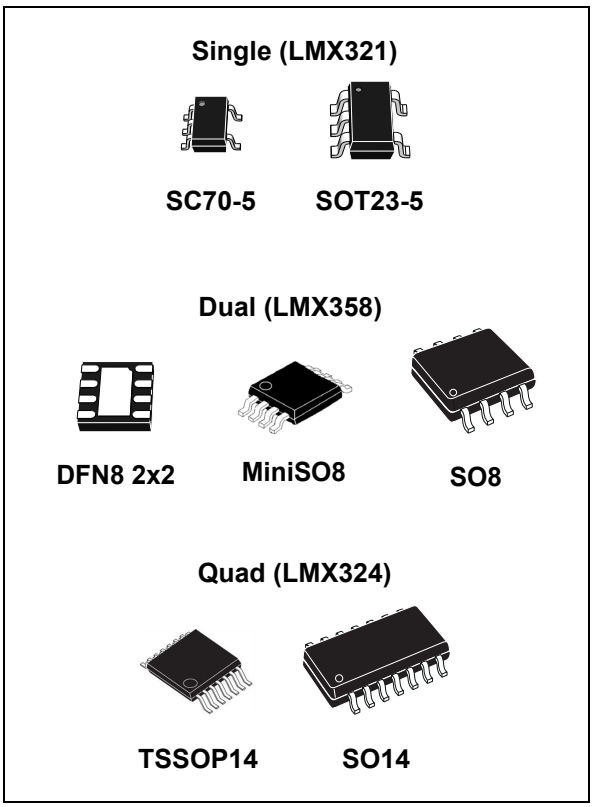
# LMX321, LMX358, LMX324

## General-purpose, low voltage rail-to-rail output operational amplifiers

**Datasheet - production data**




## Features

- Low power consumption: 120 µA at 2.7 V
- Low supply voltage: 2.3 V - 5.5 V
- Rail-to-rail output swing
- Gain bandwidth product: 1.3 MHz
- Extended temperature range: -40 °C to 125 °C
- No crossover distortion
- No phase reversal
- Tiny packages

### Related products

- See the TSV85x series for higher accuracy, stand-by options, and smaller packages

## Applications

- Battery-powered applications
- Portable devices
- Signal conditioning
- Active filtering
- Medical instrumentation

## Description

The LMX3xx series is a set of single, dual, and quad low-voltage, general-purpose, operational amplifiers. These devices can operate from 2.3 V to 5.5 V with a typical current consumption of 120 µA per channel. The LMX3xx series offers a rail-to-rail output and an input common-mode voltage that includes ground.

The LMX3xx series also exhibits a 1.3 MHz gain bandwidth and they can drive capacitive loads. The devices are stable while operating at unity gain. They are offered with industry standard pinouts in tiny packages.

**Table 1. Device summary**

| Reference | Single | Dual | Quad |
|---|---|---|---|
| LMX3xx | LMX321 | LMX358 | LMX324 |



This is information on a product in full production.

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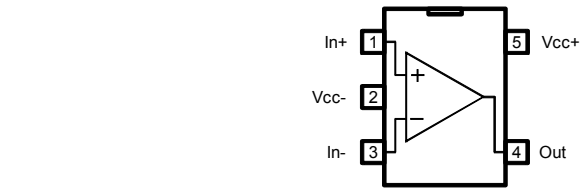
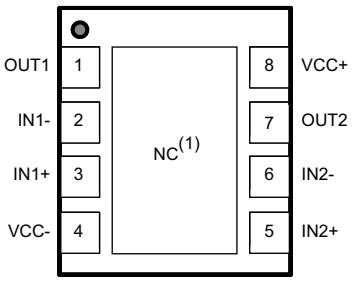
# 1 Package pin connections

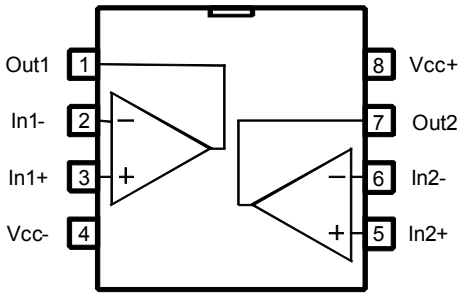
**Figure 1. Pin connections for each package (top view)**



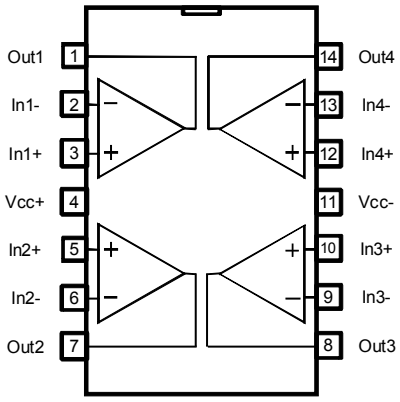

SC70-5/SOT23-5




DFN8 2x2




MiniSO8/SO8




TSSOP14/SO14

1. The exposed pad of the DFN8 2x2 can be connected to VCC- or left floating.

# 2 Absolute maximum ratings and operating conditions

**Table 2. Absolute maximum ratings (AMR)**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{CC}$ | Supply voltage(1) | 6 | V |
| $V_{id}$ | Differential input voltage (2) | $\pm V_{CC}$ | |
| $V_{in}$ | Input pins (IN+ and IN- pins) voltage (3) | $V_{cc-}$ - 0.3 to $V_{cc+}$ + 0.3 | |
| $I_{in}$ | Input current (4) | 10 | mA |
| $T_{stg}$ | Storage temperature | -65 to +150 | °C |
| $R_{thja}$ | Thermal resistance junction to ambient(5)(6) | | °C/W |
| | SC70-5 | 205 | |
| | SOT23-5 | 250 | |
| | DFN8 2x2 | 57 | |
| | MiniSO8 | 190 | |
| | SO8 | 125 | |
| | TSSOP14 | 100 | |
| | SO14 | 105 | |
| $T_j$ | Maximum junction temperature | 150 | °C |
| ESD | HBM: human body model(7) | 4000 | V |
| | MM: machine model(8) | 250 | |
| | CDM: charged device model(9) | 1300 | |
| | Latch-up immunity | 200 | mA |

1. All voltage values, except differential voltage, are with respect to network ground terminal.
2. Differential voltages are the non-inverting input terminal with respect to the inverting input terminal.
3. $V_{CC}$-$V_{in}$ must not exceed 6 V, $V_{in}$ must not exceed 6 V.
4. Input current must be limited by a resistor in series with the inputs.
5. Short-circuits can cause excessive heating and destructive dissipation.
6. $R_{th}$ are typical values.
7. Human body model: 100 pF discharged through a 1.5 kΩ resistor between two pins of the device, done for all couples of pin combinations with other pins floating.
8. Machine model: a 200 pF cap is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5 Ω), done for all couples of pin combinations with other pins floating.
9. Charged device model: all pins plus package are charged together to the specified voltage and then discharged directly to the ground.

**Table 3. Operating conditions**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{CC}$ | Supply voltage | 2.3 to 5.5 | V |
| $V_{icm}$ | Common mode input voltage range | $V_{CC-}$ - 0.2 to $V_{CC+}$ - 1 | |
| $T_{oper}$ | Operating free air temperature range | -40 to +125 | °C |

# 3 Electrical characteristics

**Table 4. Electrical characteristics at $V_{CC+}$ = 2.7 V with $V_{CC-}$ = 0 V, $V_{icm}$ = $V_{CC}$/2, $T_{amb}$ = 25° C, and $R_L$ connected to $V_{CC}$/2 (unless otherwise specified)**

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC performance** | | | | | | |
| $V_{io}$ | Input offset voltage | | | | 4 | mV |
| | | -40 °C < T< 125 °C | | | 6 | |
| $\Delta V_{io}/\Delta T$ | Input offset voltage drift(1) | -40 °C < T< 125 °C | | 1 | | µV/°C |
| $I_{io}$ | Input offset current | $V_{out}$ = $V_{cc}$/2 | | 0.5 | 30 | nA |
| | | -40 °C < T< 125 °C | | | 50 | |
| $I_{ib}$ | Input bias current | $V_{out}$ = $V_{cc}$/2 | | 27 | 60 | |
| | | -40 °C < T< 125 °C | | | 110 | |
| CMR | Common mode rejection ratio 20 log ($\Delta V_{icm}/\Delta V_{io}$) | Vic = 0 V to $V_{cc}$-1 V, $V_{out}$ = $V_{cc}$/2 | 70 | 75 | | dB |
| | | -40 °C < T< 125 °C | 68 | | | |
| $A_{vd}$ | Large signal voltage gain | $R_L$ = 10 kΩ, $V_{out}$ = 0.5 V to ($V_{cc}$-0.5 V) | 100 | 110 | | |
| | | -40 °C < T< 125 °C | 90 | | | |
| | | $R_L$ = 2 kΩ, $V_{out}$ = 0.5 V to ($V_{cc}$-0.5 V) | 90 | 100 | | |
| | | -40 °C < T< 125 °C | 80 | | | |
| $V_{CC}$-$V_{OH}$ | High level output voltage | $R_L$ = 10 kΩ, | | 10 | 100 | mV |
| | | -40 °C < T< 125 °C | | | 200 | |
| | | $R_L$ = 2 kΩ | | 40 | 300 | |
| | | -40 °C < T< 125 °C | | | 400 | |
| $V_{OL}$ | Low level output voltage | $R_L$ = 10 kΩ, | | 65 | 180 | |
| | | -40 °C < T< 125 °C | | | 280 | |
| | | $R_L$ = 2 kΩ, | | 120 | 300 | |
| | | -40 °C < T< 125 °C | | | 400 | |
| $I_{out}$ | $I_{sink}$ | $V_{out}$ = $V_{cc}$, $V_{id}$ = -1 V | 15 | 26 | | mA |
| | | -40 °C < T< 125 °C | 15 | | | |
| | $I_{source}$ | $V_{out}$ = 0 V, Vid = 1 V | 15 | 21 | | |
| | | -40 °C < T< 125 °C | 12 | | | |
| $I_{CC}$ | Supply current (per channel) | No load, $V_{out}$ = $V_{CC}$/2 | | 120 | 180 | µA |
| | | -40 °C < T< 125 °C | | | 180 | |

**Table 4. Electrical characteristics at $V_{CC+}$ = 2.7 V with $V_{CC-}$ = 0 V, $V_{icm}$ = $V_{CC}$/2, $T_{amb}$ = 25° C, and $R_L$ connected to $V_{CC}$/2 (unless otherwise specified) (continued)**

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **AC performance** | | | | | | |
| GBP | Gain bandwidth product | $R_L$ > 1 MΩ, $C_L$ = 200 pF | | 1.3 | | MHz |
| $F_u$ | Unity gain frequency | | | 1 | | |
| $\Phi_m$ | Phase margin | | | 60 | | degrees |
| $G_m$ | Gain margin | | | 10 | | dB |
| SR | Slew rate | $R_L$ > 1 MΩ, $C_L$ = 200 pF<br>$V_{out}$ = 0.5 V to $V_{CC}$ - 0.5 V | | 0.6 | | V/µs |
| $e_n$ | Equivalent input noise voltage | f = 1 kHz<br>f = 10 kHz | | 31<br>20 | | $\frac{nV}{\sqrt{Hz}}$ |
| $i_n$ | Equivalent input noise current | f = 1 kHz | | 0.30 | | $\frac{pA}{\sqrt{Hz}}$ |
| THD+N | Total harmonic distortion + noise | $f_{in}$ = 1 kHz, $A_{CL}$ = 1,<br>$R_L$ = 10 kΩ,<br>$V_{ICM}$ = $V_{CC}$/2, BW = 22 kHz,<br>$V_{out}$ = 1 Vpp | | 0.002 | | % |

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

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **DC performance** | | | | | | |
| $V_{io}$ | Input offset voltage | | | | 4 | mV |
| | | -40 °C < T< 125 °C | | | 6 | |
| $\Delta V_{io}/\Delta T$ | Input offset voltage drift(1) | -40 °C < T< 125 °C | | 1 | | µV/°C |
| $I_{io}$ | Input offset current | $V_{out}$ = $V_{cc}$/2 | | 0.5 | 30 | nA |
| | | -40 °C < T< 125 °C | | | 50 | |
| $I_{ib}$ | Input bias current | $V_{out}$ = $V_{cc}$/2 | | 27 | 60 | |
| | | -40 °C < T< 125 °C | | | 110 | |
| CMR | Common mode rejection ratio 20 log ($\Delta V_{icm}/\Delta V_{io}$) | Vic = 0 V to $V_{cc}$-1V, $V_{out}$ = $V_{cc}$/2 | 72 | 75 | | dB |
| | | -40 °C < T< 125 °C | 70 | | | |
| SVR | Supply voltage rejection ratio 20 log ($\Delta V_{cc}/\Delta V_{io}$) | $V_{cc}$ = 2.5 to 5 V | 72 | 79 | | |
| | | -40 °C < T< 125 °C | 70 | | | |
| $A_{vd}$ | Large signal voltage gain | $R_L$ = 10 kΩ, $V_{out}$ = 0.5 V to ($V_{CC}$ - 0.5 V) | 100 | 110 | | |
| | | -40 °C < T< 125 °C | 90 | | | |
| | | $R_L$ = 2 kΩ, | 90 | 100 | | |
| | | -40 °C < T< 125 °C | 80 | | | |
| $V_{CC}$-$V_{OH}$ | High level output voltage | $R_L$ = 10 kΩ | | 10 | 100 | mV |
| | | -40 °C < T< 125 °C | | | 200 | |
| | | $R_L$ = 2 kΩ, | | 40 | 300 | |
| | | -40 °C < T< 125 °C | | | 400 | |
| $V_{OL}$ | Low level output voltage | $R_L$ = 10 kΩ | | 65 | 180 | |
| | | -40 °C < T< 125 °C | | | 280 | |
| | | $R_L$ = 2 kΩ | | 120 | 300 | |
| | | -40 °C < T< 125 °C | | | 400 | |
| $I_{out}$ | $I_{sink}$ | $V_{out}$ = $V_{CC}$, $V_{id}$ = -1 V | 35 | 43 | | mA |
| | | -40 °C < T< 125 °C | 25 | | | |
| | $I_{source}$ | $V_{out}$ = 0 V, $V_{id}$ = 1 V | 60 | 70 | | |
| | | -40 °C < T< 125 °C | 50 | | | |
| $I_{CC}$ | Supply current (per channel) | No load, $V_{out}$ = $V_{CC}$/2 | | 130 | 180 | µA |
| | | -40 °C < T< 125 °C | | | 180 | |

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

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| **AC performance** | | | | | | |
| GBP | Gain bandwidth product | $R_L$ > 1 MΩ, $C_L$ = 200 pF | | 1.3 | | MHz |
| $F_u$ | Unity gain frequency | | | 1 | | |
| $\Phi_m$ | Phase margin | | | 60 | | degrees |
| $G_m$ | Gain margin | | | 10 | | dB |
| SR | Slew rate | $R_L$ > 1 MΩ, $C_L$ = 200 pF<br>$V_{out}$ = 0.5 V to $V_{CC}$ - 0.5V | | 0.7 | | V/µs |
| $e_n$ | Equivalent input noise voltage | f = 1 kHz<br>f = 10 kHz | | 30<br>20 | | $\frac{nV}{\sqrt{Hz}}$ |
| $i_n$ | Equivalent input noise current | f = 1 kHz | | 0.30 | | $\frac{pA}{\sqrt{Hz}}$ |
| THD+N | Total harmonic distortion + noise | $f_{in}$ = 1 kHz, $A_{CL}$ = 1,<br>$R_L$ = 10 kΩ,<br>$V_{ICM}$ = $V_{CC}$/2, BW = 22 kHz,<br>$V_{out}$ = 1 Vpp | | 0.002 | | % |

1. See *Section 4.4: Input offset voltage drift over temperature*.

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

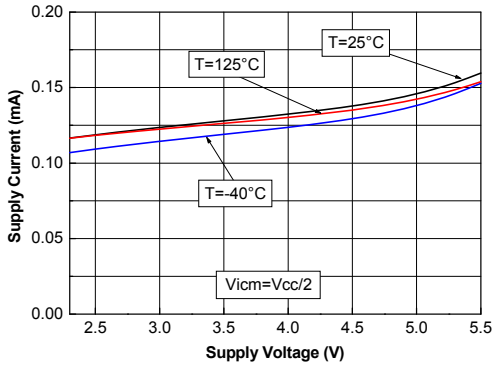



**Figure 3. Vio distribution at $V_{CC}$ = 5 V**

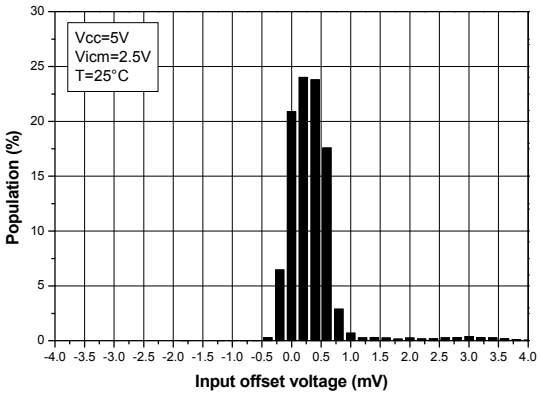



**Figure 4. Input offset voltage vs. input common mode voltage at $V_{CC}$ = 5 V**

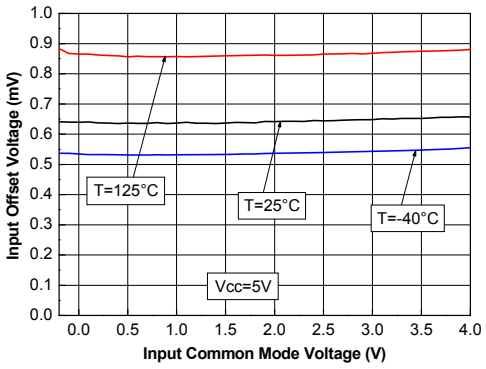



**Figure 5. Output current vs. output voltage at $V_{CC}$ = 2.7 V**

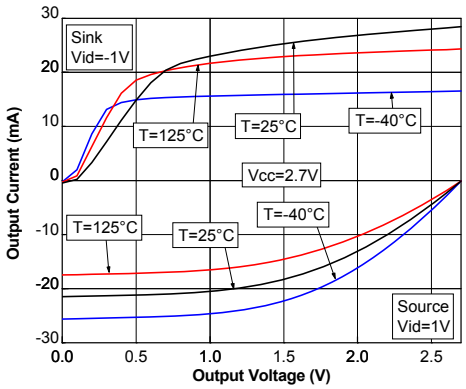



**Figure 6. Output current vs. output voltage at $V_{CC}$ = 5 V**

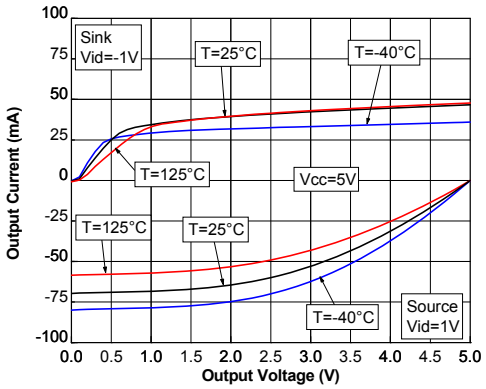



**Figure 7. Output current vs. supply voltage at $V_{icm} = V_{CC}/2$**

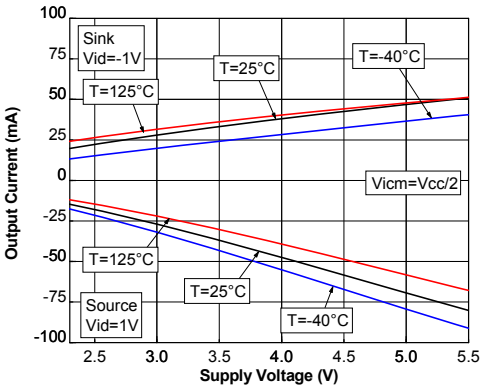


**Figure 8. Voltage gain and phase with Cl = 100 pF**

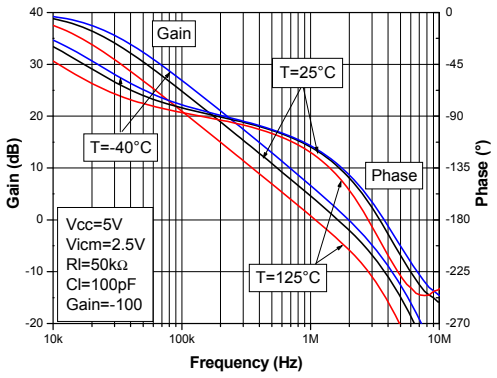



**Figure 9. Voltage gain and phase with Cl = 200 pF**

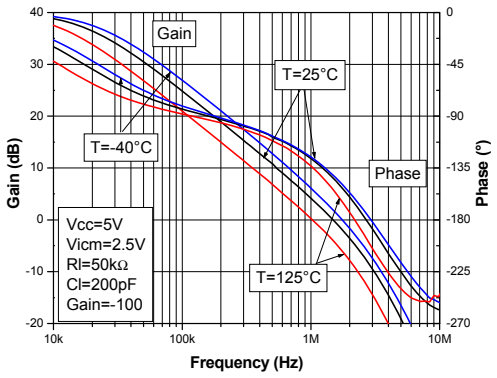



**Figure 10. Gain margin vs. load capacitor at $V_{CC}$ = 5 V**

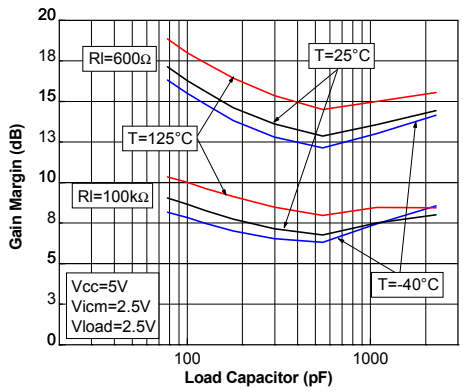



**Figure 11. Phase margin vs. load capacitor at $V_{CC}$ = 5 V**

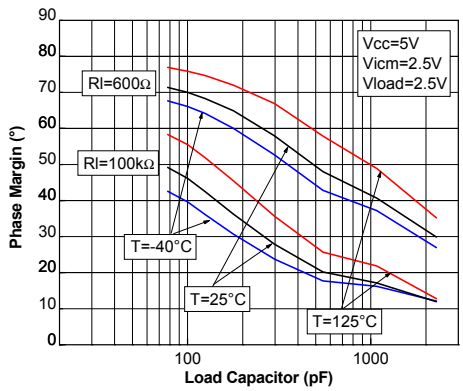



**Figure 12. Closed-loop gain in voltage follower configuration for different capacitive loads**

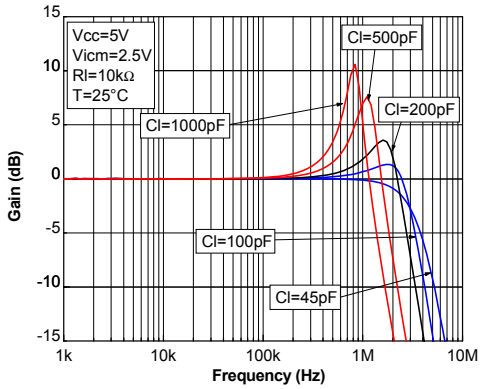



**Figure 13. Phase margin vs. output current at $V_{CC}$ = 5 V**

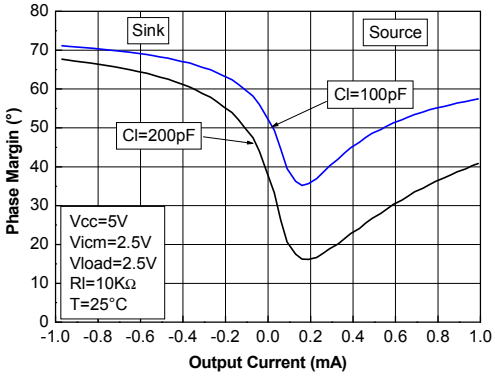


**Figure 14. Positive and negative slew rate vs. supply voltage**

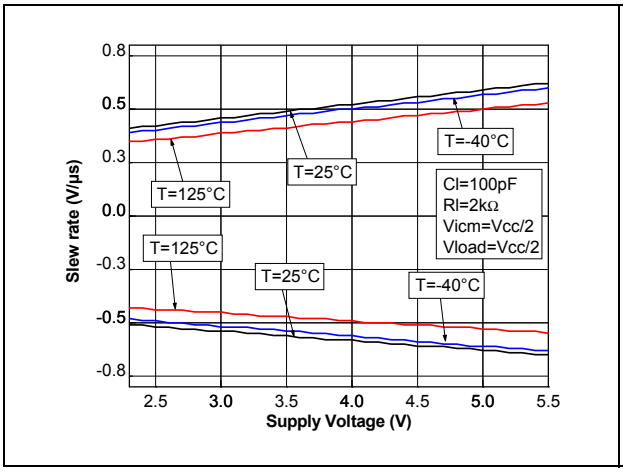



**Figure 15. Positive slew rate at $V_{CC}$ = 5 V with Cl = 100 pF**

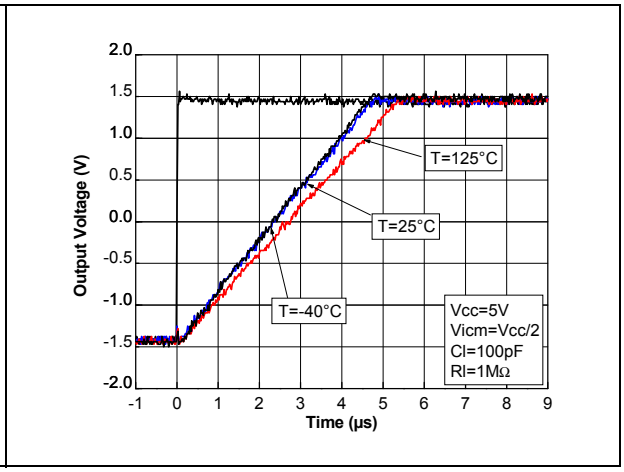



**Figure 16. Negative slew rate at $V_{CC}$ = 5 V with Cl = 100 pF**

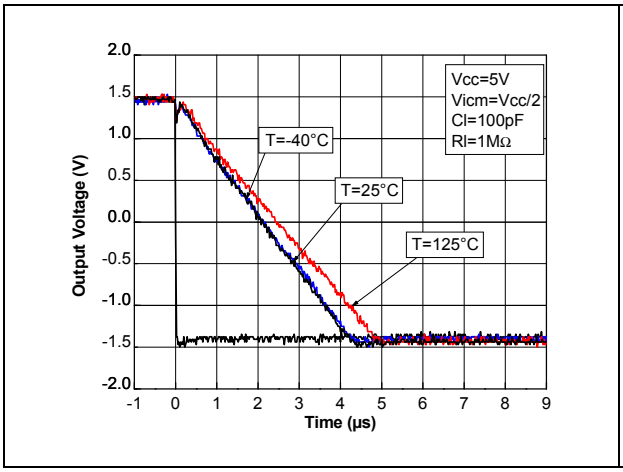



**Figure 17. Noise vs. frequency**

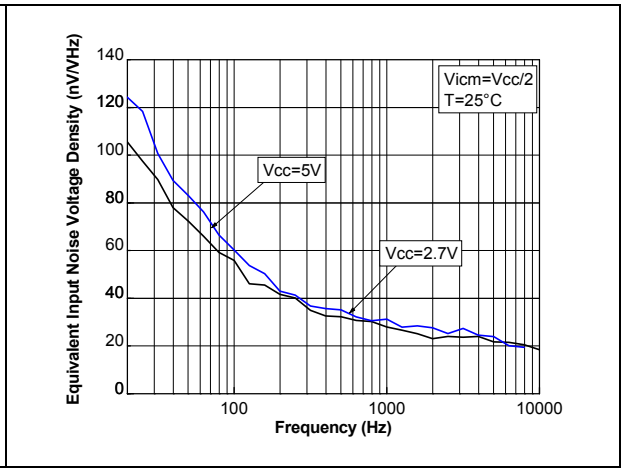



**Figure 18. 0.1 Hz to 10 Hz noise at $V_{CC}$ = 5 V**

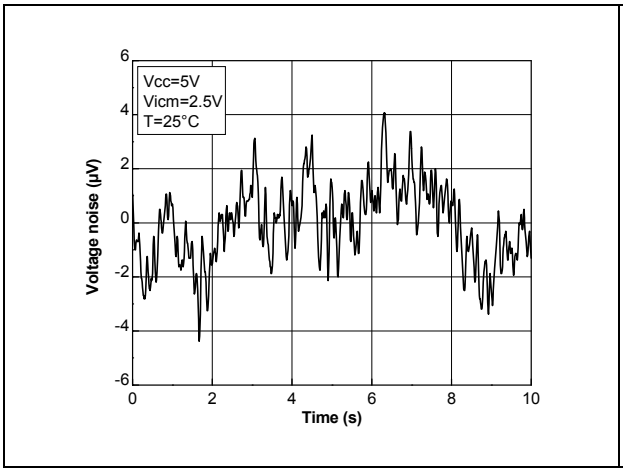



**Figure 19. Distortion + noise vs. frequency**

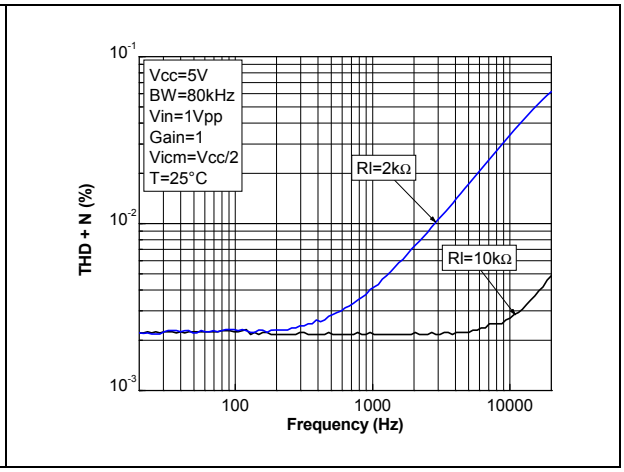
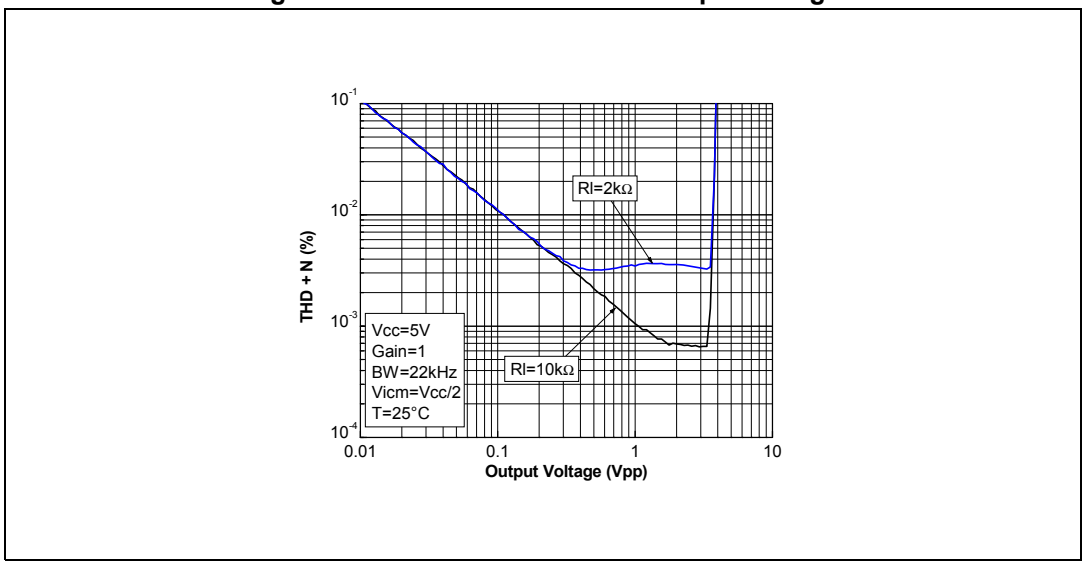


**Figure 20. Distortion + noise vs. output voltage**



# 4 Application information

## 4.1 Operating voltages

The LMX321, LMX358, and LMX324 can operate from 2.3 V to 5.5 V. The devices' parameters are fully specified for 2.7 V and 5 V power supplies. Additionally, the main specifications are guaranteed in extended temperature ranges from -40° C to +125° C.

## 4.2 Input common-mode range

The LMX321, LMX358, and LMX324 have an input common-mode range that includes ground. The input common-mode range is extended from $V_{CC-}$ - 0.2 V to $V_{CC+}$ - 1 V, with no output phase reversal.

## 4.3 Rail-to-rail output

The operational amplifiers' output levels can go close to the rails: to a maximum of 180 mV above and below the rail when connected to a 10 kΩ resistive load to $V_{CC}/2$.

## 4.4 Input offset voltage drift over temperature

The maximum input voltage drift over the temperature variation is defined in *Equation 1*.

**Equation 1**

$$\frac{\Delta Vio}{\Delta T} = \max\left|\frac{Vio(T) - Vio(25°C)}{T - 25°C}\right|$$

for $T_{min} < T < T_{max}$.

## 4.5 PCB layouts

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

## 4.6 Macromodel

Accurate macromodels of the LMX321, LMX358, and LMX324 are available on STMicroelectronics' web site at www.st.com. These models are a trade-off between accuracy and complexity (that is, time simulation) of the LMX321, LMX358, and LMX324 operational amplifiers. They emulate the nominal performances of a typical device within the specified operating conditions mentioned in the datasheet. They also help to validate a design approach and to select the right operational amplifier, *but they do not replace on-board measurements*.

# 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 SC70-5 (or SOT323-5) package information

**Figure 21. SC70-5 (or SOT323-5) package mechanical drawing**

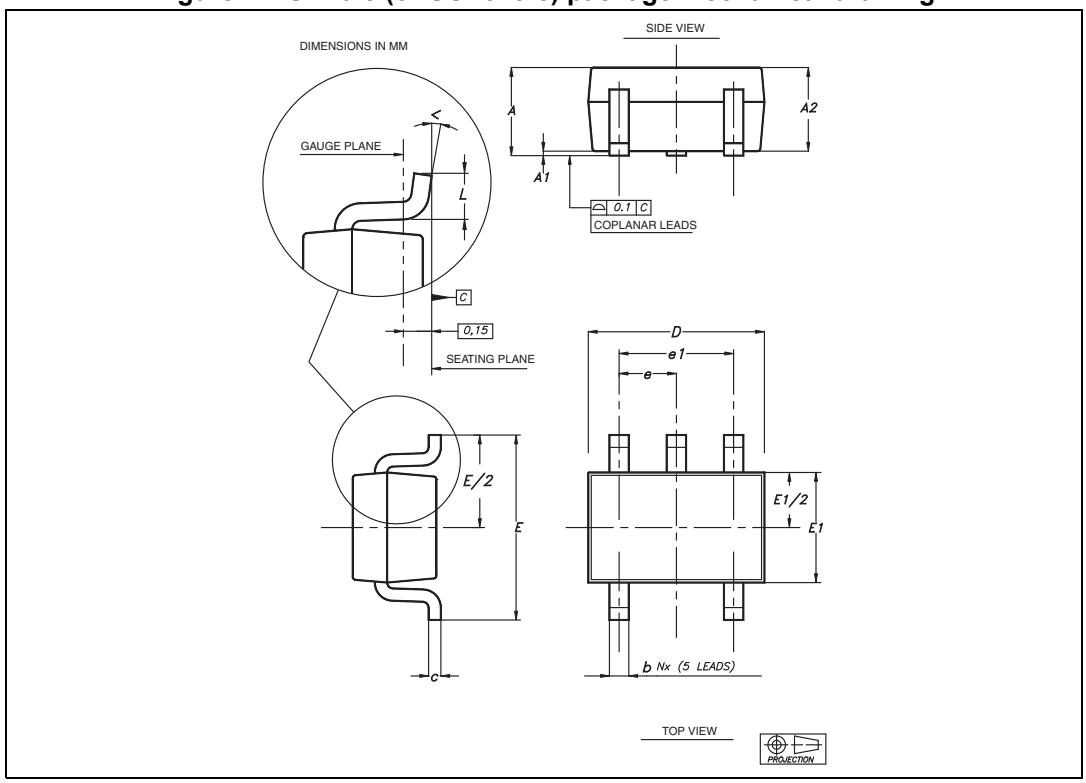



**Table 6. SC70-5 (or SOT323-5) package mechanical data**

| Ref | Dimensions | | | | | |
|---|---|---|---|---|---|---|
| | Millimeters | | | Inches | | |
| | Min | Typ | Max | Min | Typ | Max |
| A | 0.80 | | 1.10 | 0.032 | | 0.043 |
| A1 | | | 0.10 | | | 0.004 |
| A2 | 0.80 | 0.90 | 1.00 | 0.032 | 0.035 | 0.039 |
| b | 0.15 | | 0.30 | 0.006 | | 0.012 |
| c | 0.10 | | 0.22 | 0.004 | | 0.009 |
| D | 1.80 | 2.00 | 2.20 | 0.071 | 0.079 | 0.087 |
| E | 1.80 | 2.10 | 2.40 | 0.071 | 0.083 | 0.094 |
| E1 | 1.15 | 1.25 | 1.35 | 0.045 | 0.049 | 0.053 |
| e | | 0.65 | | | 0.025 | |
| e1 | | 1.30 | | | 0.051 | |
| L | 0.26 | 0.36 | 0.46 | 0.010 | 0.014 | 0.018 |
| < | 0 ° | | 8 ° | 0 ° | | 8 ° |

## 5.2 SOT23-5 package information

**Figure 22. SOT23-5 package mechanical drawing**

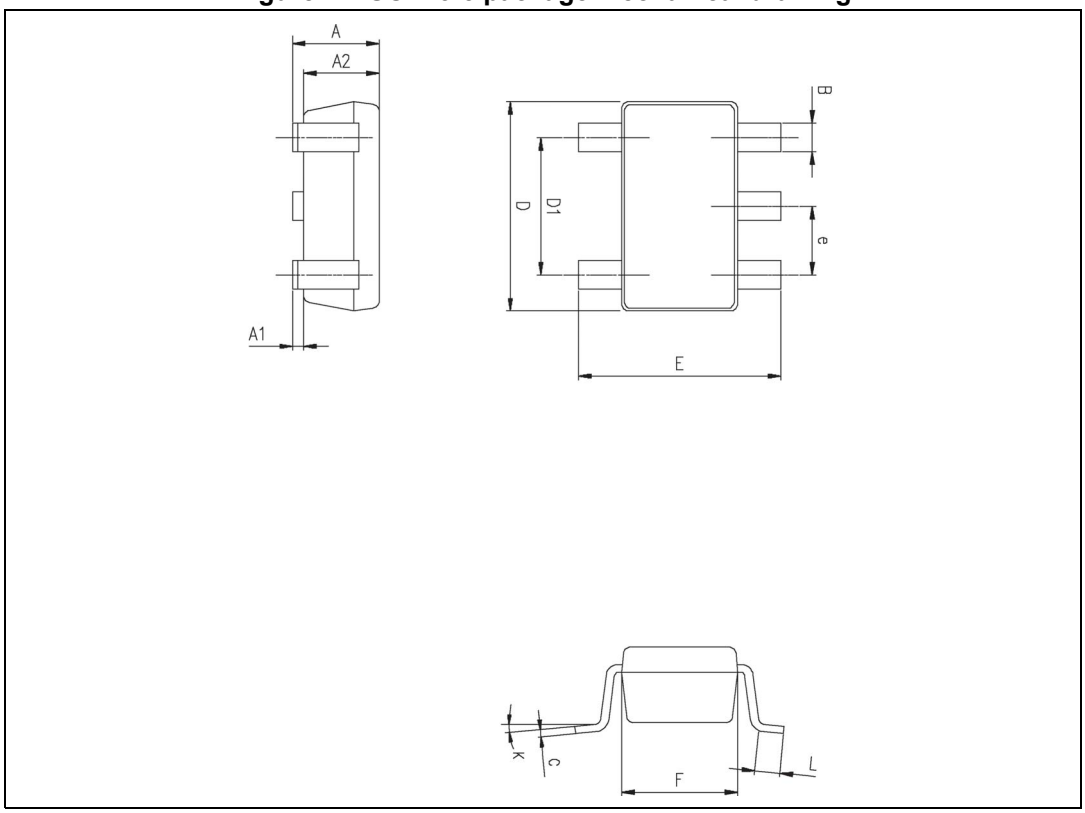



**Table 7. SOT23-5 package mechanical data**

| 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 ° | 0 ° | | 10 ° |

## 5.3 DFN8 2x2 package information

Figure 23. DFN8 2x2 package mechanical drawing

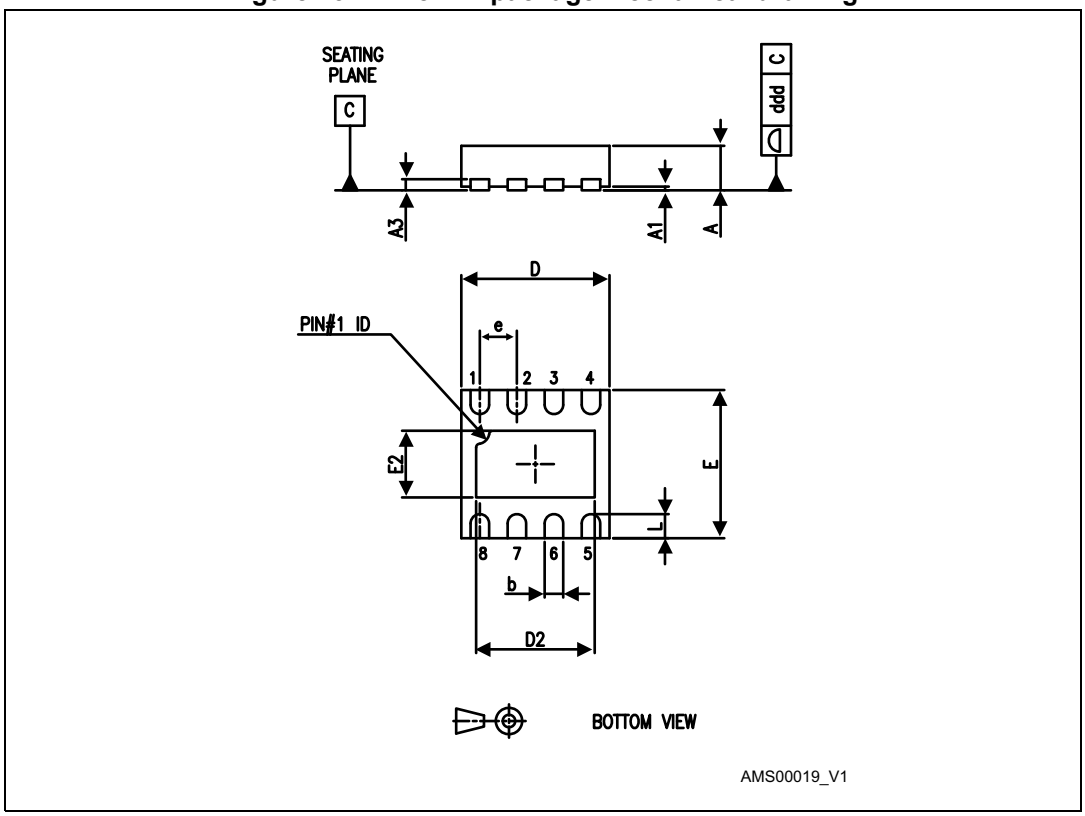
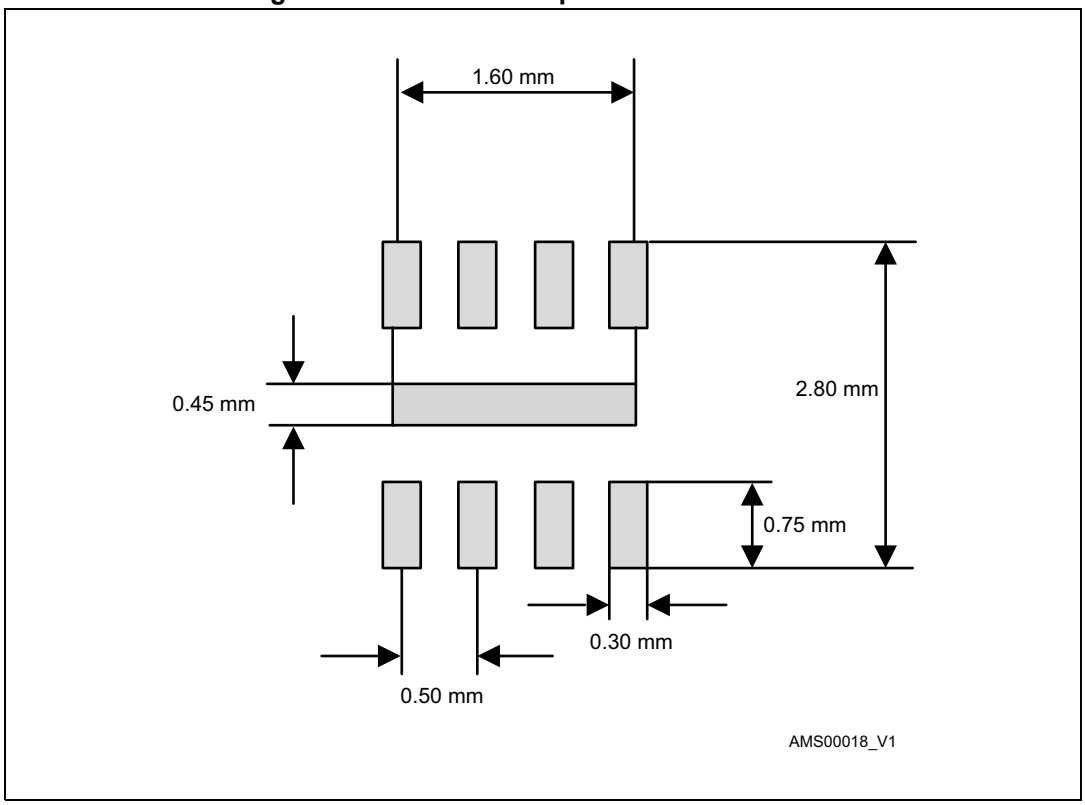



Figure 24. DFN8 2x2x0.6 mm package mechanical data (pitch 0.5 mm)

| 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 25. DFN8 2x2 footprint recommendation



## 5.4 MiniSO8 package information

**Figure 26. MiniSO8 package mechanical drawing**

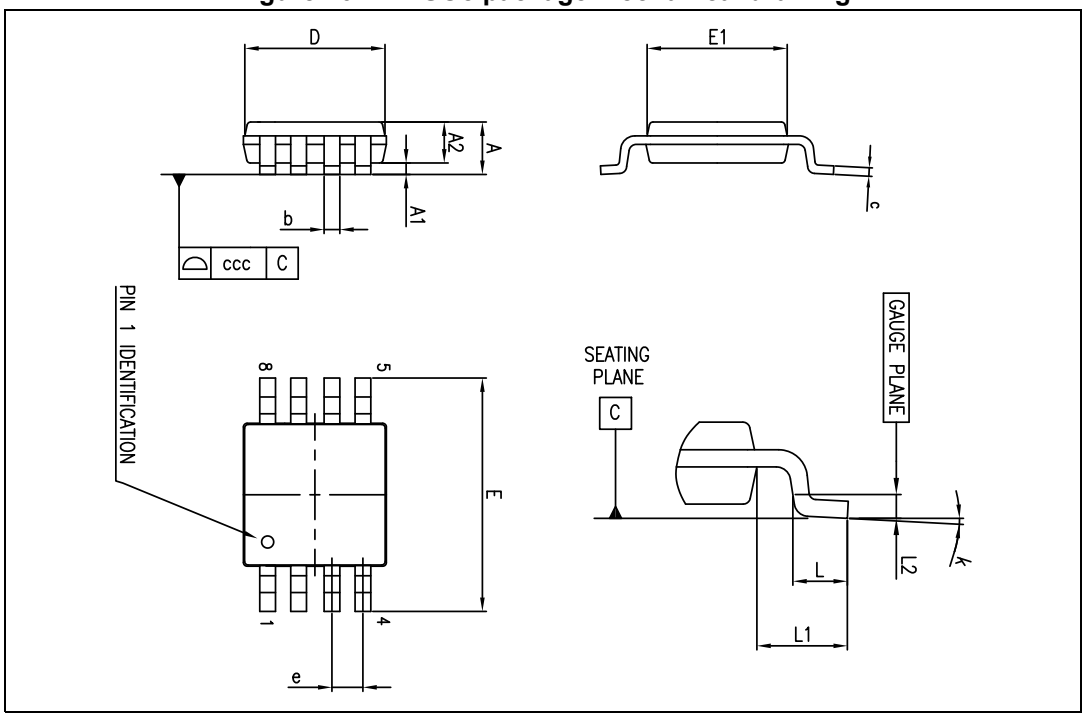



**Table 8. MiniSO8 package mechanical data**

| 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 |

## 5.5 SO8 package information

Figure 27. SO8 package mechanical drawing

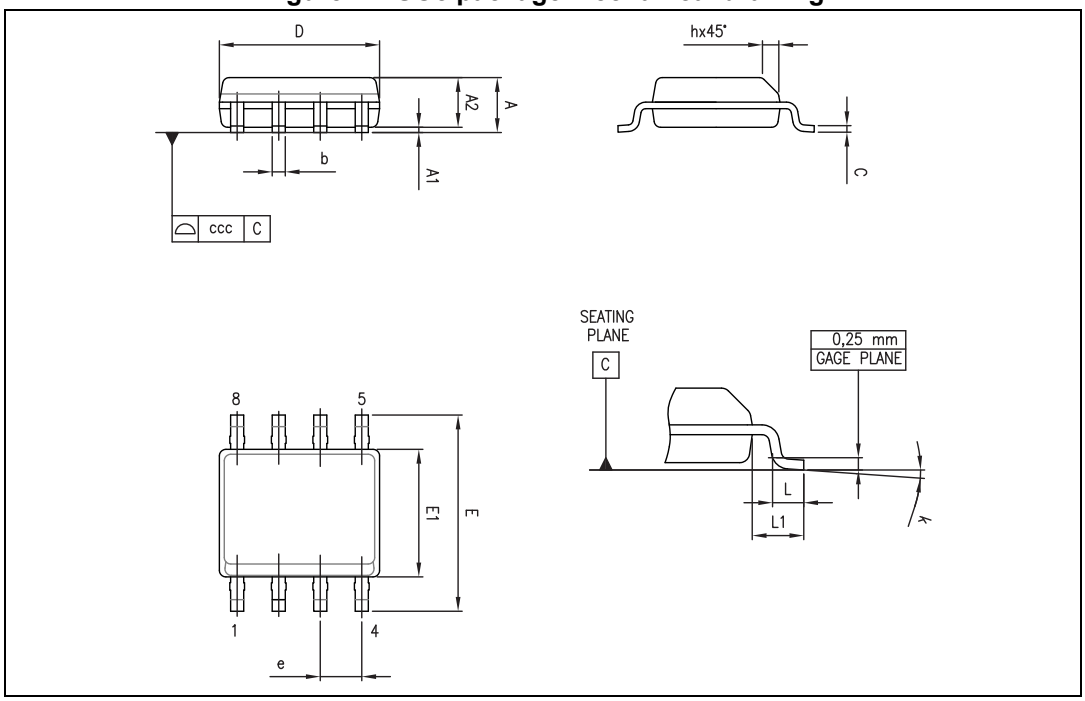



Table 9. SO8 package mechanical data

| 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 |

## 5.6 TSSOP14 package information

**Figure 28. TSSOP14 package mechanical drawing**

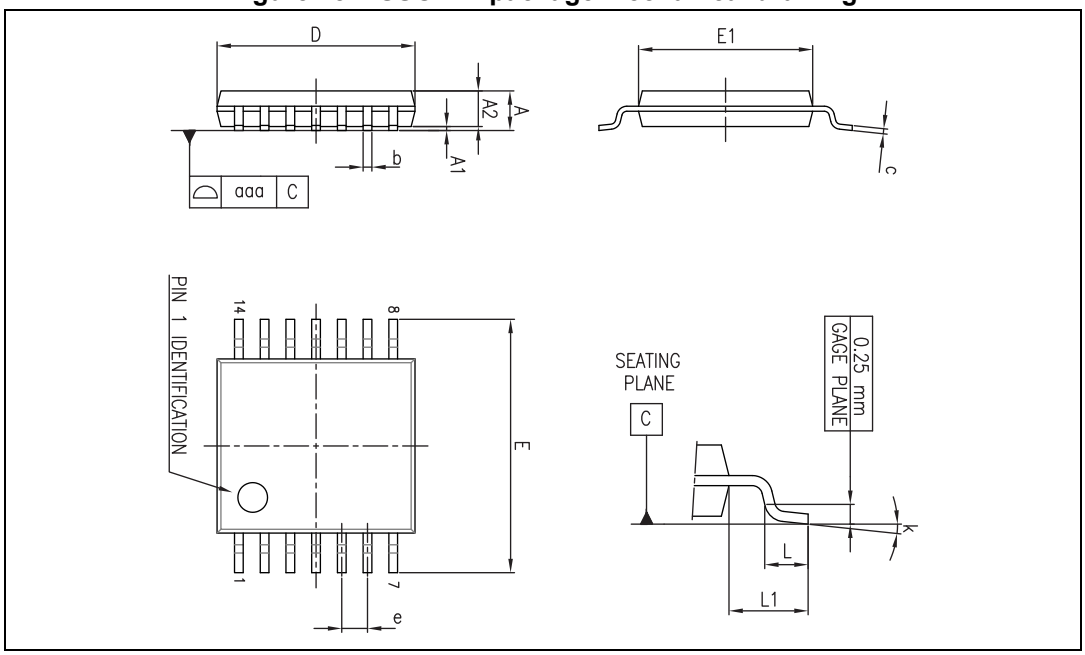



**Table 10. TSSOP14 package mechanical data**

| 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 |

## 5.7 SO14 package information

Figure 29. SO14 package mechanical drawing

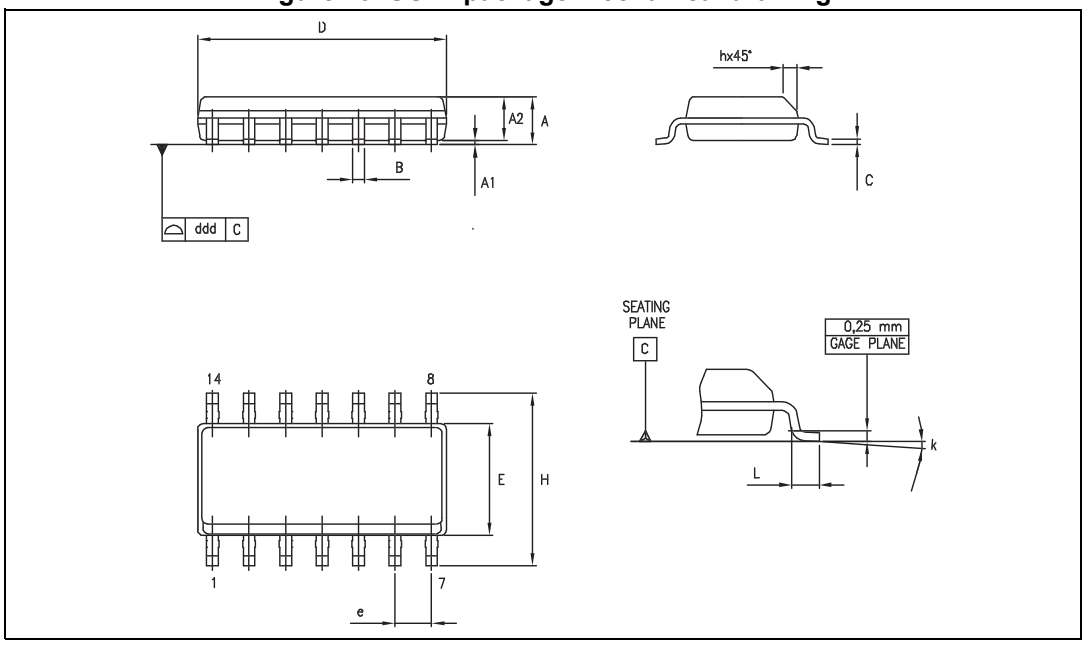



Table 11. SO14 package mechanical data

| 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 |

# 6 Ordering information

**Table 12. Order codes**

| Order code | Temperature range | Package | Packing | Marking |
|---|---|---|---|---|
| LMX321ICT | -40° C to +125° C | SC70-5 | Tape and reel | K21 |
| LMX321ILT | | SOT23-5 | | K430 |
| LMX358IQ2T | | DFN8 2x2 | | K21 |
| LMX358IST | | MiniSO8 | | K430 |
| LMX358IDT | | SO8 | | LMX358I |
| LMX324IPT | | TSSOP14 | | LMX324I |
| LMX324IDT | | SO14 | | LMX324I |

# 7 Revision history

Table 13. Document revision history

| Date | Revision | Changes |
|---|---|---|
| 19-Mar-2012 | 1 | Initial release. |
| 06-Apr-2012 | 2 | Document status promoted from Target Specification to Production Data. |
| 07-May-2013 | 3 | Added DFN8 2x2 silhouette, pinout, and package<br>*Table 2: Absolute maximum ratings (AMR)*: added $R_{thja}$ data for DFN8 2x2 package.<br>*Table 12: Order codes*: added LMX358IQ2T order code. |

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