# LMV321, LMV358, LMV324

## Low cost, low power, input/output rail-to-rail operational amplifiers

## Features

- Operating range from $V_{CC}$ = 2.7 V to 6 V
- Rail-to-rail input and output
- Extended $V_{icm}$ ($V_{DD}$ - 0.2 V to $V_{CC}$ + 0.2 V)
- Low supply current (145 µA)
- Gain bandwidth product (1 MHz)
- ESD tolerance (2 kV)
- Latch-up immunity
- Available in SOT23-5 micropackage

## Applications

- Two-cell battery powered systems
- Battery powered electronic equipment
- Cordless phones
- Personal medical care (glucose meters)
- Laptops
- PDAs

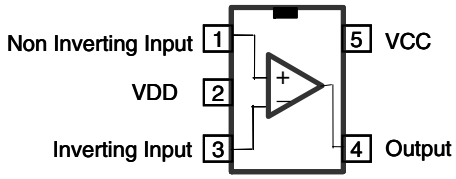
## Description

The LMV321/358/324 family (single, dual and quad) answers the need for low-cost, general-purpose operational amplifiers. They operate with voltages as low as 2.7 V and feature both input and output rail-to-rail, 145 µA consumption current and 1 MHz gain bandwidth product (GBP).

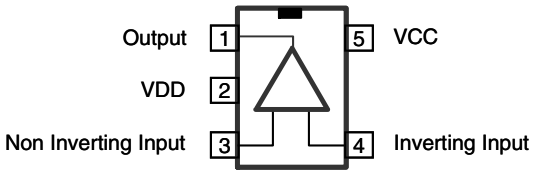
With such a low consumption and a sufficient GBP for many applications, these op-amps are very well-suited for any kind of battery supplied and portable equipment application.

The LMV321 is housed in the space-saving 5-pin SOT23-5 package, which simplifies board design (overall dimensions are 2.8 mm x 2.9 mm). The SOT23-5 has two pinning configurations to answer all application requirements.

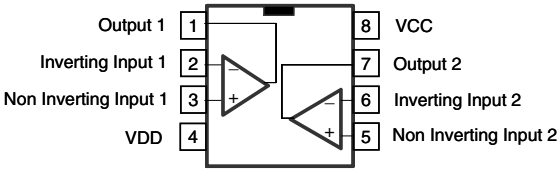
**LMV321ILT**
(SOT23-5)



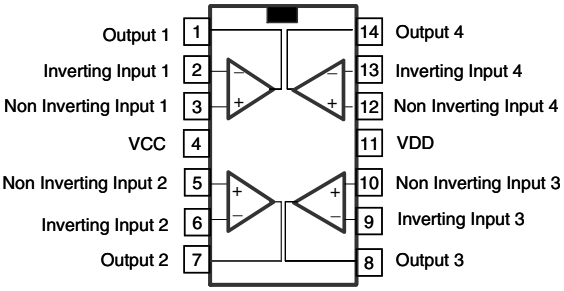

**LMV321RILT**
(SOT23-5)




**LMV358ID/IDT-LMV358IPT**
(SO-8, TSSOP-8)




**LMV324ID/IDT-LMV324IPT**
(SO-14, TSSOP-14)



# 1 Absolute maximum ratings and operating conditions

**Table 1. Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{CC}$ | Supply voltage (1) | 7 | V |
| $V_{id}$ | Differential input voltage(2) | ±1 | V |
| $V_{in}$ | Input voltage | $V_{DD}$-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)<br>SOT23-5<br>SO-8<br>SO-14<br>TSSOP8<br>TSSOP14 | <br>250<br>125<br>103<br>120<br>100 | °C/W |
| $R_{thjc}$ | Thermal resistance junction to case(3)<br>SOT23-5<br>SO-8<br>SO-14<br>TSSOP8<br>TSSOP14 | <br>81<br>40<br>31<br>37<br>32 | °C/W |
| 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) | |

1. All voltage values, except differential voltage are with respect to network terminal.
2. Differential voltages are the non-inverting input terminal with respect to the inverting input terminal. If $V_{id}$ > ±1 V, the maximum input current must not exceed ±1 mA. In this case ($V_{id}$ > ±1 V), an input series resistor must be added to limit input current.
3. Short-circuits can cause excessive heating. Destructive dissipation can result from simultaneous short-circuits on all amplifiers. All values are typical.
4. Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5 kΩ resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
5. 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.
6. Charged device model: all pins and the package are charged together to the specified voltage and then discharged directly to the ground through only one pin. This is done for all pins.
No value specified for CDM on SOT23-5L package. The value is given for SO and TSSOP packages.
7. 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 2. Operating conditions**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{CC}$ | Supply voltage | 2.7 to 6 | V |
| $V_{icm}$ | Common mode input voltage range (1) | $V_{DD}$ -0.2 to $V_{CC}$ + 0.2 | V |
| $V_{icm}$ | Common mode input voltage range (2) | $V_{DD}$ to $V_{CC}$ | V |
| $T_{oper}$ | Operating free air temperature range | -40 to + 125 | °C |

1. At 25°C, for $2.7 \leq V_{CC} \leq 6$ V, $V_{icm}$ is extended to $V_{DD}$ - 0.2 V, $V_{CC}$ + 0.2 V.
2. In full temperature range, both rails can be reached when $V_{CC}$ does not exceed 5.5 V.

# 2 Electrical characteristics

**Table 3. $V_{CC}$ = +2.7 V, $V_{DD}$ = 0 V, $C_L$ and $R_L$ connected to $V_{CC}/2$, $T_{amb}$ = 25°C (unless otherwise specified)**

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{io}$ | Input offset voltage | $V_{icm} = V_{out} = V_{CC}/2$<br>$T_{min} \le T_{amb} \le T_{max}$ | | 0.1 | 3<br>6 | mV |
| $\Delta V_{io}$ | Input offset voltage drift | | | 2 | | µV/°C |
| $I_{io}$ | Input offset current | $V_{icm} = V_{out} = V_{CC}/2$ (1)<br>$T_{min} \le T_{amb} \le T_{max}$ | | 1 | 9<br>25 | nA |
| $I_{ib}$ | Input bias current | $V_{icm} = V_{out} = V_{CC}/2$(1)<br>$T_{min} \le T_{amb} \le T_{max}$ | | 10 | 50<br>85 | nA |
| CMR | Common mode rejection ratio | $0 \le V_{icm} \le V_{CC}$ | 55 | 85 | | dB |
| SVR | Supply voltage rejection ratio | $V_{icm} = V_{CC}/2$ | 70 | 80 | | dB |
| $A_{vd}$ | Large signal voltage gain | $V_{out}$ = 0.5 V to 2.2 V<br>$R_L$ = 10 kΩ<br>$R_L$ = 2 kΩ | <br>80<br>70 | <br>100<br>88 | | dB |
| $V_{OH}$ | High level output voltage | $V_{id}$ = 100 mV<br>$T_{min} \le T_{amb} \le T_{max}$<br>$R_L$ = 10 kΩ<br>$R_L$ = 2 kΩ | <br><br>2.6<br>2.55 | <br><br>2.65<br>2.6 | | V |
| $V_{OL}$ | Low level output voltage | $V_{id}$ = -100 mV<br>$T_{min} \le T_{amb} \le T_{max}$<br>$R_L$ = 10 kΩ<br>$R_L$ = 2 kΩ | <br><br><br> | <br><br>15<br>50 | <br><br>90<br>100 | mV |
| $I_o$ | Output current | Output source current<br>$V_{id}$ = 100 mV, $V_O = V_{DD}$<br>Output sink current<br>$V_{id}$ = -100 mV, $V_O = V_{CC}$ | <br>5<br><br>5 | <br>46<br><br>46 | | mA |
| $I_{CC}$ | Supply current (per amplifier) | $V_{out} = V_{CC}/2$<br>$A_{VCL}$ = 1, no load<br>$T_{min} \le T_{amb} \le T_{max}$ | | 145 | 200<br>230 | µA |
| GBP | Gain bandwidth product | $R_L$ = 10 kΩ, $C_L$ = 100 pF,<br>f = 100 kHz | | 1 | | MHz |
| SR | Slew rate | $R_L$ = 600 Ω, $C_L$ = 100 pF,<br>$A_V$ = 1 | | 0.35 | | V/µs |
| $\phi m$ | Phase margin | $R_L$ = 600 Ω, $C_L$ = 100 pF | | 44 | | Degrees |
| en | Input voltage noise | | | 40 | | nV/√Hz |
| THD | Total harmonic distortion | | | 0.01 | | % |

1. Maximum values include unavoidable inaccuracies of the industrial tests.

**Table 4. $V_{CC}$ = +5 V, $V_{DD}$ = 0 V, $C_L$ and $R_L$ connected to $V_{CC}/2$, $T_{amb}$ = 25°C (unless otherwise specified)**

| Symbol | Parameter | Conditions | Min. | Typ. | Max. | Unit |
|---|---|---|---|---|---|---|
| $V_{io}$ | Input offset voltage | $V_{icm} = V_{out} = V_{CC}/2$<br>$T_{min} \le T_{amb} \le T_{max}$ | | 0.1 | 3<br>6 | mV |
| $\Delta V_{io}$ | Input offset voltage drift | | | 2 | | µV/°C |
| $I_{io}$ | Input offset current | $V_{icm} = V_{out} = V_{CC}/2$ (1)<br>$T_{min} \le T_{amb} \le T_{max}$ | | 1 | 9<br>25 | nA |
| $I_{ib}$ | Input bias current | $V_{icm} = V_{out} = V_{CC}/2$(1)<br>$T_{min} \le T_{amb} \le T_{max}$ | | 16 | 63<br>95 | nA |
| CMR | Common mode rejection ratio | $0 \le V_{icm} \le V_{CC}$ | 65 | 95 | | dB |
| SVR | Supply voltage rejection ratio | $V_{icm} = V_{CC}/2$ | 70 | 90 | | dB |
| $A_{vd}$ | Large signal voltage gain | $V_{out}$ = 0.5 V to 4.5 V<br>$R_L$ = 10 kΩ<br>$R_L$ = 2 kΩ | <br>85<br>77 | <br>97<br>93 | | dB |
| $V_{OH}$ | High level output voltage | $V_{id}$ = 100 mV<br>$T_{min} \le T_{amb} \le T_{max}$<br>$R_L$ = 10 kΩ<br>$R_L$ = 2 kΩ | <br><br>4.85<br>4.8 | <br><br>4.95<br>4.91 | | V |
| $V_{OL}$ | Low level output voltage | $V_{id}$ = -100 mV<br>$T_{min} \le T_{amb} \le T_{max}$<br>$R_L$ = 10 kΩ<br>$R_L$ = 2 kΩ | <br><br><br> | <br><br>40<br>80 | <br><br>180<br>200 | mV |
| $I_o$ | Output current | Output source current<br>$V_{id}$ = 100 mV, $V_O = V_{DD}$<br>Output sink current<br>$V_{id}$ = -100 mV, $V_O = V_{CC}$ | <br>7<br><br>7 | <br>48<br><br>48 | | mA |
| $I_{CC}$ | Supply current (per amplifier) | $V_{out} = V_{CC}/2$<br>$A_{VCL}$ = 1, no load<br>$T_{min} \le T_{amb} \le T_{max}$ | | 162 | 220<br>250 | µA |
| GBP | Gain bandwidth product | $R_L$ = 10 kΩ, $C_L$ = 100 pF,<br>f = 100 kHz | | 1.3 | | MHz |
| SR | Slew rate | $R_L$ = 600 Ω, $C_L$ = 100 pF,<br>$A_V$ = 1 | | 0.45 | | V/µs |
| $\phi m$ | Phase margin | $R_L$ = 600 Ω, $C_L$ = 100 pF | | 48 | | Degrees |
| en | Input voltage noise | | | 40 | | nV/√Hz |
| THD | Total harmonic distortion | | | 0.01 | | % |

1. Maximum values include unavoidable inaccuracies of the industrial tests.

**Figure 1. Supply current/amplifier vs. supply voltage**

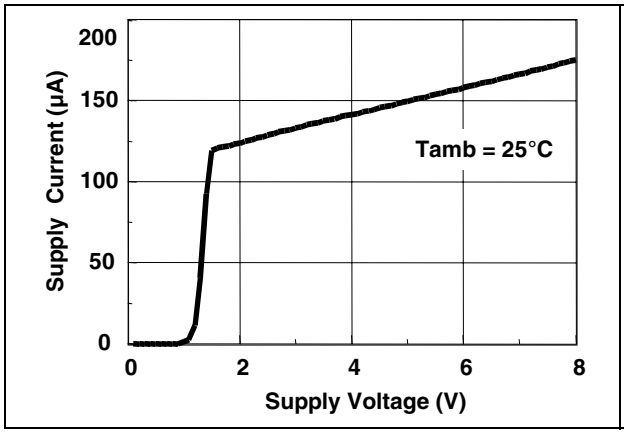



**Figure 2. Input bias current vs. temperature**

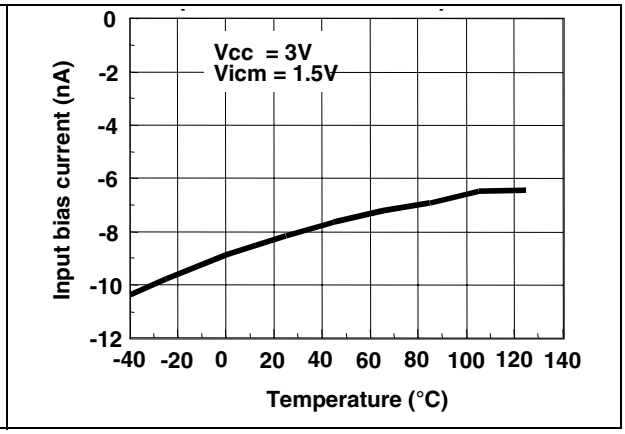



**Figure 3. Input bias current vs. temperature**

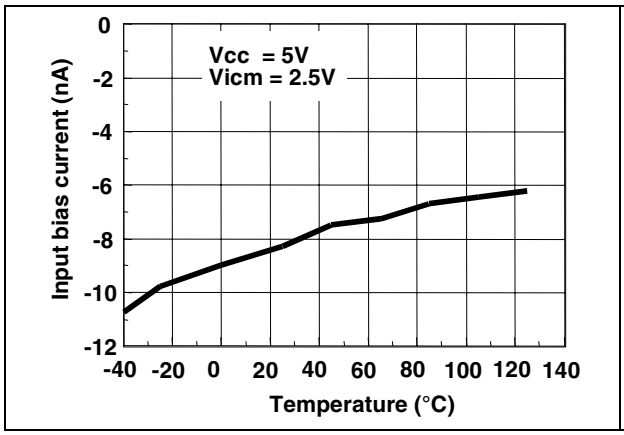



**Figure 4. Common mode rejection vs. temperature**

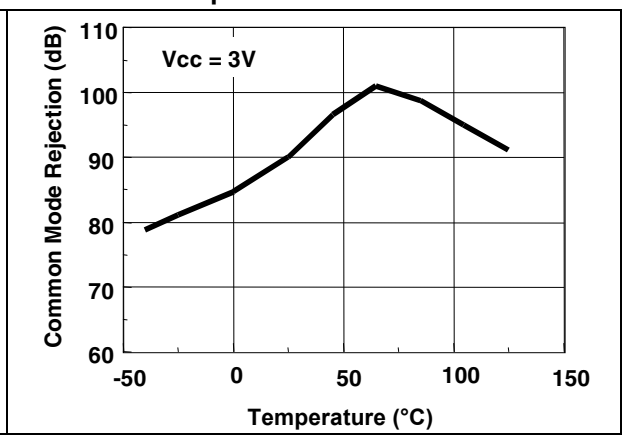



**Figure 5. Common mode rejection vs. temperature**

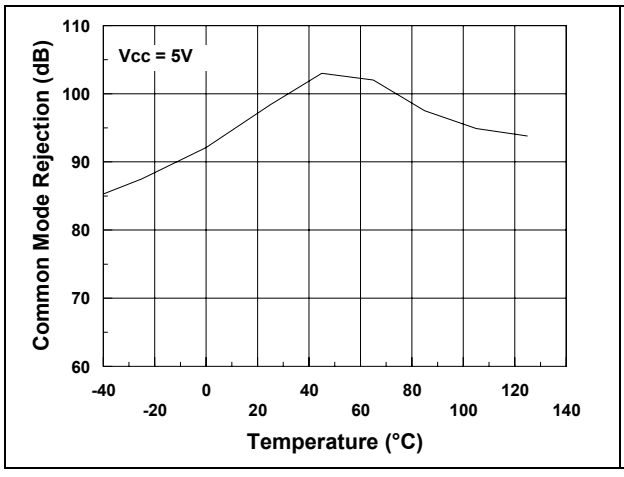



**Figure 6. Supply voltage rejection vs. temperature**

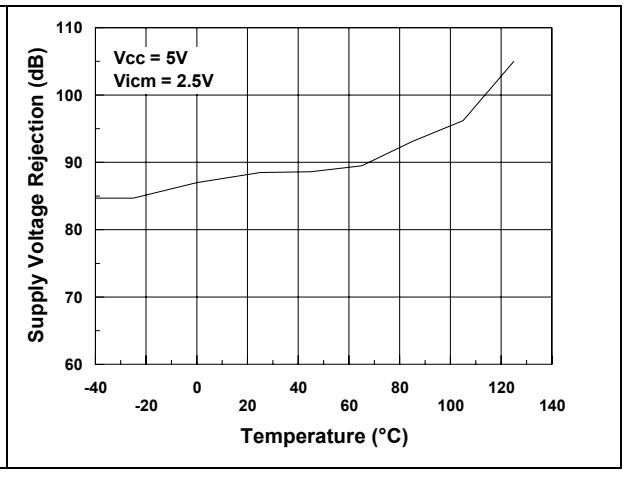


**Figure 7. Open-loop gain vs. temperature**

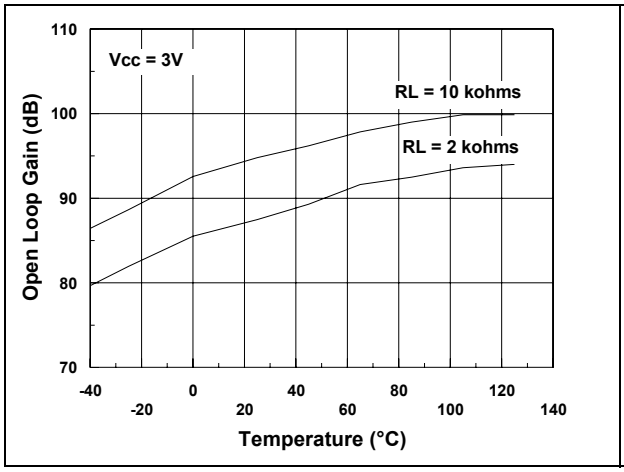



**Figure 8. Open-loop gain vs. temperature**

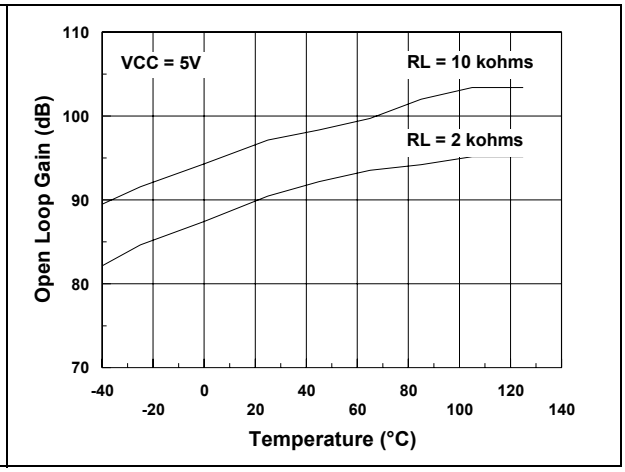



**Figure 9. Supply voltage rejection vs. temperature**

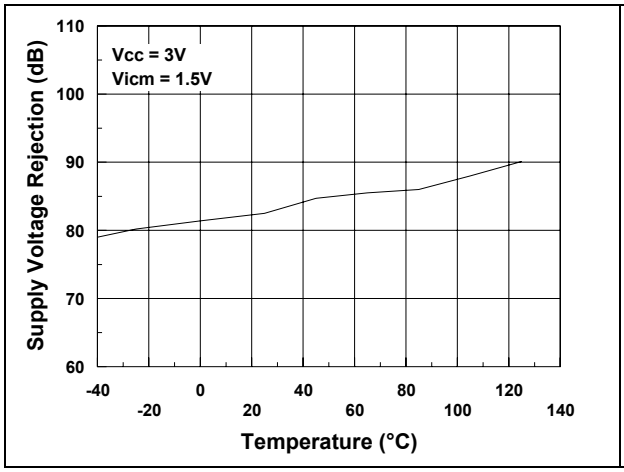



**Figure 10. Output current vs. output voltage**

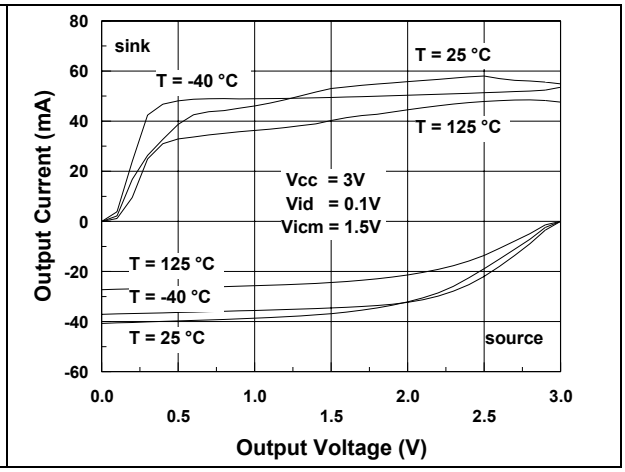



**Figure 11. Output current vs. output voltage**

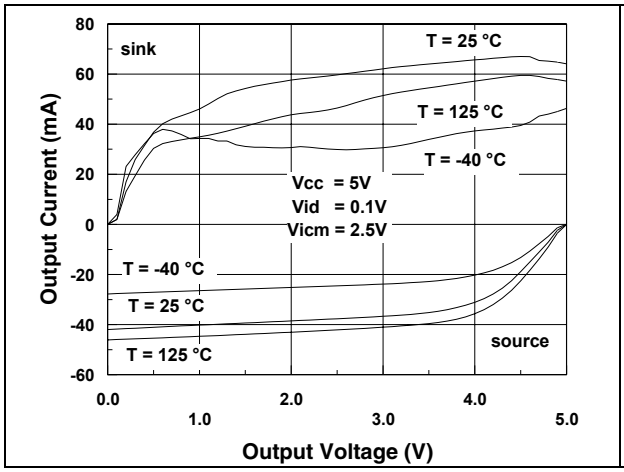
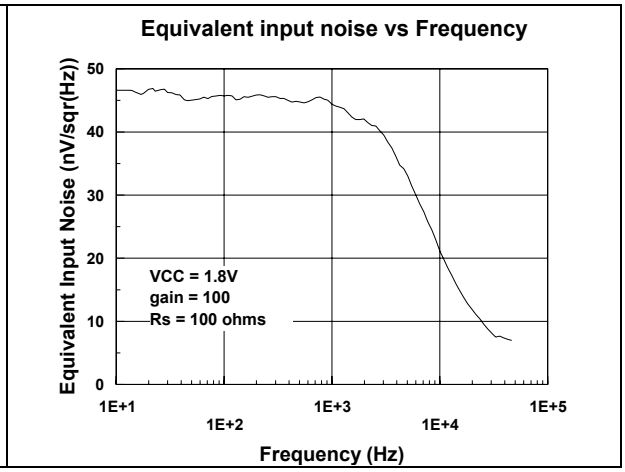



**Figure 12. Noise versus frequency**



# 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 SOT23-5 package information

**Figure 13. SOT23-5 package mechanical drawing**

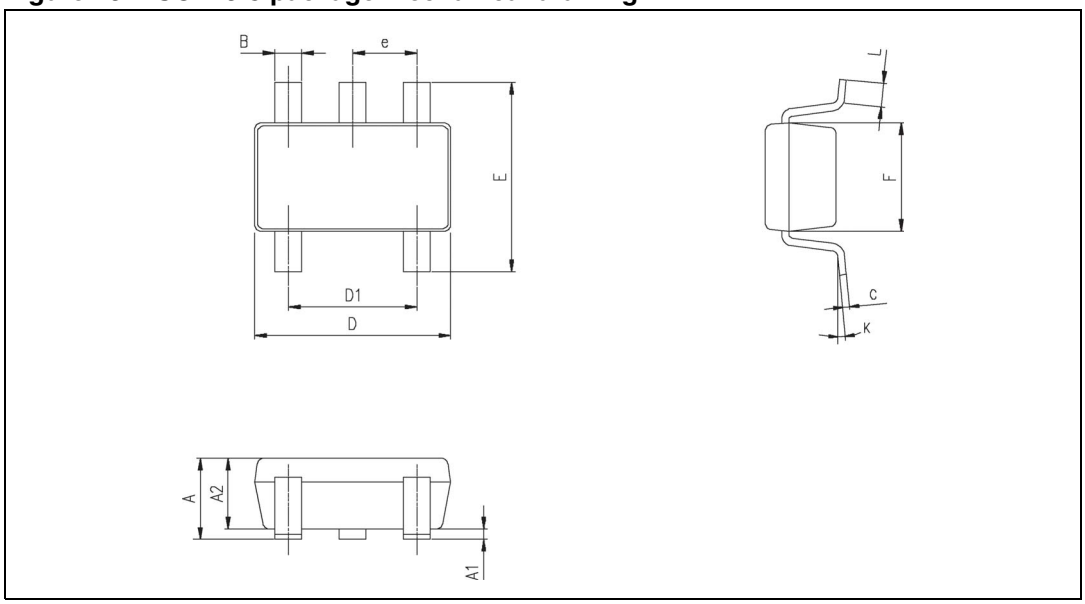



**Table 5. SOT23-5 package mechanical data**

| 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 degrees | | 10 degrees | | | |

## 3.2 SO-8 package information

**Figure 14. SO-8 package mechanical drawing**

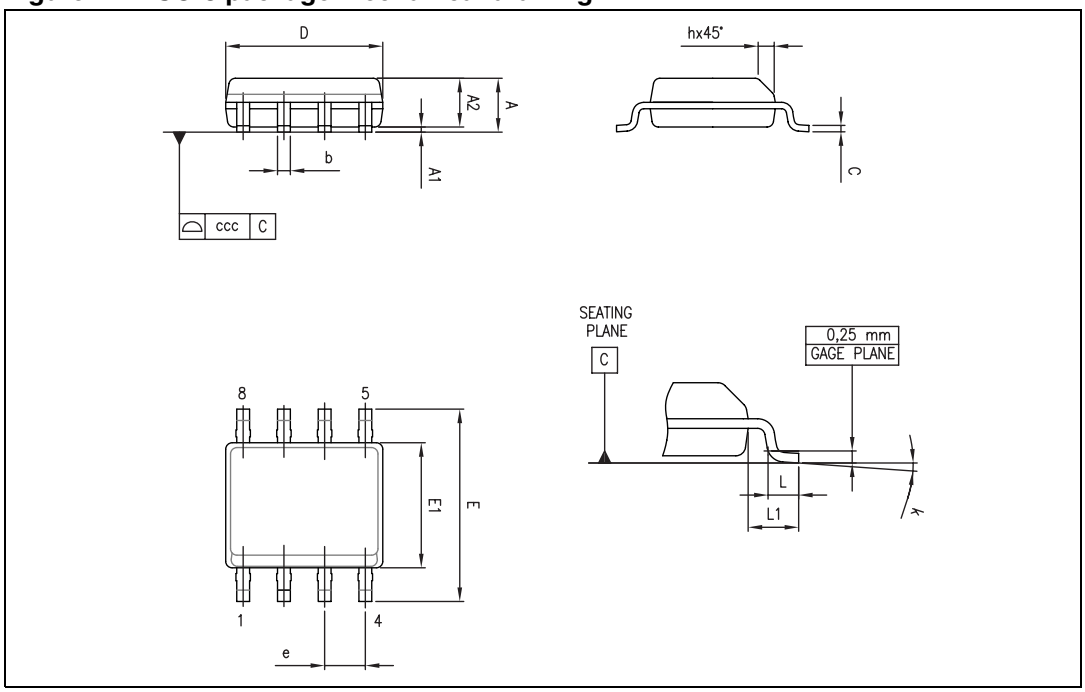



**Table 6. SO-8 package mechanical data**

| 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 | 0 | | 8° | 1° | | 8° |
| ccc | | | 0.10 | | | 0.004 |

## 3.3 TSSOP8 package information

**Figure 15. TSSOP8 package mechanical drawing**

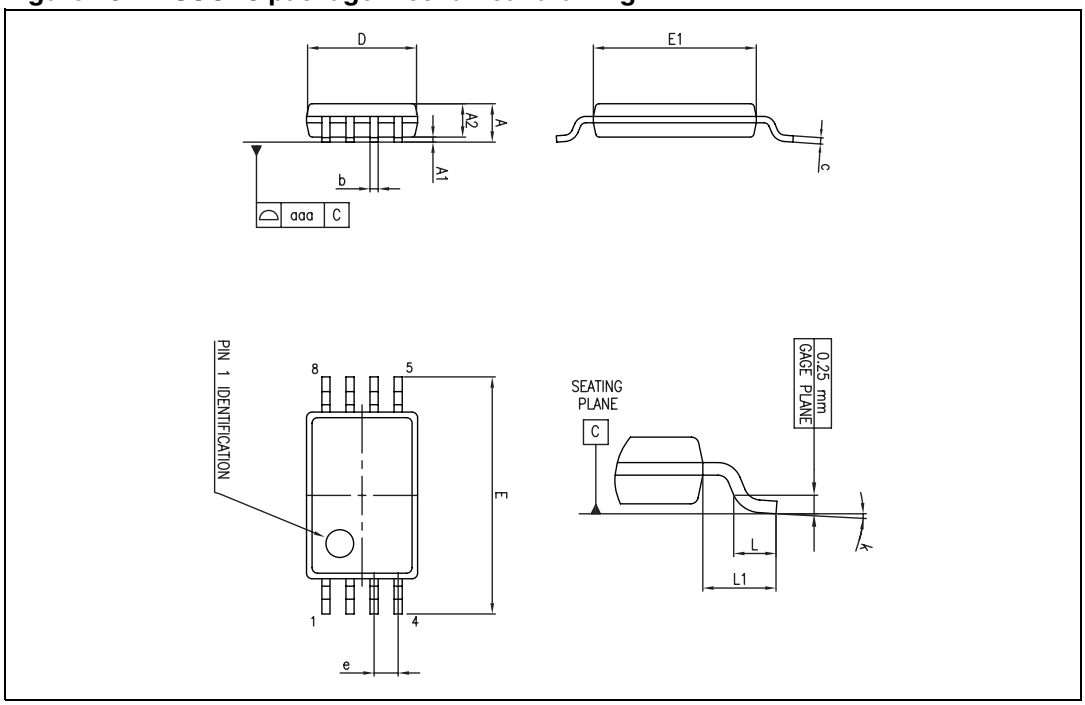



**Table 7. TSSOP8 package mechanical data**

| 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 |

## 3.4 SO-14 package information

**Figure 16. SO-14 package mechanical drawing**

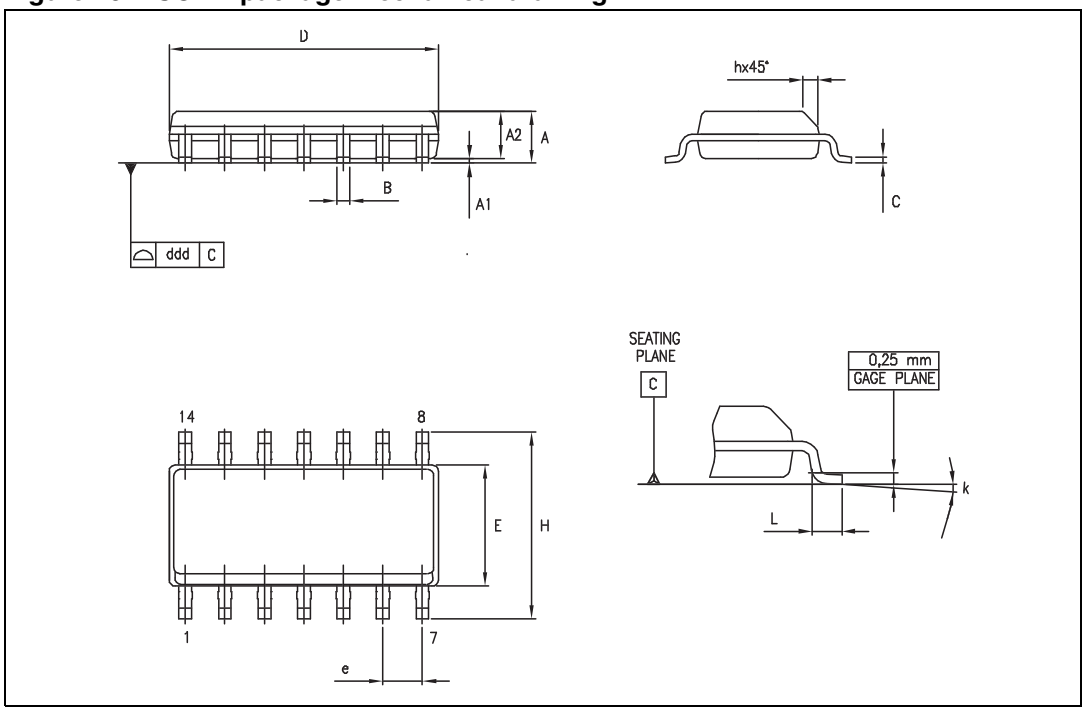



**Table 8. SO-14 package mechanical data**

| 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 17. TSSOP14 package mechanical drawing**

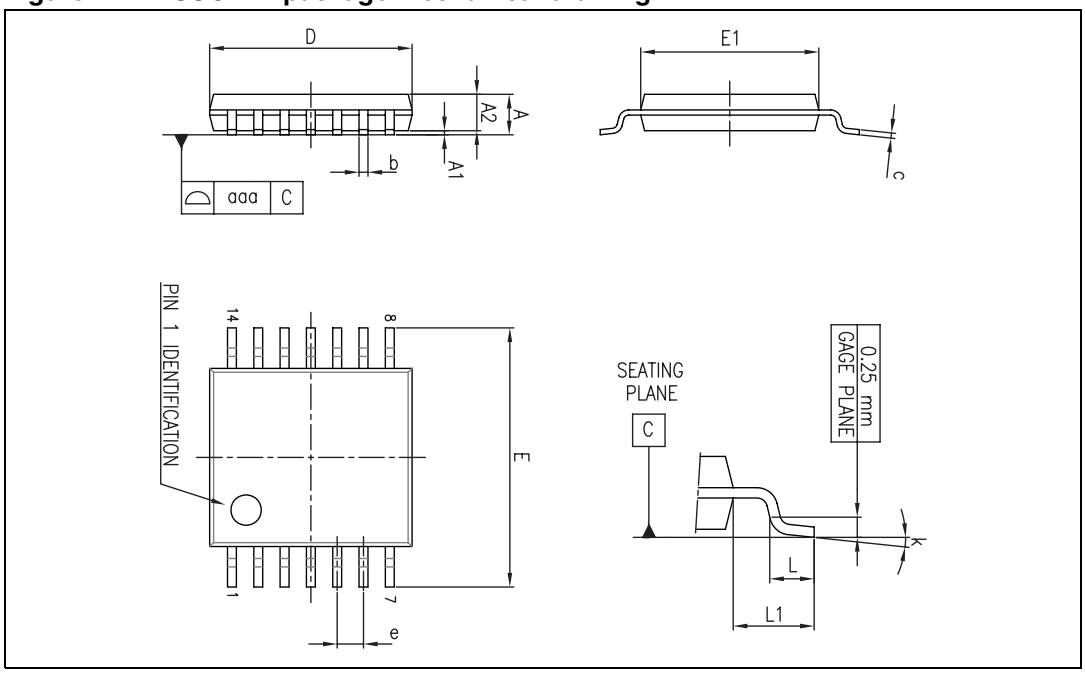



**Table 9. TSSOP14 package mechanical data**

| 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 |

# 4 Ordering information

**Table 10. Order codes**

| Order code | Temperature range | Package | Packaging | Marking |
|---|---|---|---|---|
| LMV321ILT | -40°C, +125 °C | SOT23-5 | Tape & reel | K177 |
| LMV321RILT | | | | K176 |
| LMV321IYLT(1) | | SOT23-5 (Automotive grade) | Tape & reel | K180 |
| LMV321RIYLT(2) | | | | K185 |
| LMV358ID<br>LMV358IDT | | SO-8 | Tube or tape & reel | LMV358 |
| LMV358IYD(1)<br>LMV358IYDT(1) | | SO-8 (Automotive grade) | Tube or tape & reel | LMV358IY |
| LMV358IPT | | TSSOP8 | Tape & reel | MV358 |
| LMV358IYPT(2) | | TSSOP8 (Automotive grade) | Tape & reel | K181Y |
| LMV324ID<br>LMV324IDT | | SO-14 | Tube or tape & reel | LMV324 |
| LMV324IYD(1)<br>LMV324IYDT(1) | | SO-14 (Automotive grade) | Tube or tape & reel | V324Y |
| LMV324IPT | | TSSOP14 | Tape & reel | MV324 |
| LMV324IYPT(1) | | TSSOP14 (Automotive grade) | Tape & reel | V324IY |

1. Qualification and characterization according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q 002 or equivalent.
2. Qualification and characterization according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q 002 or equivalent are ongoing.

# 5 Revision history

**Table 11. Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 1-Dec-2005 | 1 | First release - Products in full production. |
| 25-May-2007 | 2 | Added automotive grade part numbers to order codes table. Moved order codes table to *Section 4 on page 14*. |
| 20-Feb-2008 | 3 | Added *Figure 12: Noise versus frequency on page 7*.<br>Updated presentation of package information.<br>Corrected footnote for automotive grade part numbers in order codes table. |
| 18-Jan-2010 | 4 | Updated document format.<br>Updated packages in *Chapter 3: Package information*.<br>Modified *Note 1* and added *Note 2* under *Table 10: Order codes*. |

**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.**

**UNLESS EXPRESSLY APPROVED IN WRITING BY AN AUTHORIZED ST REPRESENTATIVE, ST PRODUCTS ARE NOT RECOMMENDED, AUTHORIZED OR WARRANTED FOR USE IN MILITARY, AIR CRAFT, SPACE, LIFE SAVING, OR LIFE SUSTAINING APPLICATIONS, NOR IN PRODUCTS OR SYSTEMS WHERE FAILURE OR MALFUNCTION MAY RESULT IN PERSONAL INJURY, DEATH, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE. ST PRODUCTS WHICH ARE NOT SPECIFIED AS "AUTOMOTIVE GRADE" MAY ONLY BE USED IN AUTOMOTIVE APPLICATIONS AT USER’S OWN RISK.**

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.

© 2010 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**