# TS27L4

## Very low power precision CMOS quad operational amplifiers

## Features

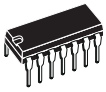
- Very low power consumption: 10 µA/op
- Output voltage can swing to ground
- Excellent phase margin on capacitive loads
- Unity gain stable
- Two input offset voltage selections

## Description

The TS27L4 series are low-cost, low-power quad operational amplifiers designed to operate with single or dual supplies. These operational amplifiers use the ST silicon gate CMOS process allowing an excellent consumption-speed ratio. These series are ideally suited for low consumption applications.

Three power consumptions are available enabling the best consumption-speed ratio:
$I_{CC}$ = 10 µA/amp: TS27L4 (very low power),
$I_{CC}$ = 150 µA/amp: TS27M4 (low power),
$I_{CC}$ = 1 mA/amp: TS274 (standard).

These CMOS amplifiers offer very high input impedance and extremely low input currents. The major advantage versus JFET devices is the very low input current drift with temperature (see *Figure 4*).



**DIP14**
(Plastic package)

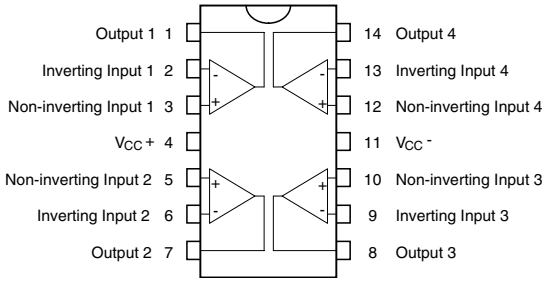


**SO-14**
(Plastic micropackage)



**TSSOP14**
(Thin shrink small outline package)

**Pin connections** (top view)



# 1 Circuit schematics

**Figure 1. Internal block diagram**

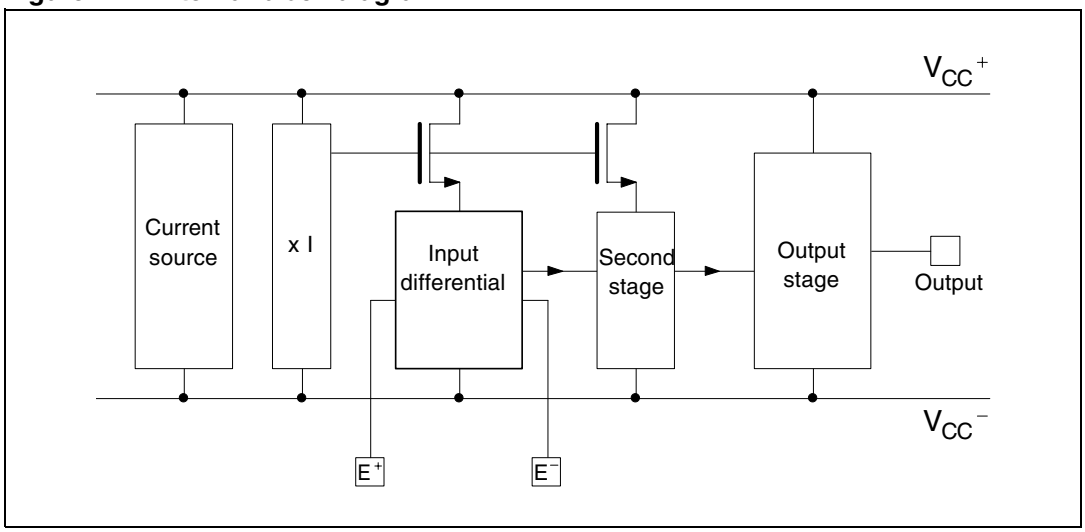
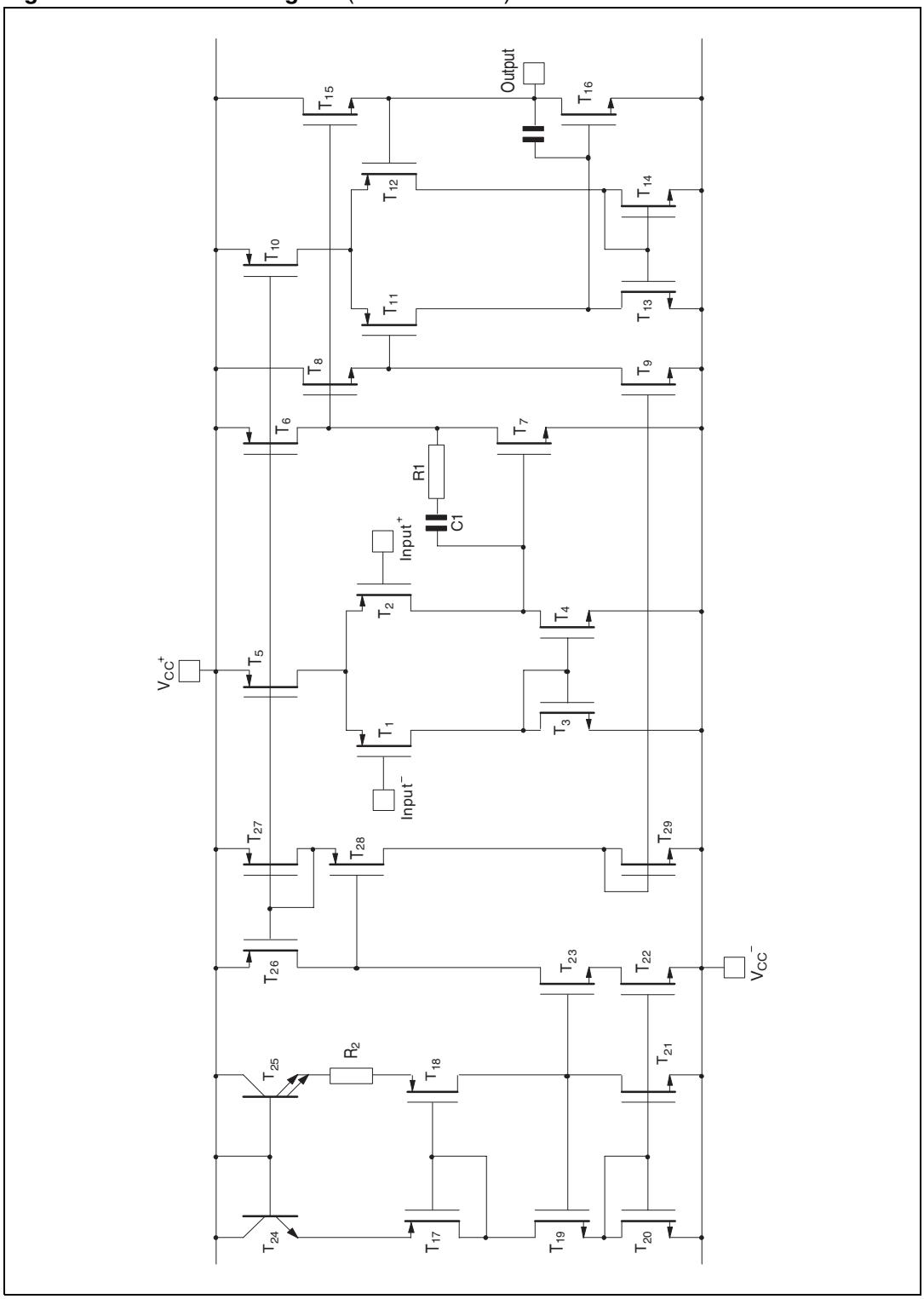


**Figure 2. Schematic diagram** (for 1/4 TS27L4)



# 2 Absolute maximum ratings and operating conditions

**Table 1. Absolute maximum ratings**

| Symbol | Parameter | Value | Unit |
|---|---|---|---|
| $V_{CC+}$ | Supply voltage (1) | 18 | V |
| $V_{id}$ | Differential input voltage (2) | ±18 | V |
| $V_{in}$ | Input voltage (3) | -0.3 to 18 | V |
| $I_o$ | Output current for $V_{CC}^+ \geq 15V$ | ±30 | mA |
| $I_{in}$ | Input current | ±5 | mA |
| $T_{stg}$ | Storage temperature range | -65 to +150 | °C |
| $R_{thja}$ | Thermal resistance junction to ambient(4)<br>SO-14<br>TSSOP14<br>DIP14 | <br>105<br>100<br>80 | °C/W |
| $R_{thjc}$ | Thermal resistance junction to case(4)<br>SO-14<br>TSSOP14<br>DIP14 | <br>31<br>32<br>33 | °C/W |
| ESD | HBM: human body model(5) | 1 | kV |
| | MM: machine model(6) | 100 | V |
| | CDM: charged device model(7) | 1.5 | kV |

1. All 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. The magnitude of the input and the output voltages must never exceed the magnitude of the positive supply voltage.
4. Short-circuits can cause excessive heating and destructive dissipation. Values are typical.
5. 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.
6. 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.
7. 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.

**Table 2. Operating conditions**

| Symbol | Parameter | TS27L4C | TS27L4I | Unit |
|---|---|---|---|---|
| $V_{CC}^+$ | Supply voltage | 3 to 16 | | V |
| $V_{icm}$ | Common mode input voltage range | 0 to $V_{CC}^+$ - 1.5 | | V |
| $T_{oper}$ | Operating free-air temperature range | 0 to +70 | -40 to +125 | °C |

# 3 Electrical characteristics

**Table 3. $V_{CC}^+$ = +10 V, $V_{CC}^-$ = 0 V, $T_{amb}$ = +25° C (unless otherwise specified)**

| Symbol | Parameter | TS27L4C/AC | | | TS27L4I/AI | | | Unit |
|---|---|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | Min. | Typ. | Max. | |
| $V_{io}$ | Input offset voltage<br>$V_o$ = 1.4V, $V_{ic}$ = 0V<br>TS27L4<br>TS27L4A<br>$T_{min} \le T_{amb} \le T_{max}$<br>TS27L4<br>TS27L4A | | <br><br>1.1<br>0.9 | <br><br>10<br>5<br><br>12<br>6.5 | | <br><br>1.1<br>0.9 | <br><br>10<br>5<br><br>12<br>6.5 | mV |
| $DV_{io}$ | Input offset voltage drift | | 2 | | | 2 | | µV/°C |
| $I_{io}$ | Input offset current (1)<br>$V_{ic}$ = 5V, $V_O$ = 5V<br>$T_{min} \le T_{amb} \le T_{max}$ | | 1 | <br>100 | | 1 | <br>200 | pA |
| $I_{ib}$ | Input bias current (1)<br>$V_{ic}$ = 5V, $V_O$ = 5V<br>$T_{min} \le T_{amb} \le T_{max}$ | | 1 | <br>150 | | 1 | <br>300 | pA |
| $V_{OH}$ | High level output voltage<br>$V_{id}$ = 100mV, $R_L$ = 1MΩ<br>$T_{min} \le T_{amb} \le T_{max}$ | 8.8<br>8.7 | 9 | | 8.8<br>8.6 | 9 | | V |
| $V_{OL}$ | Low level output voltage<br>$V_{id}$ = -100mV | | | 50 | | | 50 | mV |
| $A_{vd}$ | Large signal voltage gain<br>$V_{iC}$ = 5V, $R_L$ = 1MΩ, $V_o$ = 1V to 6V<br>$T_{min} \le T_{amb} \le T_{max}$ | 60<br>45 | 100 | | 60<br>40 | 100 | | V/mV |
| GBP | Gain bandwidth product<br>$A_v$ = 40dB, $R_L$ = 1MΩ, $C_L$ = 100pF, $f_{in}$ = 100kHz | | 0.1 | | | 0.1 | | MHz |
| CMR | Common mode rejection ratio<br>$V_{iC}$ = 1V to 7.4V, $V_o$ = 1.4V | 65 | 80 | | 65 | 80 | | dB |
| SVR | Supply voltage rejection ratio<br>$V_{CC}^+$ = 5V to 10V, $V_o$ = 1.4V | 60 | 80 | | 60 | 80 | | dB |
| $I_{CC}$ | Supply current (per amplifier)<br>$A_v$ = 1, no load, $V_o$ = 5V<br>$T_{min} \le T_{amb} \le T_{max}$ | | 10 | 15<br>17 | | 10 | 15<br>18 | µA |
| $I_o$ | Output short circuit current<br>$V_o$ = 0V, $V_{id}$ = 100mV | | 60 | | | 60 | | mA |
| $I_{sink}$ | Output sink current<br>$V_o$ = $V_{CC}$, $V_{id}$ = -100mV | | 45 | | | 45 | | mA |
| SR | Slew rate at unity gain<br>$R_L$ = 1MΩ, $C_L$ = 100pF, $V_i$ = 3 to 7V | | 0.04 | | | 0.04 | | V/µs |

**Table 3. $V_{CC}^+$ = +10 V, $V_{CC}^-$ = 0 V, $T_{amb}$ = +25° C (unless otherwise specified) (continued)**

| Symbol | Parameter | TS27L4C/AC | | | TS27L4I/AI | | | Unit |
|---|---|---|---|---|---|---|---|---|
| | | Min. | Typ. | Max. | Min. | Typ. | Max. | |
| $\phi m$ | Phase margin at unity gain<br>$A_v$ = 40dB, $R_L$ = 1MΩ, $C_L$ = 100pF | | 45 | | | 45 | | Degrees |
| $K_{ov}$ | Overshoot factor | | 30 | | | 30 | | % |
| $e_n$ | Equivalent input noise voltage<br>f = 1kHz, $R_s$ = 100Ω | | 68 | | | 68 | | $\frac{nV}{\sqrt{Hz}}$ |
| $V_{o1}/V_{o2}$ | Channel separation | | 120 | | | 120 | | dB |

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

# 4 Typical characteristics

**Figure 3. Supply current (each amplifier) versus supply voltage**

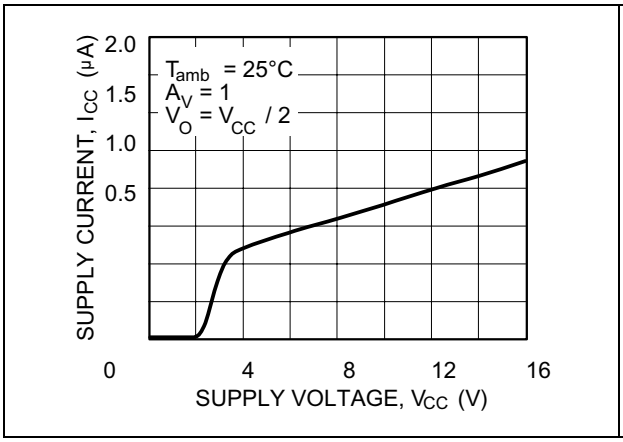



**Figure 4. Input bias current versus free air temperature**

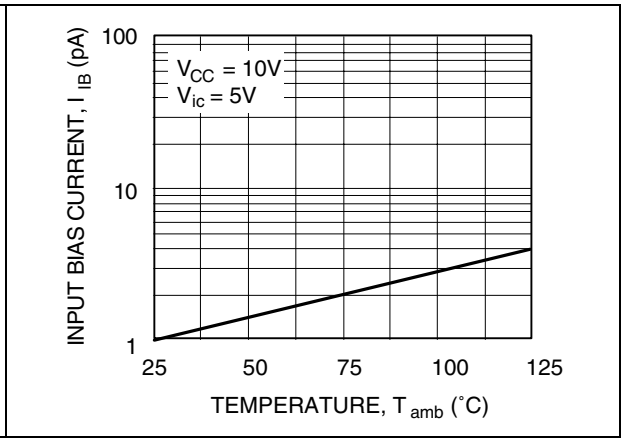



**Figure 5. High level output voltage versus high level output current**

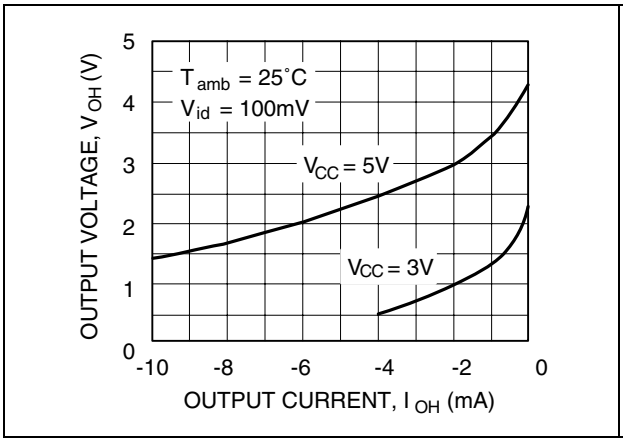



**Figure 6. High level output voltage versus high level output current**

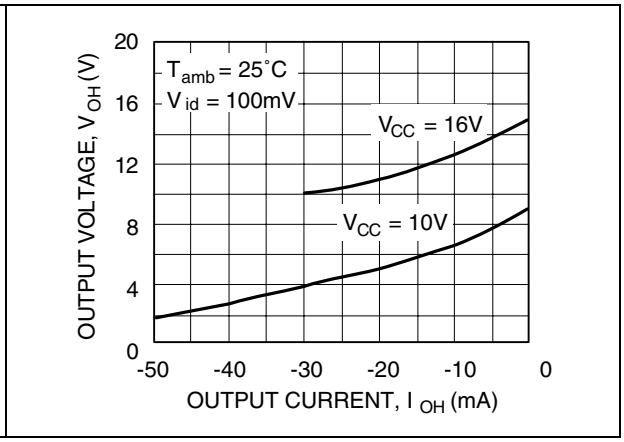



**Figure 7. Low level output voltage versus low level output current**

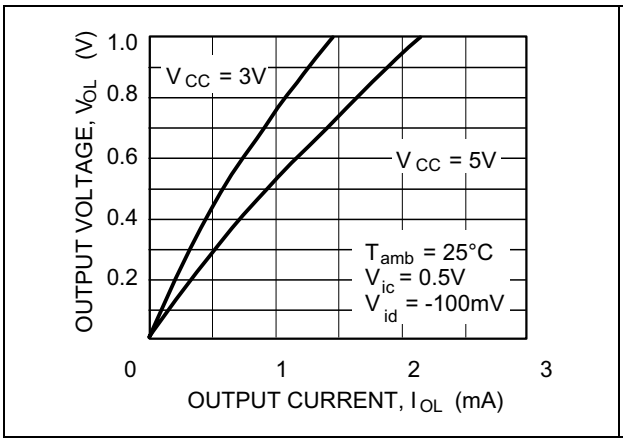



**Figure 8. Low level output voltage versus low level output current**

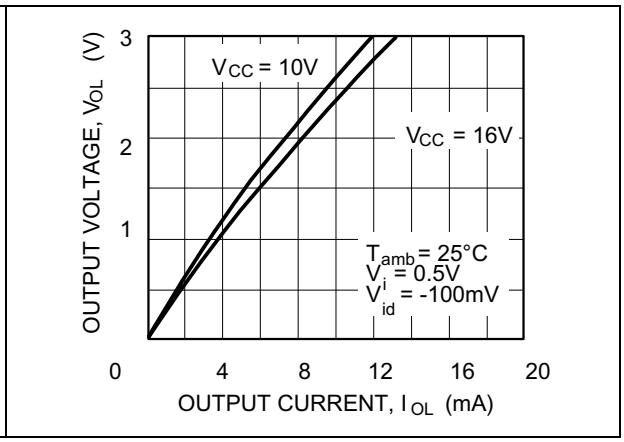


**Figure 9. Open loop frequency response and phase shift**

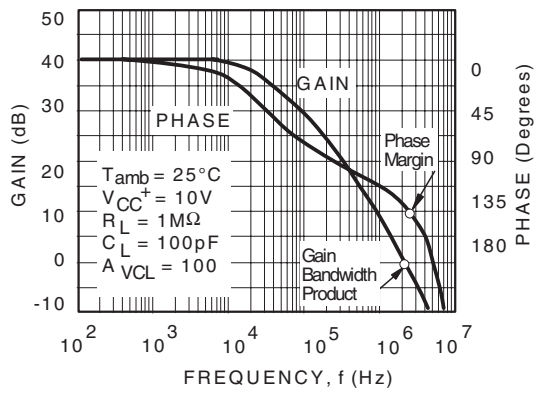



**Figure 10. Gain bandwidth product versus supply voltage**

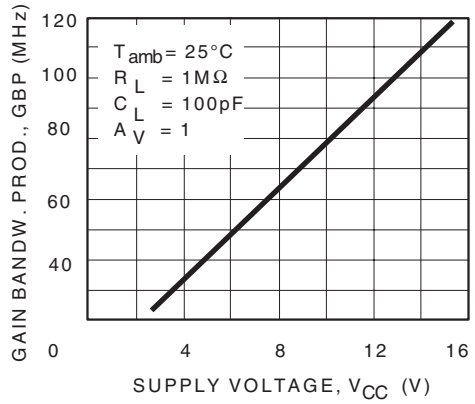



**Figure 11. Phase margin versus supply voltage**

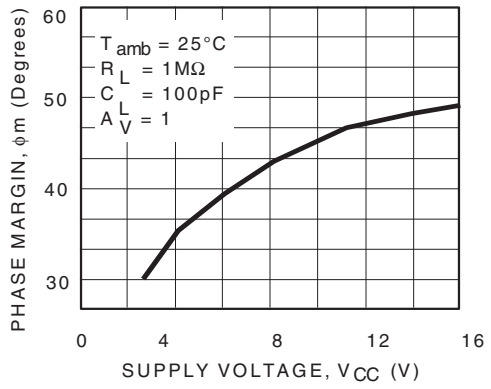



**Figure 12. Phase margin versus capacitive load**

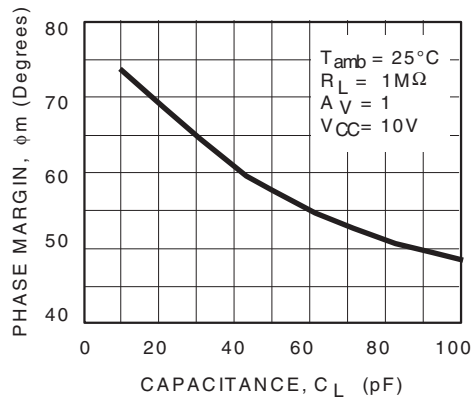



**Figure 13. Slew rate versus supply voltage**

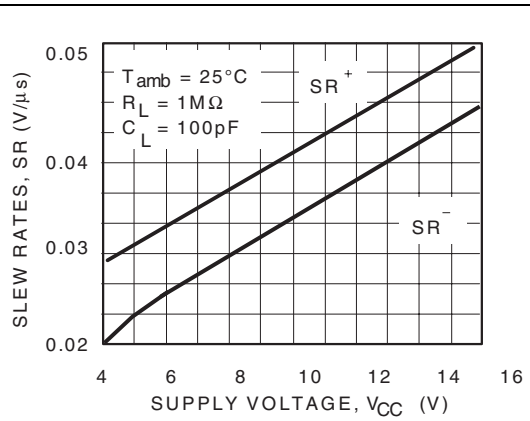
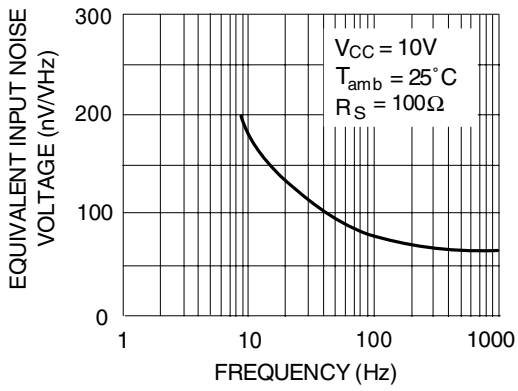



**Figure 14. Input voltage noise versus frequency**



# 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 DIP14 package information

**Figure 15. DIP14 package mechanical drawing**

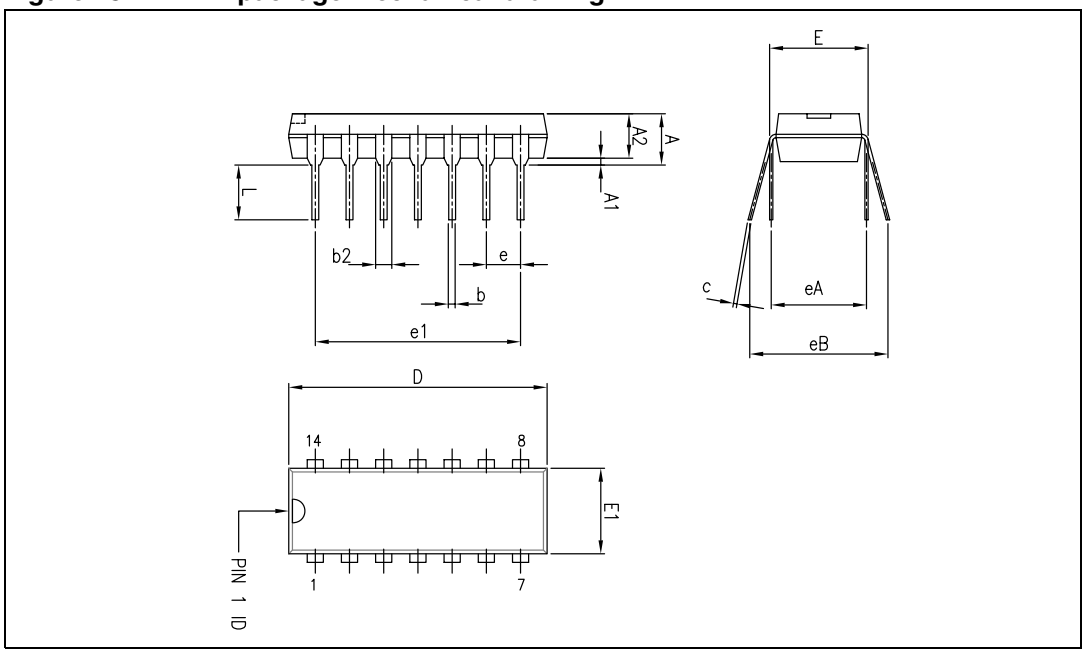



**Table 4. DIP14 package mechanical data**

| Dimensions | | | | | | |
|---|---|---|---|---|---|---|
| Ref. | Millimeters | | | Inches | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | | | 5.33 | | | 0.21 |
| A1 | 0.38 | | | 0.015 | | |
| A2 | 2.92 | 3.30 | 4.95 | 0.11 | 0.13 | 0.19 |
| b | 0.36 | 0.46 | 0.56 | 0.014 | 0.018 | 0.022 |
| b2 | 1.14 | 1.52 | 1.78 | 0.04 | 0.06 | 0.07 |
| c | 0.20 | 0.25 | 0.36 | 0.007 | 0.009 | 0.01 |
| D | 18.67 | 19.05 | 19.69 | 0.73 | 0.75 | 0.77 |
| E | 7.62 | 7.87 | 8.26 | 0.30 | 0.31 | 0.32 |
| E1 | 6.10 | 6.35 | 7.11 | 0.24 | 0.25 | 0.28 |
| e | | 2.54 | | | 0.10 | |
| e1 | | 15.24 | | | 0.60 | |
| eA | | 7.62 | | | 0.30 | |
| eB | | | 10.92 | | | 0.43 |
| L | 2.92 | 3.30 | 3.81 | 0.11 | 0.13 | 0.15 |

## 5.2 SO-14 package information

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

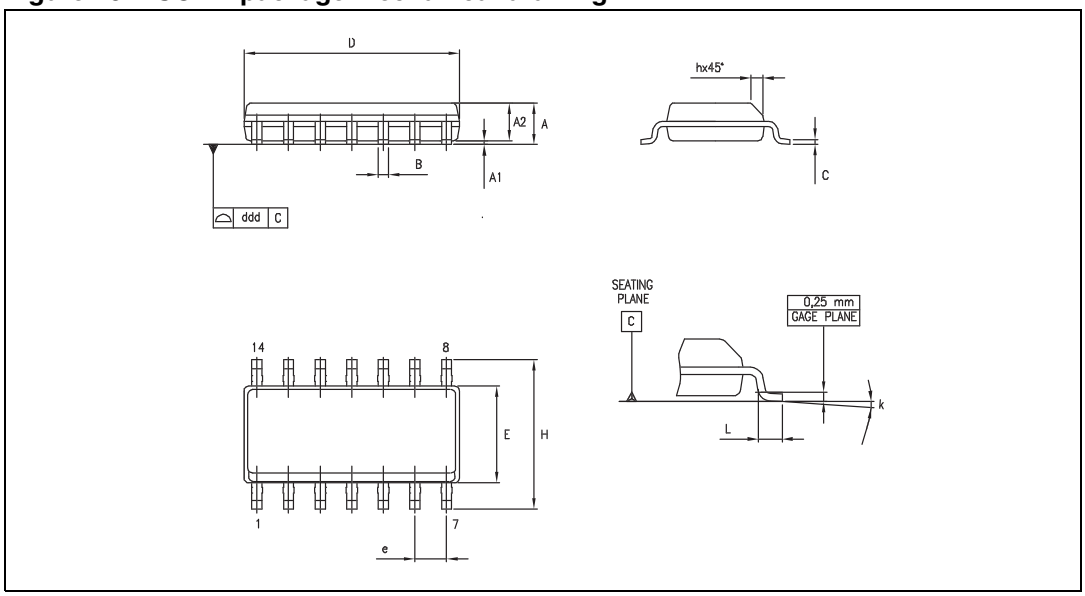



**Table 5. SO-14 package mechanical data**

| 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 |

## 5.3 TSSOP14 package information

**Figure 17. TSSOP14 package mechanical drawing**

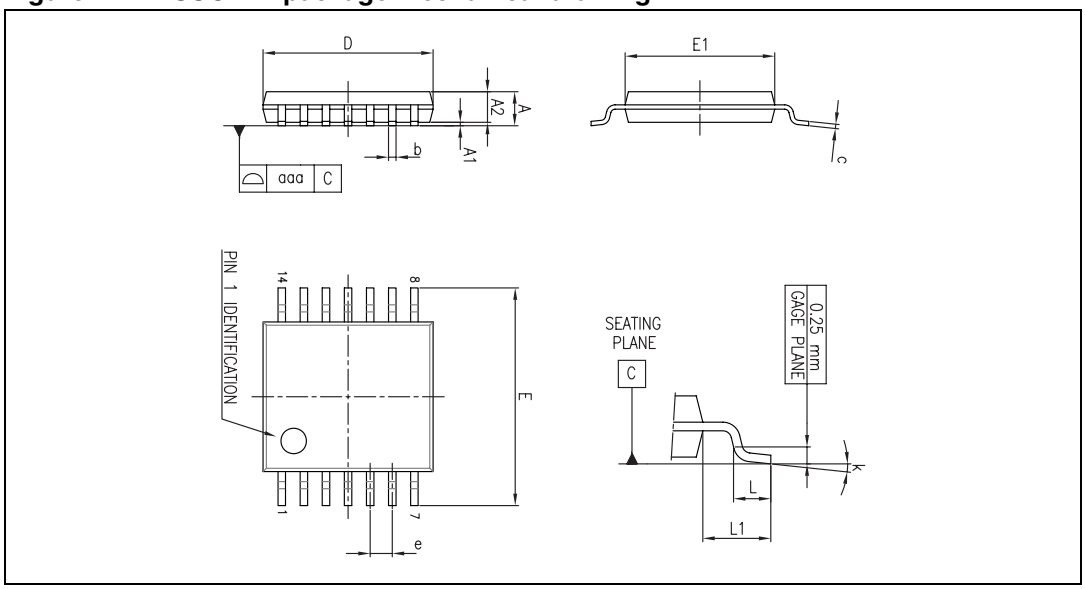



**Table 6. TSSOP14 package mechanical data**

| 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 |

# 6 Ordering information

**Table 7. Order codes**

| Order code | Temperature range | Package | Packing | Marking |
|---|---|---|---|---|
| TS27L4CD<br>TS27L4CDT | 0°C, +70°C | SO-14 | Tube or<br>Tape & reel | 27L4C |
| TS27L4ACD<br>TS27L4ACDT | | | | 27L4AC |
| TS27L4CN<br>TS27L4ACN | | DIP14 | Tube | TS27L4CN |
| | | | | TS27L4ACN |
| TS27L4CPT<br>TS27L4ACPT | | TSSOP14 | Tape & reel | 27L4C |
| | | | | 27L4AC |
| TS27L4ID<br>TS27L4IDT | -40°C, +125°C | SO-14 | Tube or<br>Tape & reel | 27L4I |
| TS27L4AID<br>TS27L4AIDT | | | | 27L4AI |
| TS27L4IN<br>TS27L4AIN | | DIP14 | Tube | TS27L4IN |
| | | | | TS27L4AIN |
| TS27L4IPT<br>TS27L4AIPT | | TSSOP14 | Tape & reel | 27L4I |
| | | | | 27L4AI |

# 7 Revision history

**Table 8. Document revision history**

| Date | Revision | Changes |
|---|---|---|
| 11-Nov-2001 | 1 | Initial release. |
| 08-Sep-2008 | 2 | Removed TS27L4B version of device.<br>Added $R_{thja}$, $R_{thjc}$, and ESD parameters in *Table 1: Absolute maximum ratings*.<br>Expanded *Table 7: Order codes*.<br>Updated document format. |
| 02-Mar-2009 | 3 | Removed TS27L4*M* from *Table 7: Order codes*.<br>Updated package mechanical drawings and data in *Chapter 5: Package information*. |

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