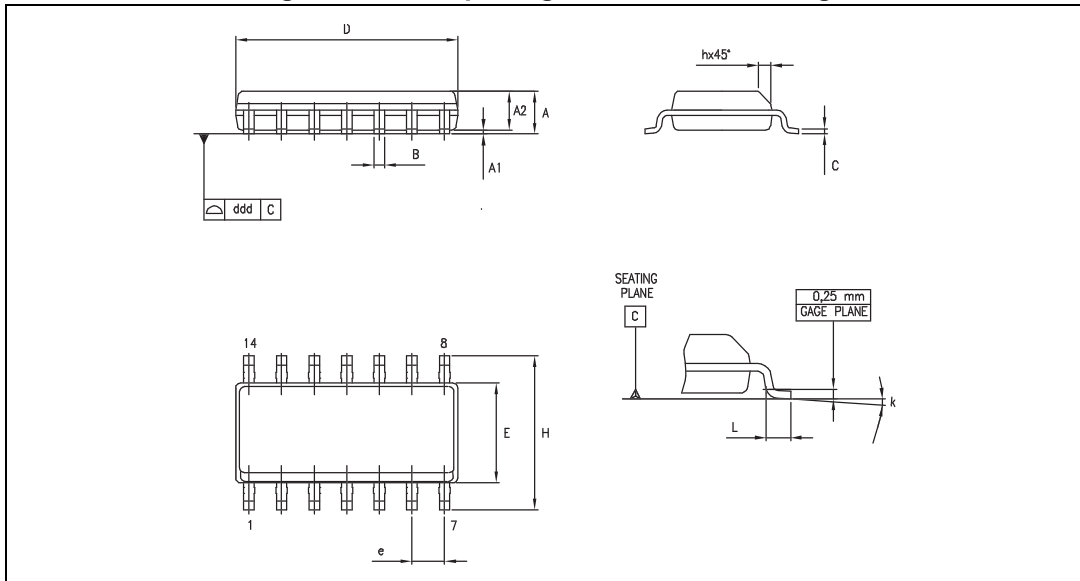


Table 13. SO14 package mechanical data

| Dimensions | | | | | | |
|------------|-------------|------|------|-----------------------|------|-------|
| Ref. | Millimeters | | | Inches ⁽¹⁾ | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | 1.35 | | 1.75 | 0.050 | | 0.068 |
| A1 | 0.10 | | 0.25 | 0.004 | | 0.009 |
| A2 | 1.10 | | 1.65 | 0.040 | | 0.060 |
| B | 0.33 | | 0.51 | 0.010 | | 0.020 |
| C | 0.19 | | 0.25 | 0.007 | | 0.009 |
| D | 8.55 | | 8.75 | 0.330 | | 0.340 |
| E | 3.80 | | 4.0 | 0.150 | | 0.150 |
| e | | 1.27 | | | 0.05 | |
| H | 5.80 | | 6.20 | 0.220 | | 0.240 |
| h | 0.25 | | 0.50 | 0.009 | | 0.020 |
| L | 0.40 | | 1.27 | 0.015 | | 0.050 |
| k | 8° (max.) | | | | | |
| ddd | | | 0.10 | | | 0.004 |

1. Values in inches are rounded to three decimal digits.

4.9 TSSOP14 package information

Figure 36. TSSOP14 package mechanical drawing

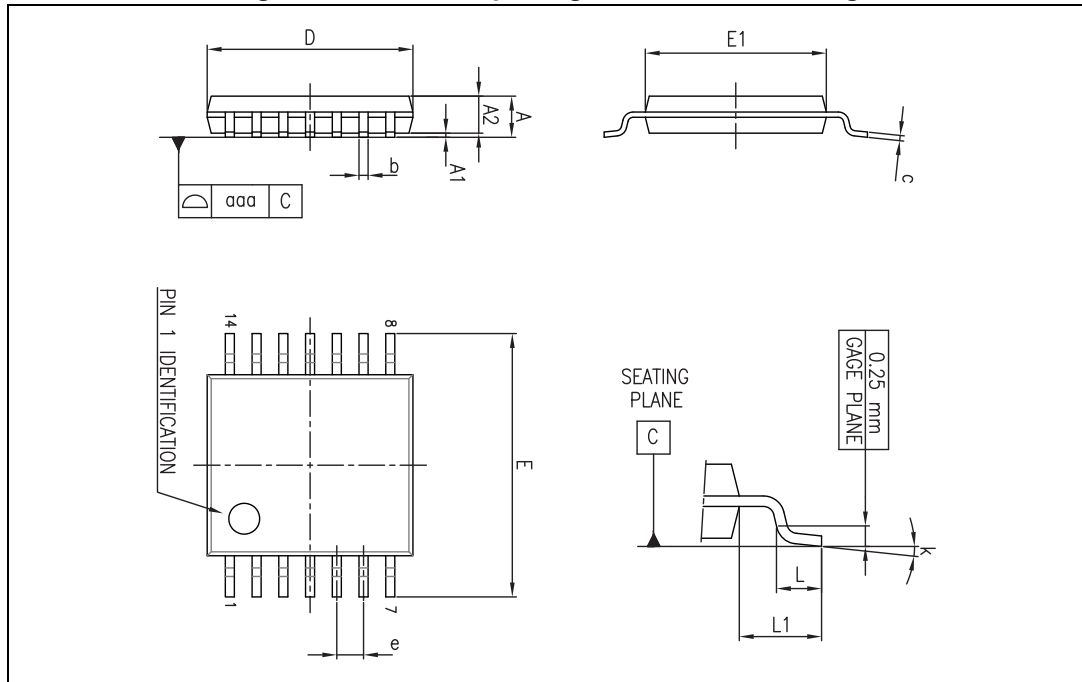


Table 14. TSSOP14 package mechanical data

| Ref. | Dimensions | | | | | |
|------|-------------|------|------|-----------------------|--------|--------|
| | Millimeters | | | Inches ⁽¹⁾ | | |
| | 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 |

1. Values in inches are rounded to three decimal digits.

5 Ordering information

Table 15. Order codes

| Order code | Temperature range | Package | Packaging | Marking |
|--------------------------|-------------------|--------------|---------------|---------|
| TS331ILT | -40 °C, +125 °C | SOT23-5 | Tape and reel | K506 |
| TS331IYLT ⁽¹⁾ | | | | K513 |
| TS331ICT | | SC70-5 | | K55 |
| TS331IQT | | DFN6 1.2x1.3 | | K3 |
| TS332IQ2T | | DFN8 2x2 | | K55 |
| TS332IDT | | SO8 | | 332I |
| TS332IYDT ⁽¹⁾ | | | | 332IY |
| TS332IST | | MiniSO8 | | K507 |
| TS334IQ4T | | QFN16 3x3 | | K307 |
| TS334IDT | | SO14 | | 334I |
| TS334IYDT ⁽¹⁾ | | | | 334IY |
| TS334IPT | | TSSOP14 | | 334I |
| TS334IYPT ⁽¹⁾ | | | | 334IY |

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

6 Revision history

Table 16. Document revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 29-Mar-2010 | 1 | Initial release. |
| 01-Dec-2011 | 2 | <ul style="list-style-type: none"> – Added TS332 and TS334 devices. – Added V_{out} parameter in Table 1: Absolute maximum ratings. – Removed note "The magnitude of input and output voltages must never exceed the supply rail ± 0.3 V." from Table 1. – Removed note "All values over the temperature range are guaranteed through correlation and simulation. No production tests have been performed at the temperature range limits." from Table 3, Table 4 and Table 5. – Removed "$V_{icm} = 0$ V" from Test conditions column in Table 3, Table 4 and Table 5. – Modified minimal I_{sink} value in Table 5. |
| 29-Oct-2012 | 3 | <ul style="list-style-type: none"> – Added DFN6 package for TS331 – Modified notes 3, 4, and 5 in Table 1 – Added Automotive grade order codes in Table 15 |
| 30-Apr-2013 | 4 | <ul style="list-style-type: none"> – Added DFN8 2x2 and QFN16 3x3 silhouette, pinout, and package information. – Figure 1: updated pinout diagrams; added footnote 2. – Table 1: updated R_{thjc} and R_{thjc} – Table 3, Table 4, Table 5: updated symbol for input offset voltage drift. – Table 15: added order codes TS332IQ2T, TS334IQ4T, and TS334IYDT. |

Please Read Carefully:

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.

ST PRODUCTS ARE NOT AUTHORIZED FOR USE IN WEAPONS. NOR ARE ST PRODUCTS DESIGNED OR AUTHORIZED FOR USE IN: (A) SAFETY CRITICAL APPLICATIONS SUCH AS LIFE SUPPORTING, ACTIVE IMPLANTED DEVICES OR SYSTEMS WITH PRODUCT FUNCTIONAL SAFETY REQUIREMENTS; (B) AERONAUTIC APPLICATIONS; (C) AUTOMOTIVE APPLICATIONS OR ENVIRONMENTS, AND/OR (D) AEROSPACE APPLICATIONS OR ENVIRONMENTS. WHERE ST PRODUCTS ARE NOT DESIGNED FOR SUCH USE, THE PURCHASER SHALL USE PRODUCTS AT PURCHASER'S SOLE RISK, EVEN IF ST HAS BEEN INFORMED IN WRITING OF SUCH USAGE, UNLESS A PRODUCT IS EXPRESSLY DESIGNATED BY ST AS BEING INTENDED FOR "AUTOMOTIVE, AUTOMOTIVE SAFETY OR MEDICAL" INDUSTRY DOMAINS ACCORDING TO ST PRODUCT DESIGN SPECIFICATIONS. PRODUCTS FORMALLY ESCC, QML OR JAN QUALIFIED ARE DEEMED SUITABLE FOR USE IN AEROSPACE BY THE CORRESPONDING GOVERNMENTAL AGENCY.

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2013 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Philippines - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

www.st.com

