

Low power, 1.7 MHz, rail-to-rail output, 36 V operational amplifier



Features

- Low offset voltage: 1 mV max. @ 25 °C
- Low current consumption: 375 μ A max. / operator @ 36 V
- Wide supply voltage: 2.7 to 36 V
- Gain bandwidth product: 1.7 MHz
- Unity gain stable
- Rail-to-rail output
- Input common mode voltage includes ground
- High ESD tolerance: 4 kV HBM
- EMI hardened
- Extended temperature range: -40 to 125 °C
- Automotive qualification
- Micropackage: SO8, MiniSO8, DFN8 3x3 Wettable flanks

Applications

- Industrial
- Power supplies
- Automotive

Description

The **TSB622** is a general purpose dual operational amplifier featuring an extended supply voltage operating range and rail-to-rail output. It also offers an excellent speed/power consumption ratio with 1.7 MHz gain bandwidth product while consuming less than 375 μ A per operator at 36 V supply voltage.

The **TSB622** operates over a wide temperature range from -40 °C to 125 °C making this device ideal for industrial and automotive applications with the associated qualification.

Thanks to its small package size, the **TSB622** can be used in applications where space on the board is limited. It can thus reduce the overall cost of the PCB.

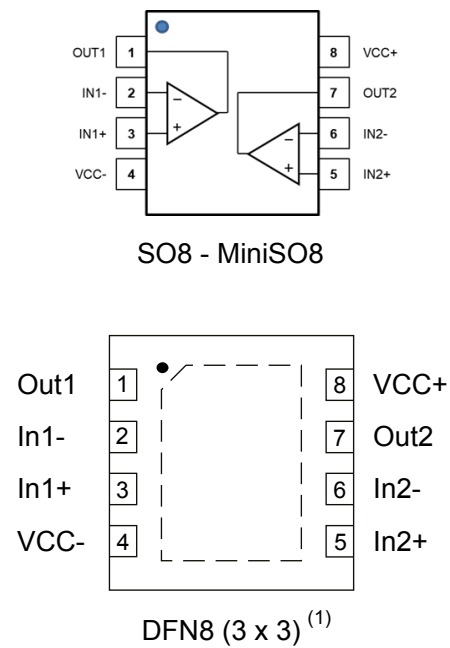
Maturity status link

[TSB622](#)

Related products

| | |
|------------------------|--|
| TSB612 | For lower speed |
| TSB572 | For higher speed and rail-to-rail inputs |
| TSB712 | For a higher precision and speed |

1 Pin connections

Figure 1. Pin connections (top view)


⁽¹⁾ Exposed pad can be left floating or connected to ground.

Table 1. Pin description

| Pin n° | Pin name | Description |
|--------|----------|-------------------------|
| 1 | OUT1 | Output |
| 2 | IN1 - | Negative input voltage |
| 3 | IN1 + | Positive input voltage |
| 4 | VCC - | Negative supply voltage |
| 5 | IN2 + | Positive input voltage |
| 6 | IN2 - | Negative input voltage |
| 7 | OUT2 | Output |
| 8 | VCC + | Positive supply voltage |

2 Absolute maximum ratings and operating conditions

Table 2. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|-------------|---|--|------|
| V_{CC} | Supply voltage ⁽¹⁾ | 40 | V |
| V_{id} | Differential input voltage ⁽²⁾ | $\pm V_{CC}$ | V |
| V_{in} | Input voltage | $(V_{CC-}) - 0.2$ to $(V_{CC+}) + 0.2$ | V |
| I_{in} | Input current ⁽³⁾ | 10 | mA |
| T_{stg} | Storage temperature | -65 to 150 | °C |
| T_j | Junction temperature | 150 | °C |
| R_{th-ja} | Thermal resistance junction to ambient ^{(4) (5)} | | °C/W |
| | SO8 | 125 | |
| | MiniSO8 | 190 | |
| ESD | DFN8 3x3 WF | 40 | V |
| | Human Body Model (HBM) ⁽⁶⁾ | 4000 | |
| | Machine Model (MM) ⁽⁷⁾ | 200 | |
| | Charged Device Model (CDM) ⁽⁸⁾ | 1500 | |

1. All voltage values, except differential voltage, are with respect to network ground terminal.
2. The differential voltage is the non-inverting input terminal with respect to the inverting input terminal.
3. Input current must be limited by a resistor in series with the inputs.
4. R_{th} are typical values.
5. Short-circuits can cause excessive heating and destructive dissipation.
6. According to JEDEC standard JESD22-A114F.
7. According to JEDEC standard JESD22-A115A.
8. According to ANSI/ESD STM5.3.1.

Table 3. Operating conditions

| Symbol | Parameter | Value | Unit |
|-----------|--------------------------------------|--------------------------------------|------|
| V_{CC} | Supply voltage | 2.7 to 36 | V |
| V_{icm} | Common mode voltage on input pins | $(V_{CC-}) - 0.1$ to $(V_{CC+}) - 1$ | V |
| T | Operating free-air temperature range | -40 to 125 | °C |

3 Electrical characteristics

Table 4. Electrical characteristics $V_{CC+} = 2.7\text{ V}$, $V_{CC-} = 0\text{ V}$, $V_{icm} = V_{CC}/2$, $T = 25\text{ }^{\circ}\text{C}$, $R_L = 10\text{ k}\Omega$ connected to $V_{CC}/2$ (unless otherwise specified)

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|----------------------------|--|---|------|-------|------|--------------------------------|
| DC performance | | | | | | |
| V_{IO} | Input offset voltage | $T = 25\text{ }^{\circ}\text{C}$ | -1 | | 1 | mV |
| | | $T_{min} < T < T_{max}$ | -1.6 | | 1.6 | |
| $ \Delta V_{IO}/\Delta T $ | Input offset voltage drift | $T_{min} < T < T_{max}$ | | 2 | | $\mu\text{V}/^{\circ}\text{C}$ |
| I_{IB} | Input bias current | $T = 25\text{ }^{\circ}\text{C}$ | | 15 | 30 | nA |
| | | $T_{min} < T < T_{max}$ | | | 45 | |
| I_{IO} | Input offset current | $T = 25\text{ }^{\circ}\text{C}$ | | 3 | 10 | |
| | | $T_{min} < T < T_{max}$ | | | 15 | |
| CMR | Common mode rejection ratio: $20 \log (\Delta V_{icm}/\Delta V_{io})$ | $V_{icm} = -0.1\text{ to }V_{CC} - 1\text{ V}$, $V_{OUT} = V_{CC}/2$ | 90 | 115 | | dB |
| | | $T_{min} < T < T_{max}$ | 85 | | | |
| A_{VD} | Large signal voltage gain | $V_{OUT} = 0.5\text{ V to } (V_{CC} - 0.5\text{ V})$ | 90 | 105 | | dB |
| | | $T_{min} < T < T_{max}$ | 82 | | | |
| V_{OH} | High-level output voltage, $V_{OH} = V_{CC} - V_{OUT}$ | $T = 25\text{ }^{\circ}\text{C}$ | | 35 | 46 | mV |
| | | $T_{min} < T < T_{max}$ | | | 55 | |
| V_{OL} | Low-level output voltage | $T = 25\text{ }^{\circ}\text{C}$ | | 50 | 60 | |
| | | $T_{min} < T < T_{max}$ | | | 75 | |
| I_{OUT} | I_{sink} | $V_{OUT} = V_{CC}$ | 20 | 27 | | mA |
| | | $T_{min} < T < T_{max}$ | 10 | | | |
| | I_{source} | $V_{OUT} = 0\text{ V}$ | 20 | 28 | | |
| | | $T_{min} < T < T_{max}$ | 8 | | | |
| I_{CC} | Supply current (per channel) | No load, $V_{OUT} = V_{CC}/2$ | | 280 | 330 | μA |
| | | $T_{min} < T < T_{max}$ | | | 400 | |
| AC performance | | | | | | |
| GBP | Gain bandwidth product | $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$ | 1 | 1.45 | | MHz |
| | | $T_{min} < T < T_{max}$ | 0.7 | | | |
| Φ_m | Phase margin | $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$ | | 60 | | degrees |
| G_m | Gain margin | | | 18 | | dB |
| SR | Slew rate | $T = 25\text{ }^{\circ}\text{C}$ | 0.30 | 0.53 | | $\text{V}/\mu\text{s}$ |
| | | $T_{min} < T < T_{max}$ | 0.20 | | | |
| E_N | Equivalent input noise voltage | $f = 1\text{ kHz}$ | | 30 | | $\text{nV}/\sqrt{\text{Hz}}$ |
| THD+N | Total harmonic distortion + noise | $f_{in} = 1\text{ kHz}$, Gain = 1, $R_L = 100\text{ k}\Omega$, $V_{icm} = (V_{CC} - 1\text{ V}) / 2$, BW = 22 kHz, $V_{OUT} = 1\text{ V}_{pp}$ | | 0.005 | | % |
| C_S | Channel separation | $f = 1\text{ kHz}$ | | 120 | | dB |
| t_{rec} | Overload recovery time | | | 2 | | μs |

Table 5. Electrical characteristics $V_{CC+} = 12\text{ V}$, $V_{CC-} = 0\text{ V}$, $V_{icm} = V_{CC}/2$, $T = 25\text{ }^{\circ}\text{C}$, $R_L = 10\text{ k}\Omega$ connected to $V_{CC}/2$ (unless otherwise specified)

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|----------------------------|--|---|------|-------|------|--------------------------------|
| DC performance | | | | | | |
| V_{IO} | Input offset voltage | $T = 25\text{ }^{\circ}\text{C}$ | -1 | | 1 | mV |
| | | $T_{min} < T < T_{max}$ | -1.6 | | 1.6 | |
| $ \Delta V_{IO}/\Delta T $ | Input offset voltage drift | $T_{min} < T < T_{max}$ | | 2 | | $\mu\text{V}/^{\circ}\text{C}$ |
| I_{IB} | Input bias current | $T = 25\text{ }^{\circ}\text{C}$ | | 15 | 30 | nA |
| | | $T_{min} < T < T_{max}$ | | | 45 | |
| I_{IO} | Input offset current | $T = 25\text{ }^{\circ}\text{C}$ | | 3 | 10 | |
| | | $T_{min} < T < T_{max}$ | | | 15 | |
| CMR | Common mode rejection ratio: $20 \log (\Delta V_{icm}/\Delta V_{io})$ | $V_{icm} = -0.1 \text{ to } V_{CC} - 1\text{ V}$, $V_{OUT} = V_{CC}/2$ | 100 | 130 | | dB |
| | | $T_{min} < T < T_{max}$ | 95 | | | |
| A_{VD} | Large signal voltage gain | $V_{OUT} = 0.5\text{ V to } (V_{CC} - 0.5\text{ V})$ | 98 | 115 | | dB |
| | | $T_{min} < T < T_{max}$ | 90 | | | |
| V_{OH} | High-level output voltage, $V_{OH} = V_{CC} - V_{OUT}$ | $T = 25\text{ }^{\circ}\text{C}$ | | 68 | 80 | mV |
| | | $T_{min} < T < T_{max}$ | | | 95 | |
| V_{OL} | Low-level output voltage | $T = 25\text{ }^{\circ}\text{C}$ | | 86 | 100 | mV |
| | | $T_{min} < T < T_{max}$ | | | 125 | |
| I_{OUT} | I_{sink} | $V_{OUT} = V_{CC}$ | 25 | 35 | | mA |
| | | $T_{min} < T < T_{max}$ | 10 | | | |
| | I_{source} | $V_{OUT} = 0\text{ V}$ | 30 | 37 | | |
| | | $T_{min} < T < T_{max}$ | 15 | | | |
| I_{CC} | Supply current (per channel) | No load, $V_{OUT} = V_{CC}/2$ | | 295 | 345 | μA |
| | | $T_{min} < T < T_{max}$ | | | 420 | |
| AC performance | | | | | | |
| GBP | Gain bandwidth product | $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$ | 1.1 | 1.55 | | MHz |
| | | $T_{min} < T < T_{max}$ | 0.8 | | | |
| Φ_m | Phase margin | $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$ | | 60 | | degrees |
| G_m | Gain margin | | | 18 | | dB |
| SR | Slew rate | $T = 25\text{ }^{\circ}\text{C}$ | 0.35 | 0.58 | | $\text{V}/\mu\text{s}$ |
| | | $T_{min} < T < T_{max}$ | 0.20 | | | |
| E_N | Equivalent input noise voltage | $f = 1\text{ kHz}$ | | 30 | | $\text{nV}/\sqrt{\text{Hz}}$ |
| THD+N | Total harmonic distortion + noise | $f_{in} = 1\text{ kHz}$, Gain = 1, $R_L = 100\text{ k}\Omega$, $V_{icm} = (V_{CC} - 1\text{ V}) / 2$, BW = 22 kHz, $V_{OUT} = 1\text{ V}_{pp}$ | | 0.005 | | % |
| C_S | Channel separation | $f = 1\text{ kHz}$ | | 120 | | dB |
| t_{rec} | Overload recovery time | | | 2 | | μs |

Table 6. Electrical characteristics $V_{CC+} = 36\text{ V}$, $V_{CC-} = 0\text{ V}$, $V_{icm} = V_{CC}/2$, $T = 25\text{ °C}$, $R_L = 10\text{ k}\Omega$ connected to $V_{CC}/2$ (unless otherwise specified)

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|----------------------------|---|---|------|-------|------|-------------------------|
| DC performance | | | | | | |
| V_{IO} | Input offset voltage | $T = 25\text{ °C}$ | -1 | | 1 | mV |
| | | $T_{min} < T < T_{max}$ | -1.6 | | 1.6 | |
| $ \Delta V_{IO}/\Delta T $ | Input offset voltage drift | $T_{min} < T < T_{max}$ | | 2 | | $\mu\text{V}/\text{°C}$ |
| I_{IB} | Input bias current | $T = 25\text{ °C}$ | | 15 | 30 | nA |
| | | $T_{min} < T < T_{max}$ | | | 45 | |
| I_{IO} | Input offset current | $T = 25\text{ °C}$ | | 3 | 10 | |
| | | $T_{min} < T < T_{max}$ | | | 15 | |
| CMR | Common mode rejection ratio: $20 \log(\Delta V_{icm}/\Delta V_{io})$ | $V_{icm} = -0.1\text{ to }V_{CC} - 1\text{ V}$, $V_{OUT} = V_{CC}/2$ | 105 | 135 | | dB |
| | | $T_{min} < T < T_{max}$ | 100 | | | |
| SVR | Supply voltage rejection ratio: $20 \log(\Delta V_{CC}/\Delta V_{io})$ | $V_{CC} = 4.5\text{ to }36\text{ V}$, $V_{icm} = 0\text{ V}$ | 100 | 124 | | dB |
| | | $T_{min} < T < T_{max}$ | 95 | | | |
| A_{VD} | Large signal voltage gain | $V_{OUT} = 0.5\text{ V to } (V_{CC} - 0.5\text{ V})$ | 105 | 120 | | dB |
| | | $T_{min} < T < T_{max}$ | 100 | | | |
| V_{OH} | High-level output voltage, $V_{OH} = V_{CC} - V_{OUT}$ | $T = 25\text{ °C}$ | | 110 | 140 | mV |
| | | $T_{min} < T < T_{max}$ | | | 180 | |
| V_{OL} | Low-level output voltage | $T = 25\text{ °C}$ | | 125 | 150 | |
| | | $T_{min} < T < T_{max}$ | | | 195 | |
| I_{OUT} | I_{sink} | $V_{OUT} = V_{CC}$ | 35 | 45 | | mA |
| | | $T_{min} < T < T_{max}$ | 15 | | | |
| | I_{source} | $V_{OUT} = 0\text{ V}$ | 35 | 45 | | |
| | | $T_{min} < T < T_{max}$ | 25 | | | |
| I_{CC} | Supply current (per channel) | No load, $V_{OUT} = V_{CC}/2$ | | 310 | 375 | μA |
| | | $T_{min} < T < T_{max}$ | | | 420 | |
| AC performance | | | | | | |
| GBP | Gain bandwidth product | $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$ | 1.2 | 1.7 | | MHz |
| | | $T_{min} < T < T_{max}$ | 0.95 | | | |
| Φ_m | Phase margin | $R_L = 10\text{ k}\Omega$, $C_L = 100\text{ pF}$ | | 58 | | degrees |
| G_m | Gain margin | | | 18 | | dB |
| SR | Slew rate | $T = 25\text{ °C}$ | 0.35 | 0.60 | | V/ μs |
| | | $T_{min} < T < T_{max}$ | 0.25 | | | |
| E_N | Equivalent input noise voltage | $f = 1\text{ kHz}$ | | 25 | | nV/ $\sqrt{\text{Hz}}$ |
| THD+N | Total harmonic distortion + noise | $f_{in} = 1\text{ kHz}$, Gain = 1, $R_L = 100\text{ k}\Omega$, $V_{icm} = (V_{CC} - 1\text{ V}) / 2$, BW = 22 kHz, $V_{OUT} = 1\text{ V}_{pp}$ | | 0.005 | | % |
| C_S | Channel separation | $f = 1\text{ kHz}$ | | 120 | | dB |
| t_{rec} | Overload recovery time | | | 2 | | μs |

4 Typical performance characteristics

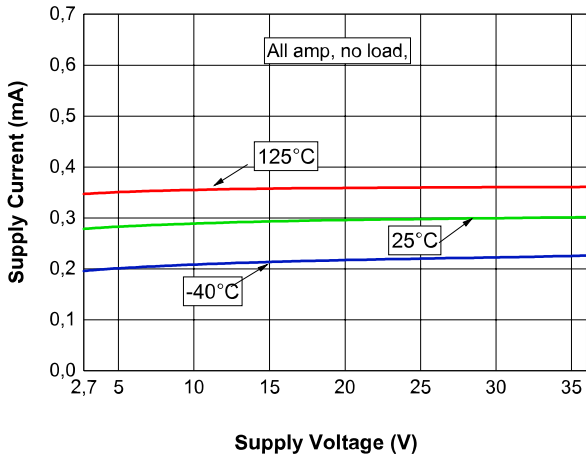
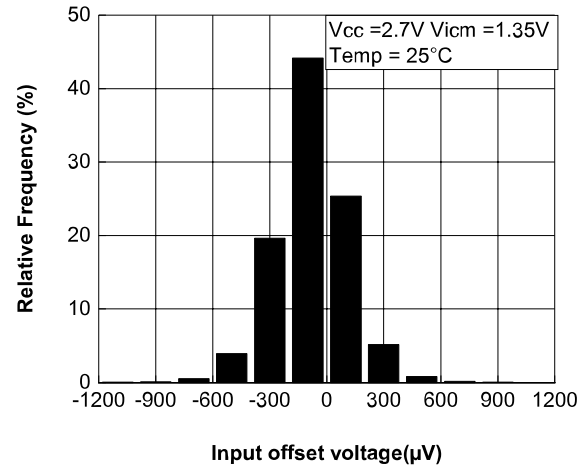
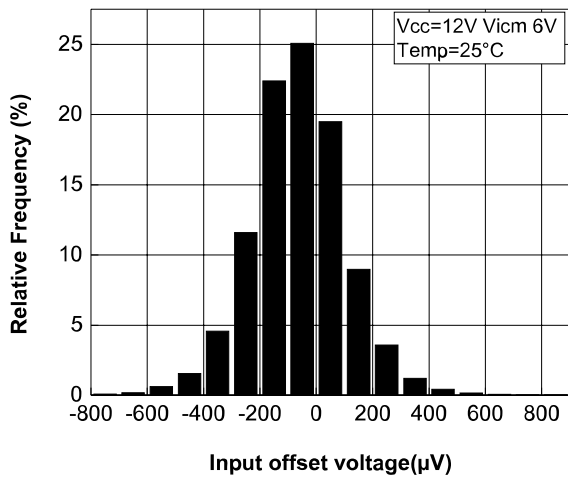
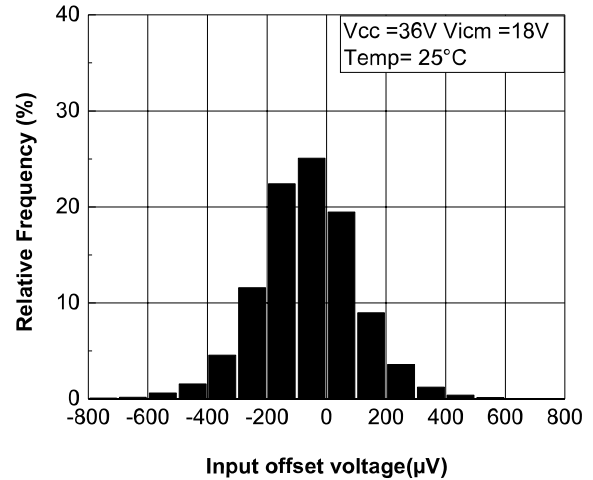
Figure 2. Supply current vs. supply voltage

Figure 3. Input offset voltage distribution at $V_{CC} = 2.7\text{ V}$

Figure 4. Input offset voltage distribution at $V_{CC} = 12\text{ V}$

Figure 5. Input offset voltage distribution at $V_{CC} = 36\text{ V}$


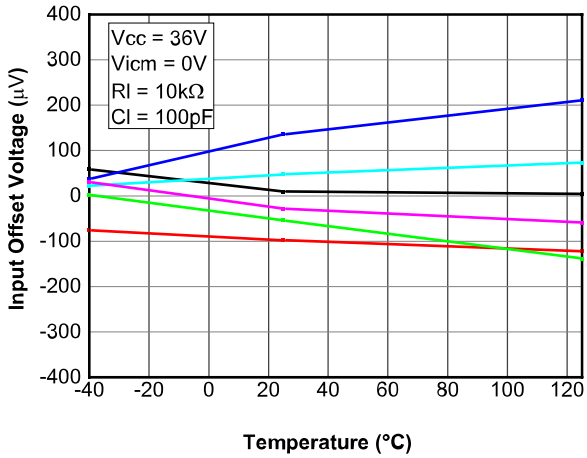
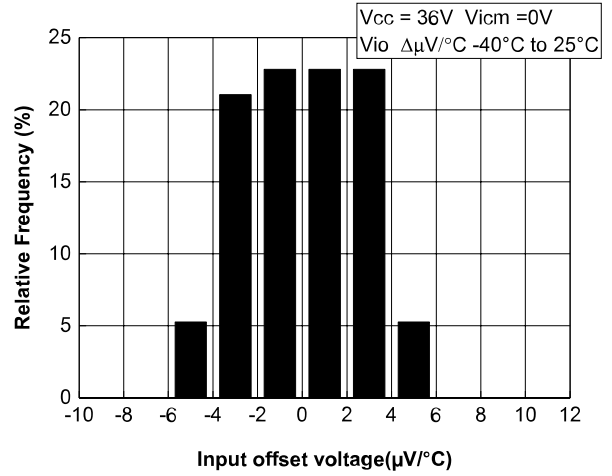
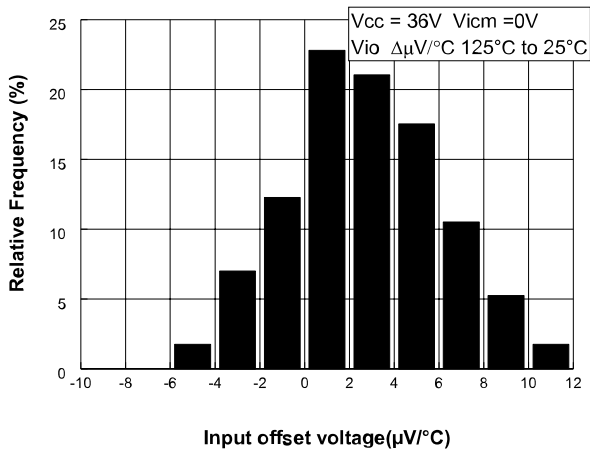
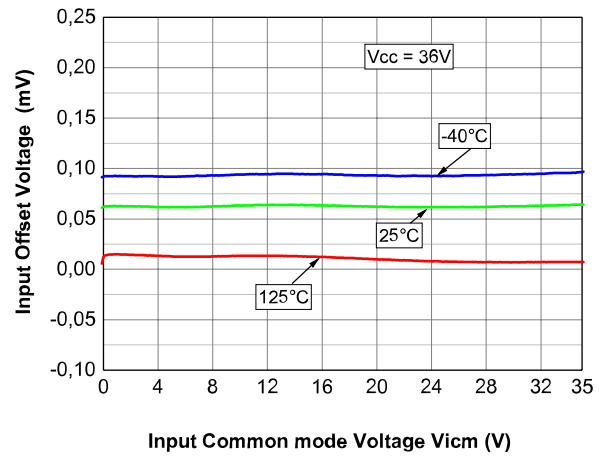
Figure 6. Input offset voltage vs. temperature at $V_{CC} = 36\text{ V}$

Figure 7. Input offset voltage temperature variation distribution at $V_{CC} = 36\text{ V}$

Figure 8. Input offset voltage temperature variation distribution at $V_{CC} = 36\text{ V}$

Figure 9. Input offset voltage vs. common-mode voltage at $V_{CC} = 36\text{ V}$


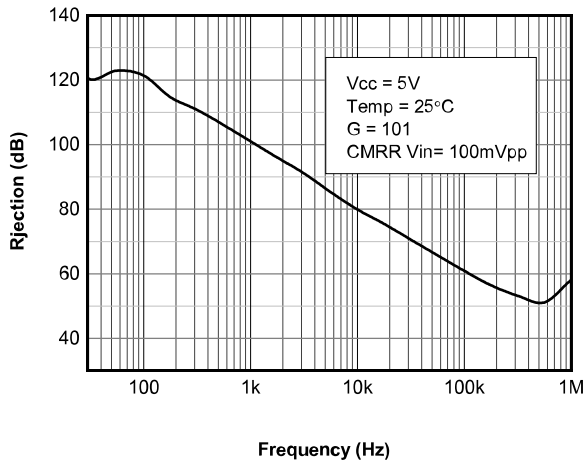
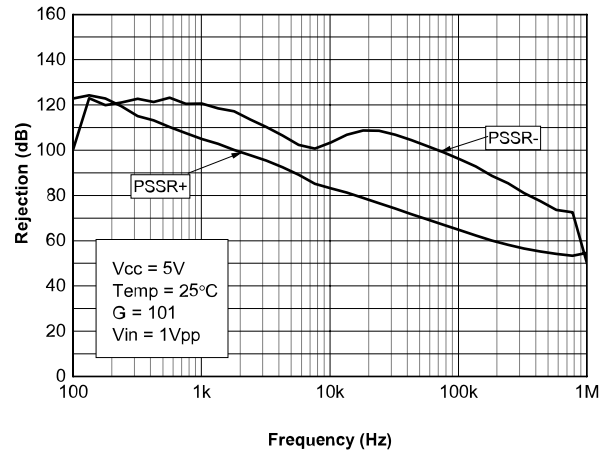
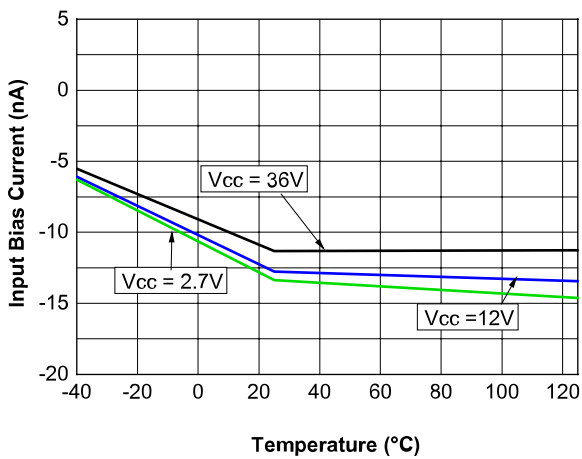
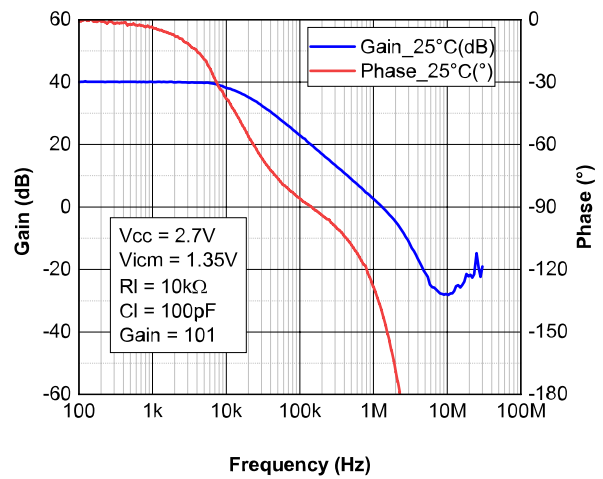
Figure 10. Common-mode reject. ratio CMR at $V_{CC} = 5\text{ V}$

Figure 11. Supply voltage rejection ratio SVR at $V_{CC} = 5\text{ V}$

Figure 12. Input bias current vs. temperature

Figure 13. Bode diagram at $V_{CC} = 2.7\text{ V}$


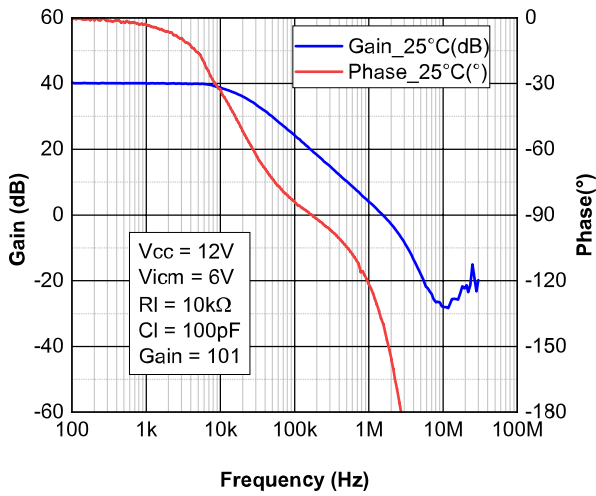
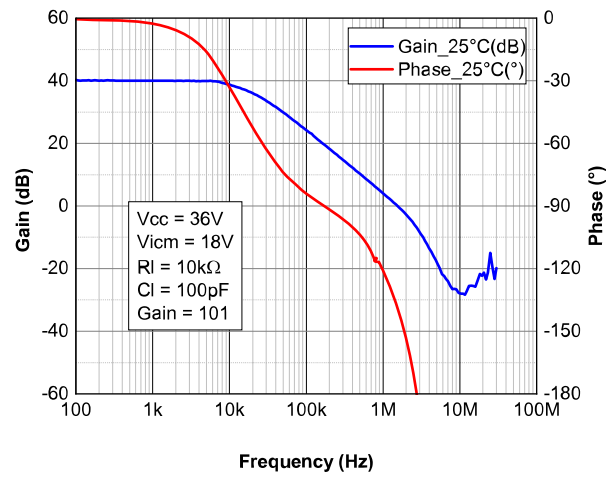
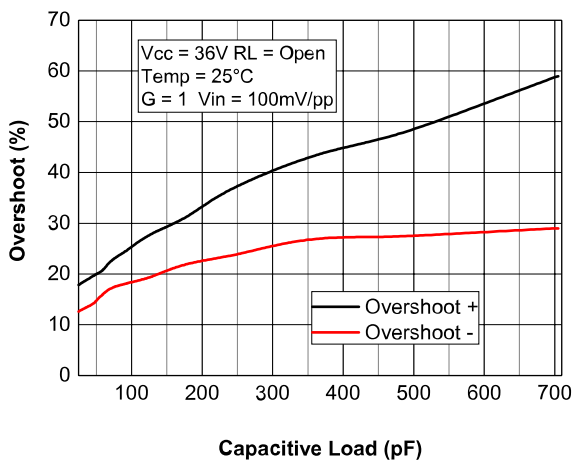
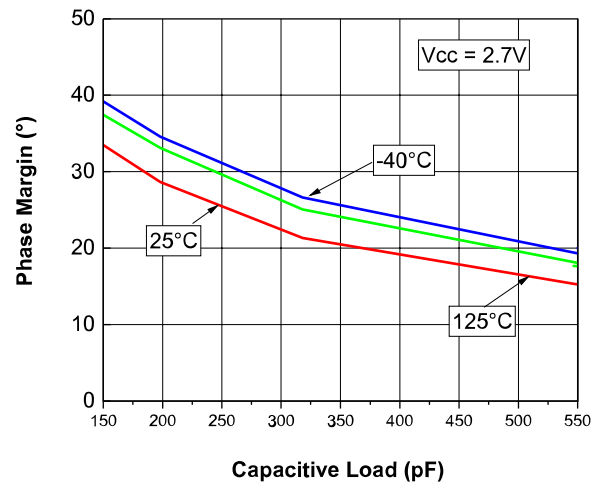
Figure 14. Bode diagram at $V_{CC} = 12\text{ V}$

Figure 15. Bode diagram at $V_{CC} = 36\text{ V}$

Figure 16. Overshoot vs. capacitive load at $V_{CC} = 36\text{ V}$

Figure 17. Phase margin vs. capacitive load at $V_{CC} = 2.7\text{ V}$


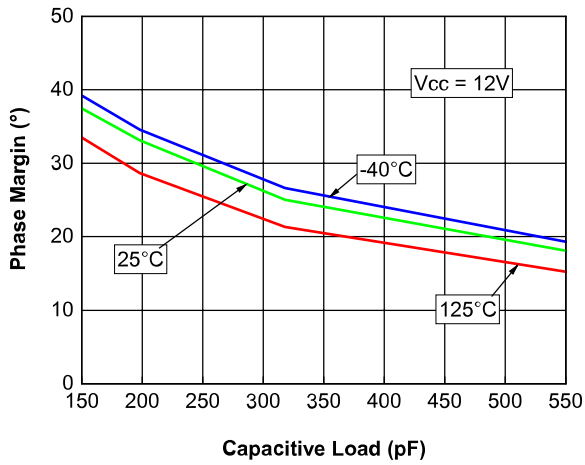
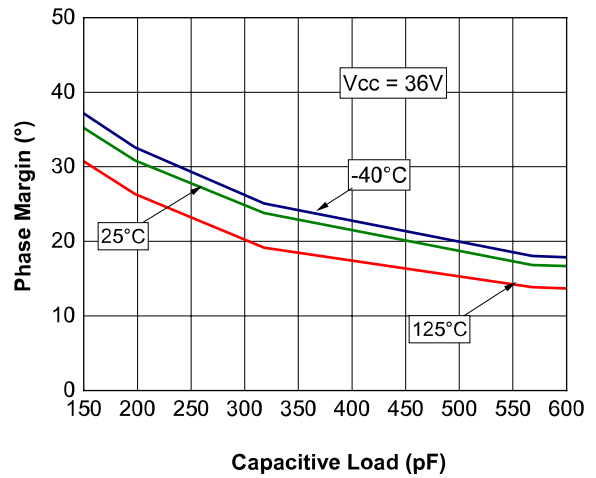
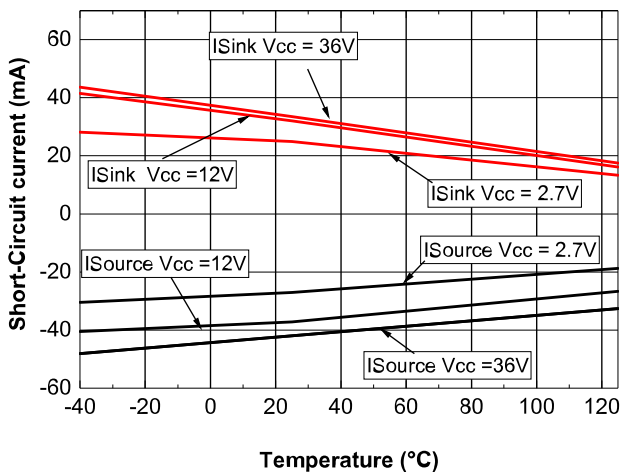
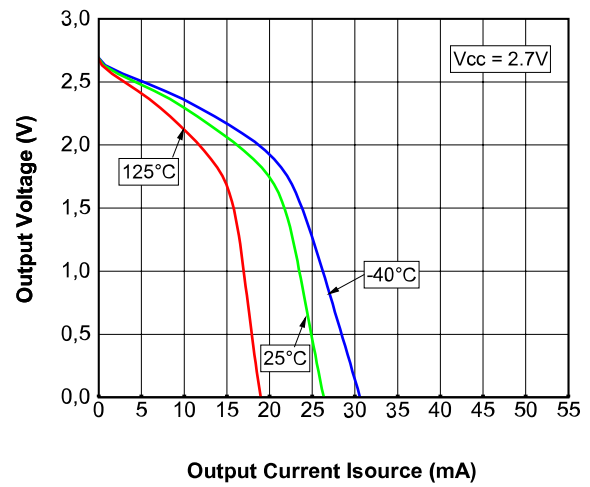
Figure 18. Phase margin vs. capacitive load at $V_{CC} = 12\text{ V}$

Figure 19. Phase margin vs. capacitive load at $V_{CC} = 36\text{ V}$

Figure 20. Short-circuit current vs. temperature

Figure 21. Output source current vs. output voltage at $V_{CC} = 2.7\text{ V}$


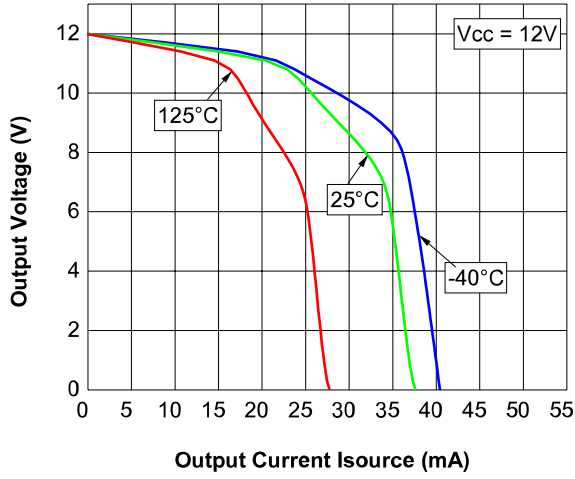
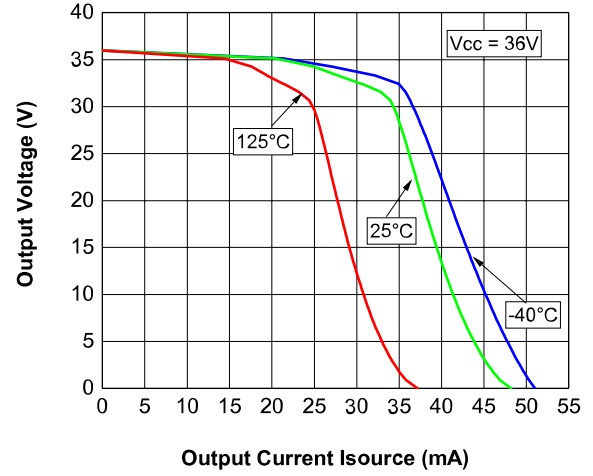
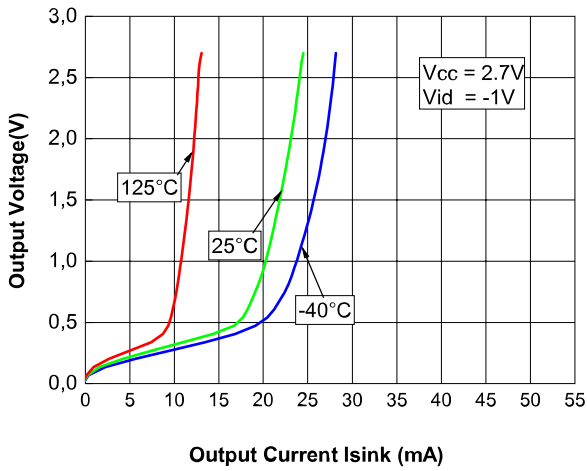
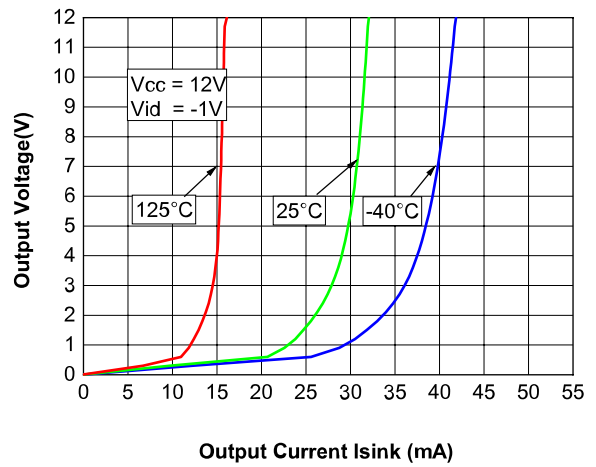
Figure 22. Output source current vs. output voltage at $V_{CC} = 12\text{ V}$

Figure 23. Output source current vs. output voltage at $V_{CC} = 36\text{ V}$

Figure 24. Output sink current vs. output voltage at $V_{CC} = 2.7\text{ V}$

Figure 25. Output sink current vs. output voltage at $V_{CC} = 12\text{ V}$


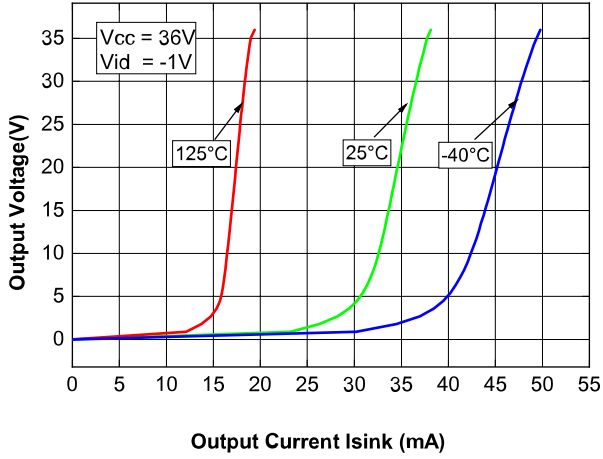
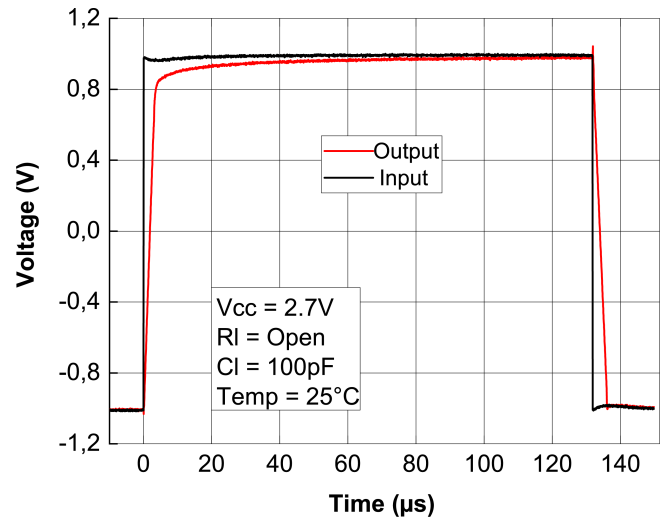
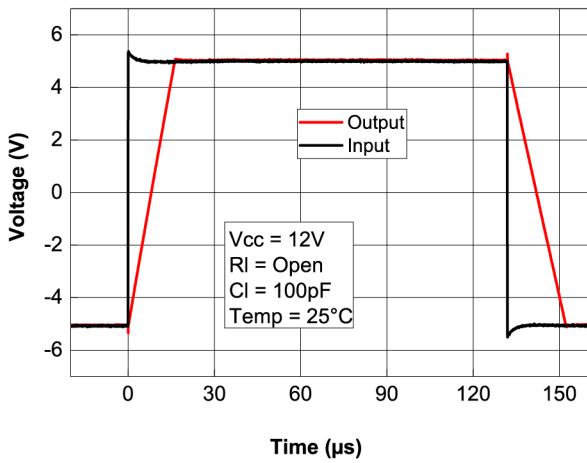
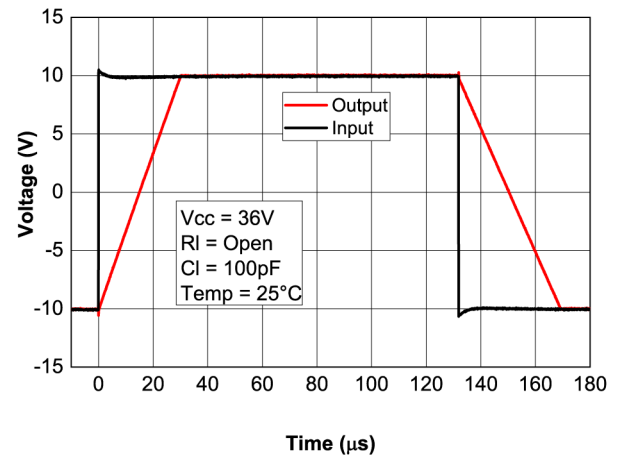
Figure 26. Output sink current vs. output voltage at $V_{CC} = 36\text{ V}$

Figure 27. Slew rate at $V_{CC} = 2.7\text{ V}$

Figure 28. Slew rate at $V_{CC} = 12\text{ V}$

Figure 29. Slew rate at $V_{CC} = 36\text{ V}$


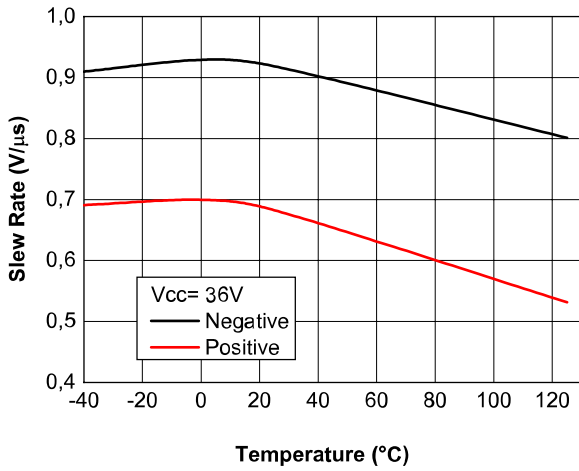
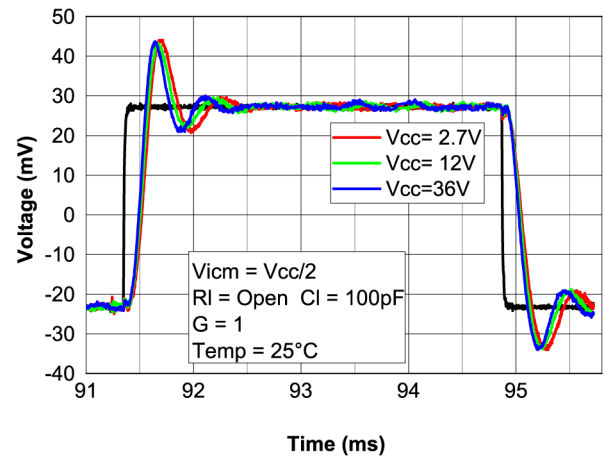
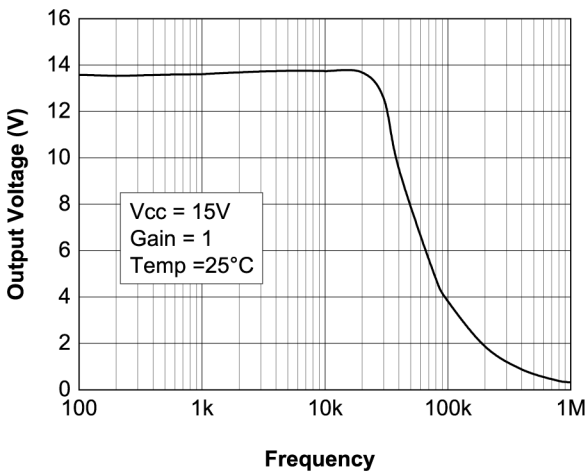
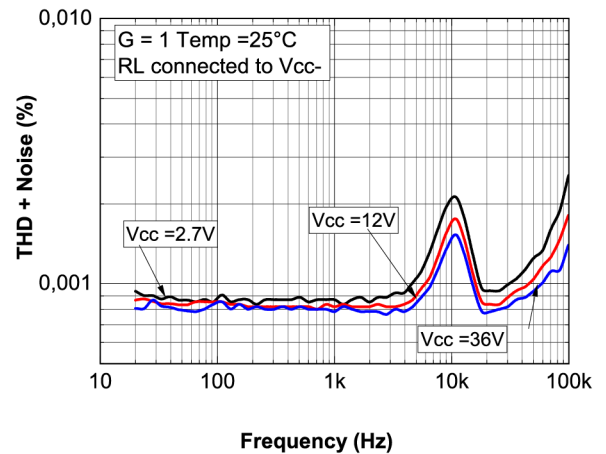
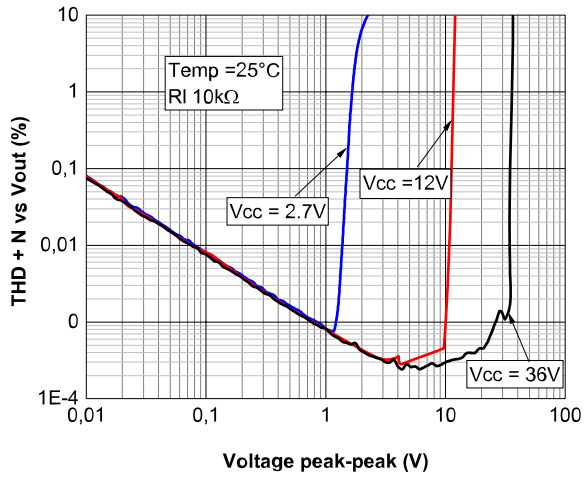
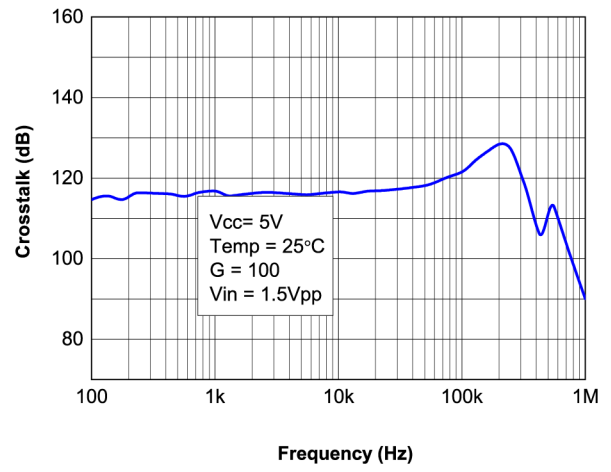
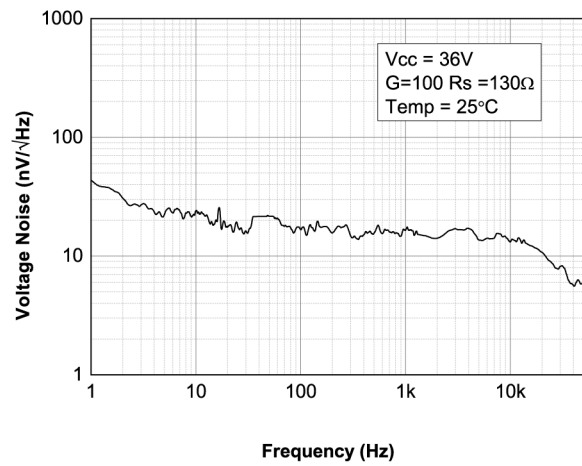
Figure 30. Slew rate vs. temperature at $V_{CC} = 36\text{ V}$

Figure 31. Small signal step response

Figure 32. Maximum output voltage vs. frequency

Figure 33. THD+Noise vs. frequency


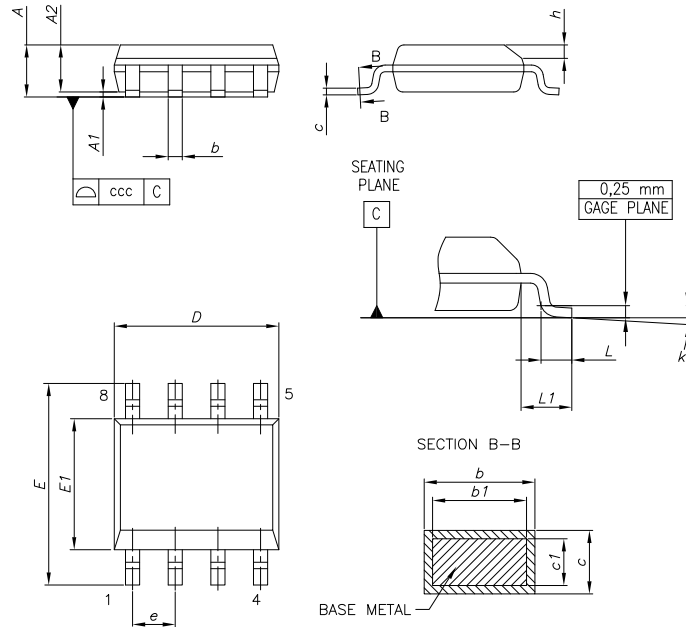
Figure 34. THD+Noise vs. output voltage

Figure 35. Cross talk vs. frequency

Figure 36. Equivalent input noise voltage vs. frequency


5 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.

5.1 SO8 package information

Figure 37. SO8 package outline



0016023_So-807_fig2_Rev10

Table 7. SO8 mechanical data

| Dim. | mm | | |
|------|------|------|------|
| | Min. | Typ. | Max. |
| A | | | 1.75 |
| A1 | 0.10 | | 0.25 |
| A2 | 1.25 | | |
| b | 0.31 | | 0.51 |
| b1 | 0.28 | | 0.48 |
| c | 0.10 | | 0.25 |
| c1 | 0.10 | | 0.23 |
| D | 4.80 | 4.90 | 5.00 |
| E | 5.80 | 6.00 | 6.20 |
| E1 | 3.80 | 3.90 | 4.00 |
| e | | 1.27 | |
| h | 0.25 | | 0.50 |
| L | 0.40 | | 1.27 |
| L1 | | 1.04 | |
| L2 | | 0.25 | |
| k | 0° | | 8° |
| ccc | | | 0.10 |

5.2 MiniSO8 package information

Figure 38. MiniSO8 package outline

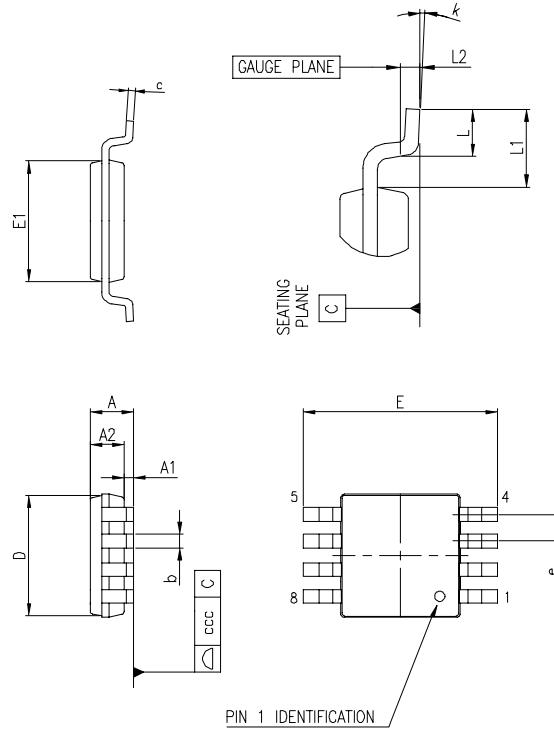


Table 8. MiniSO8 mechanical data

| Dim. | 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 | 0.03 | 0.033 | 0.037 |
| b | 0.22 | | 0.4 | 0.009 | | 0.016 |
| c | 0.08 | | 0.23 | 0.003 | | 0.009 |
| D | 2.8 | 3 | 3.2 | 0.11 | 0.118 | 0.126 |
| E | 4.65 | 4.9 | 5.15 | 0.183 | 0.193 | 0.203 |
| E1 | 2.8 | 3 | 3.1 | 0.11 | 0.118 | 0.122 |
| e | | 0.65 | | | 0.026 | |
| L | 0.4 | 0.6 | 0.8 | 0.016 | 0.024 | 0.031 |
| L1 | | 0.95 | | | 0.037 | |
| L2 | | 0.25 | | | 0.01 | |
| k | 0° | | 8° | 0° | | 8° |
| ccc | | | 0.1 | | | 0.004 |

5.3 DFN8 3x3 package information

Figure 39. DFN8 3x3 package outline and mechanical data

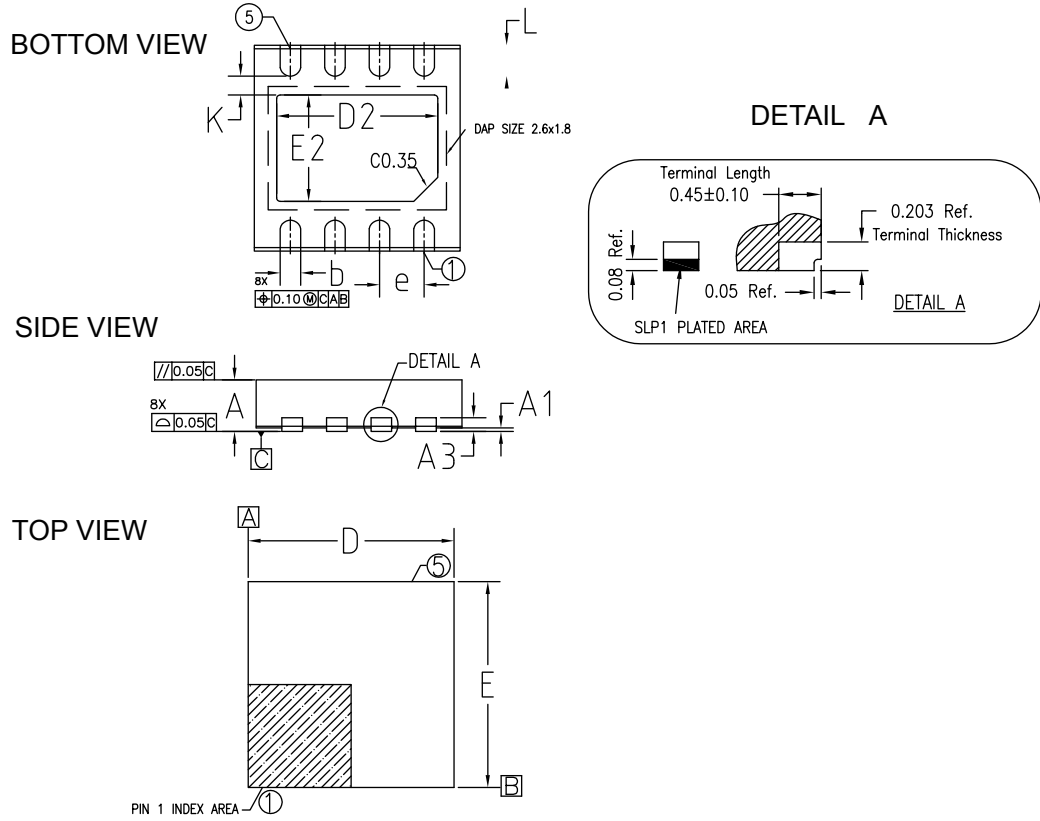
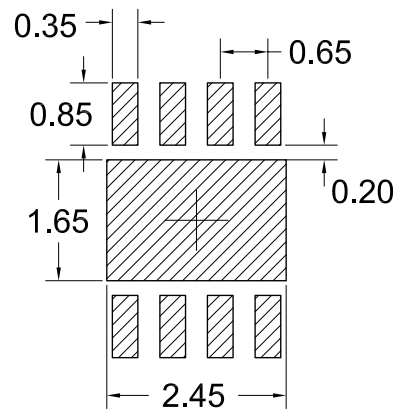


Table 9. DFN8 3x3 mechanical data

| Symbol | mm | | |
|--------|------|-----------|------|
| | Min. | Typ. | Max. |
| A | 0.70 | 0.75 | 0.80 |
| A1 | 0.0 | | 0.05 |
| A3 | | 0.20 Ref. | |
| b | 0.25 | 0.30 | 0.35 |
| D | 2.95 | 3.00 | 3.05 |
| D2 | 2.25 | 2.35 | 2.45 |
| e | | 0.65 BSC | |
| E | 2.95 | 3.00 | 3.05 |
| E2 | 1.45 | 1.55 | 1.65 |
| L | 0.35 | 0.45 | 0.55 |
| K | | 2.75 Ref. | |
| N | | 8 | |

Figure 40. DFN8 3x3 footprint data



6 Ordering information

Table 10. Order code

| Order code | Package | Packaging | Marking |
|----------------------------|-------------|-------------|----------|
| TSB622IDT | SO8 | Tape & Reel | TSB622I |
| TSB622IYDT ⁽¹⁾ | | | TSB622IY |
| TSB622IST | MiniSO8 | | K2K |
| TSB622IYST ⁽¹⁾ | | | K2L |
| TSB622IQ3T | DFN8 3x3 WF | | K2K |
| TSB622IYQ3T ⁽¹⁾ | | | K2L |

1. Qualified and characterized according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q002 or equivalent.

Revision history

Table 11. Document revision history

| Date | Revision | Changes |
|-------------|----------|------------------|
| 03-Nov-2021 | 1 | Initial release. |

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