



# TS27M2, TS27M2A, TS27M2B

## Low-power CMOS dual operational amplifiers

### Features

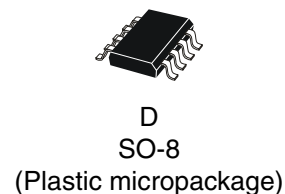
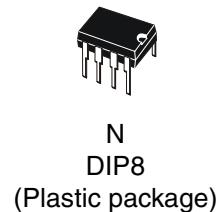
- Wide supply voltage range: 3 to 16 V
- Ultra-low consumption: 150  $\mu\text{A/op}$  typ
- Output voltage swing to ground
- Excellent phase margin on capacitive load
- Gain bandwidth product: 1 MHz typ
- $V_{\text{io}}$  down to 2 mV max. (B version)

### Description

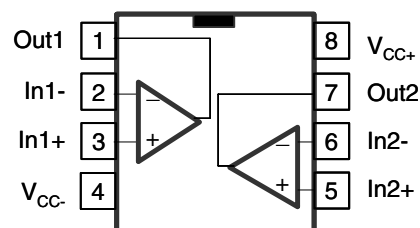
The TS27x2 series are low-cost and low-power dual operational amplifiers designed to operate with high-voltage single or dual supplies. These operational amplifiers use the ST silicon gate CMOS process, providing an excellent consumption-speed ratio thanks to three different power consumptions, making them ideal for low-consumption applications:

$I_{\text{CC}} = 10 \mu\text{A/amp}$ : TS27L2 (very low power),  
 $I_{\text{CC}} = 150 \mu\text{A/amp}$ : TS27M2 (low power) and  
 $I_{\text{CC}} = 1 \text{ mA/amp}$ : TS272 (high speed)

The devices also offer a very high input impedance and extremely low input currents. Their main advantage compared to JFET devices is the very low input current drift with temperature ([Figure 3](#)).



Pin connections (top view)



# 1 Absolute maximum ratings and operating conditions

**Table 1. Absolute maximum ratings**

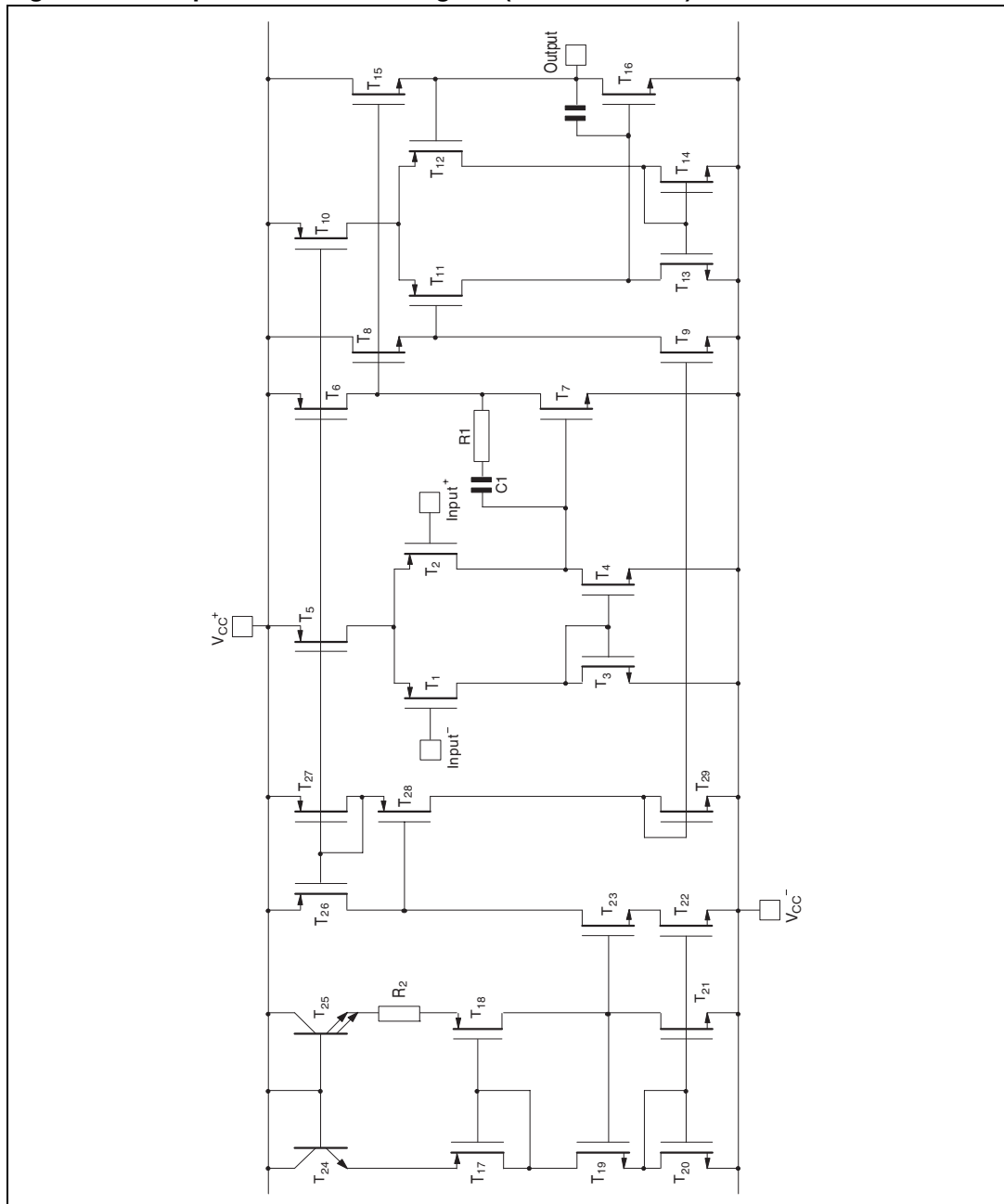
| Symbol              | Parameter                                 | TS27M2x/Ax/Bx | Unit |
|---------------------|-------------------------------------------|---------------|------|
| $V_{CC}^+$          | Supply voltage <sup>(1)</sup>             | 18            | V    |
| $V_{id}$            | Differential input voltage <sup>(2)</sup> | $\pm 18$      | V    |
| $V_i$               | Input voltage <sup>(3)</sup>              | -0.3 to 18    | V    |
| $I_o$               | Output current for $V_{CC}^+ \geq 15V$    | $\pm 30$      | mA   |
| $I_{in}$            | Input current                             | $\pm 5$       | mA   |
| $R_{thja}^{(4)(5)}$ | SO-8                                      | 125           | °C/W |
|                     | DIP8                                      | 85            |      |
|                     | TSSOP8                                    | 120           |      |
| $T_{stg}$           | Storage temperature range                 | -65 to +150   | °C   |
| $T_j$               | Maximum junction temperature              | 150           | °C   |
| ESD                 | HBM: human body model <sup>(6)</sup>      | 500           | V    |
|                     | MM: machine model <sup>(7)</sup>          | 100           | V    |
|                     | CDM: charged device model <sup>(8)</sup>  | 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.
5.  $R_{th}$  are typical values.
6. Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5 k $\Omega$  resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
7. 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  $\Omega$ ). This is done for all couples of connected pin combinations while the other pins are floating.
8. 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                            | Value                 |               |               | Unit |
|------------|--------------------------------------|-----------------------|---------------|---------------|------|
|            |                                      | TS27M2C/AC/BC         | TS27M2I/AI/BI | TS27M2M/AM/BM |      |
| $V_{CC}^+$ | 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   | -55 to +125   | °C   |

Figure 1. Simplified schematic diagram (for 1/2 TS27M2)



## 2 Electrical characteristics

**Table 3. Electrical characteristics at  $V_{CC+} = +10\text{ V}$ ,  $V_{CC-} = 0\text{ V}$ ,  $T_{\text{amb}} = +25^{\circ}\text{ C}$  (unless otherwise specified)**

| Symbol         | Parameter                                                                                                                                                                   | TS27M2xC   |                    |                                | TS27M2xI<br>TS27M2xM |                    |                                  | Unit                           |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------|--------------------|--------------------------------|----------------------|--------------------|----------------------------------|--------------------------------|
|                |                                                                                                                                                                             | Min.       | Typ.               | Max.                           | Min.                 | Typ.               | Max.                             |                                |
| DC performance |                                                                                                                                                                             |            |                    |                                |                      |                    |                                  |                                |
| $V_{io}$       | Input offset voltage<br>$V_O = 1.4\text{ V}$ , $V_{ic} = 0\text{ V}$<br>TS27M2<br>TS27M2A<br>TS27M2B<br>$T_{min} \leq T_{amb} \leq T_{max}$<br>TS27M2<br>TS27M2A<br>TS27M2B |            | 1.1<br>0.9<br>0.25 | 10<br>5<br>2<br>12<br>6.5<br>3 |                      | 1.1<br>0.9<br>0.25 | 10<br>5<br>2<br>12<br>6.5<br>3.5 | mV                             |
| $DV_{io}$      | Input offset voltage drift                                                                                                                                                  |            | 2                  |                                |                      | 2                  |                                  | $\mu\text{V}/^{\circ}\text{C}$ |
| $I_{io}$       | Input offset current <sup>(1)</sup><br>$V_{ic} = 5\text{ V}$ , $V_O = 5\text{ V}$<br>$T_{min} \leq T_{amb} \leq T_{max}$                                                    |            | 1                  | 100                            |                      | 1                  | 200                              | pA                             |
| $I_{ib}$       | Input bias current <sup>(1)</sup><br>$V_{ic} = 5\text{ V}$ , $V_O = 5\text{ V}$<br>$T_{min} \leq T_{amb} \leq T_{max}$                                                      |            | 1                  | 150                            |                      | 1                  | 300                              | pA                             |
| $V_{OH}$       | High level output voltage<br>$V_{id} = 100\text{ mV}$ , $R_L = 100\text{ }\Omega$<br>$T_{min} \leq T_{amb} \leq T_{max}$                                                    | 8.7<br>8.6 | 8.9                |                                | 8.7<br>8.5           | 8.9                |                                  | V                              |
| $V_{OL}$       | Low level output voltage<br>$V_{id} = -100\text{ mV}$                                                                                                                       |            |                    | 50                             |                      |                    | 50                               | mV                             |
| $A_{vd}$       | Large signal voltage gain<br>$V_{ic} = 5\text{ V}$ , $R_L = 100\text{ k}\Omega$ , $V_o = 1\text{ V to }6\text{ V}$<br>$T_{min} \leq T_{amb} \leq T_{max}$                   | 30<br>20   | 50                 |                                | 30<br>10             | 50                 |                                  | V/mV                           |
| CMR            | Common mode rejection ratio<br>$V_{ic} = 1\text{ V to }7.4\text{ V}$ , $V_o = 1.4\text{ V}$                                                                                 | 65         | 80                 |                                | 65                   | 80                 |                                  | dB                             |
| SVR            | Supply voltage rejection ratio<br>$V_{CC}^{+} = 5\text{ V to }10\text{ V}$ , $V_o = 1.4\text{ V}$                                                                           | 60         | 80                 |                                | 60                   | 80                 |                                  | dB                             |
| $I_{CC}$       | Supply current (per amplifier)<br>$A_v = 1$ , no load, $V_o = 5\text{ V}$<br>$T_{min} \leq T_{amb} \leq T_{max}$                                                            |            | 150                | 200<br>250                     |                      | 150                | 200<br>300                       | $\mu\text{A}$                  |
| $I_o$          | Output short circuit current<br>$V_o = 0\text{ V}$ , $V_{id} = 100\text{ mV}$                                                                                               | 45         | 60                 |                                |                      | 60                 |                                  | mA                             |
| $I_{sink}$     | Output sink current<br>$V_o = V_{CC}$ , $V_{id} = -100\text{ mV}$                                                                                                           | 34         | 45                 |                                |                      | 45                 |                                  | mA                             |

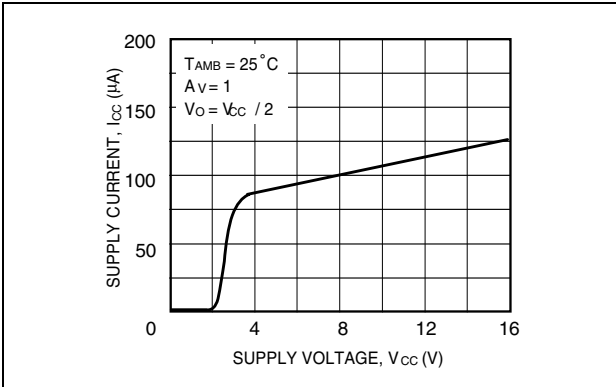
**Table 3. Electrical characteristics at  $V_{CC+} = +10\text{ V}$ ,  $V_{CC-} = 0\text{ V}$ ,  $T_{amb} = +25^\circ\text{ C}$   
(unless otherwise specified) (continued)**

| Symbol                           | Parameter                                                                                                                        | TS27M2xC |      |      | TS27M2xI<br>TS27M2xM |      |      | Unit                   |
|----------------------------------|----------------------------------------------------------------------------------------------------------------------------------|----------|------|------|----------------------|------|------|------------------------|
|                                  |                                                                                                                                  | Min.     | Typ. | Max. | Min.                 | Typ. | Max. |                        |
| AC performance                   |                                                                                                                                  |          |      |      |                      |      |      |                        |
| GBP                              | Gain bandwidth product<br>A <sub>v</sub> = 40 dB, R <sub>L</sub> = 100 kΩ, C <sub>L</sub> = 100 pF,<br>f <sub>in</sub> = 100 kHz | 0.5      | 1    |      | 0.5                  | 1    |      | MHz                    |
| SR                               | Slew rate at unity gain<br>R <sub>L</sub> = 100 kΩ, C <sub>L</sub> = 100 pF, V <sub>i</sub> = 3 to 7 V                           | 0.3      | 0.6  |      | 0.3                  | 0.6  |      | V/μs                   |
| φ <sub>m</sub>                   | Phase margin at unity gain<br>A <sub>v</sub> = 40 dB, R <sub>L</sub> = 100 kΩ, C <sub>L</sub> = 100 pF                           |          | 45   |      |                      | 45   |      | Degrees                |
| K <sub>OV</sub>                  | Overshoot factor                                                                                                                 |          | 30   |      |                      | 30   |      | %                      |
| e <sub>n</sub>                   | Equivalent input noise voltage<br>f = 1 kHz, R <sub>s</sub> = 100 Ω                                                              |          | 38   |      |                      | 38   |      | $\frac{nV}{\sqrt{Hz}}$ |
| V <sub>o1</sub> /V <sub>o2</sub> | Channel separation                                                                                                               |          | 120  |      |                      | 120  |      | dB                     |

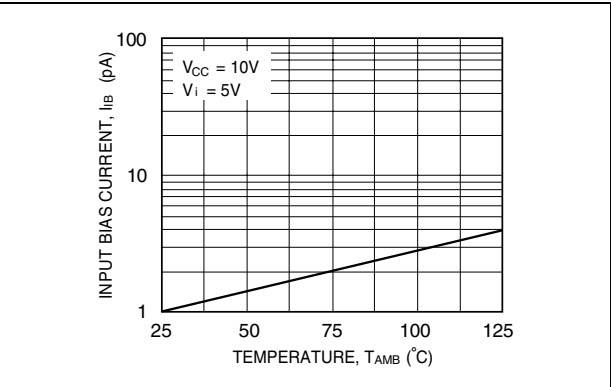
1. Maximum values including unavoidable inaccuracies of industrial tests.

### 3 Typical characteristics

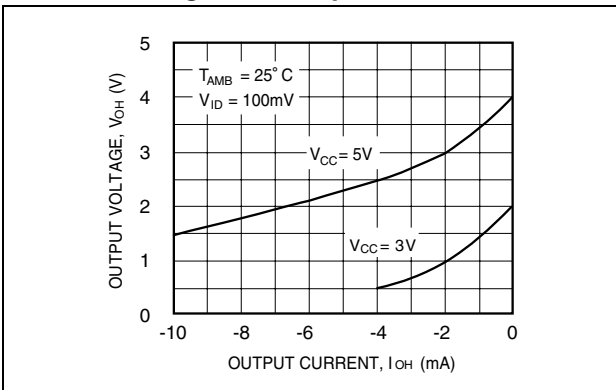
**Figure 2. Supply current (each amplifier) versus supply voltage**



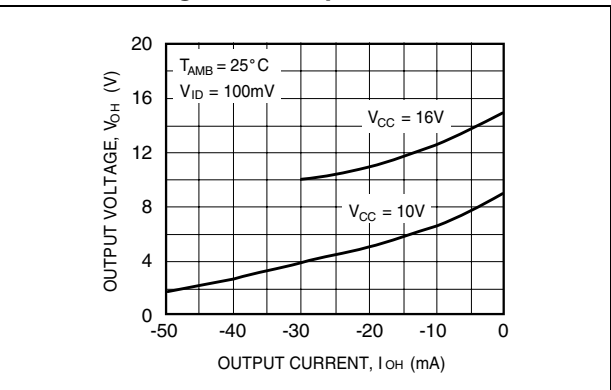
**Figure 3. Input bias current versus free air temperature**



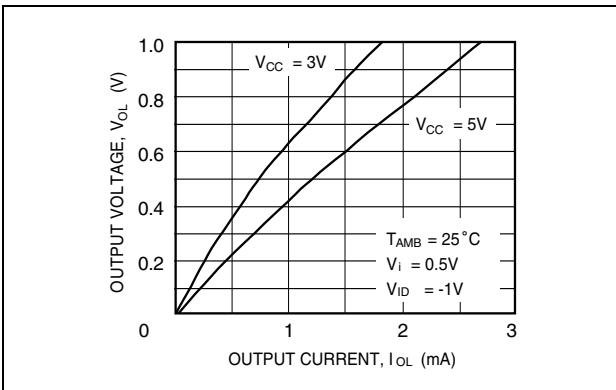
**Figure 4. High level output voltage versus high level output current**



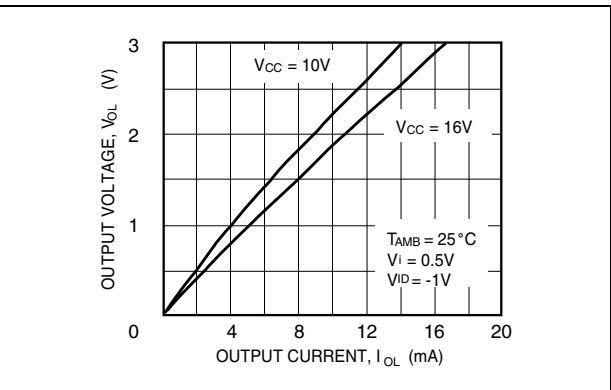
**Figure 5. High level output voltage versus high level output current**



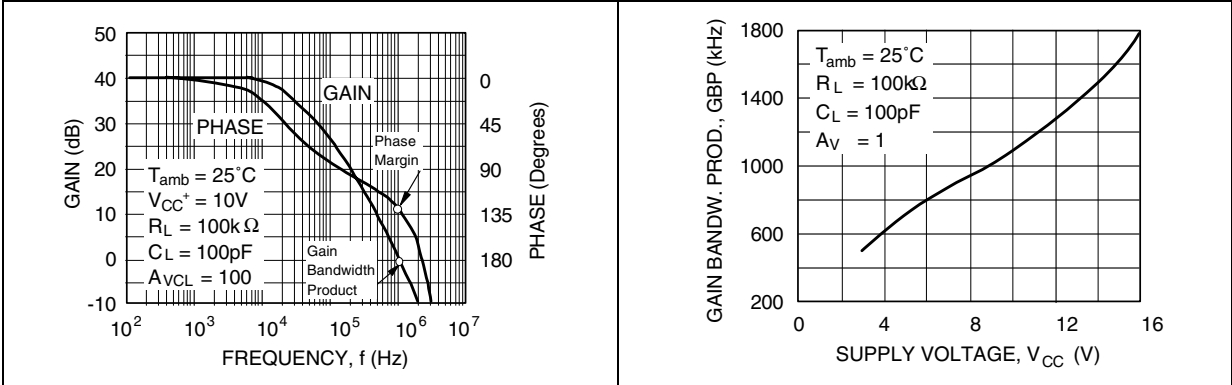
**Figure 6. Low level output voltage versus low level output current**



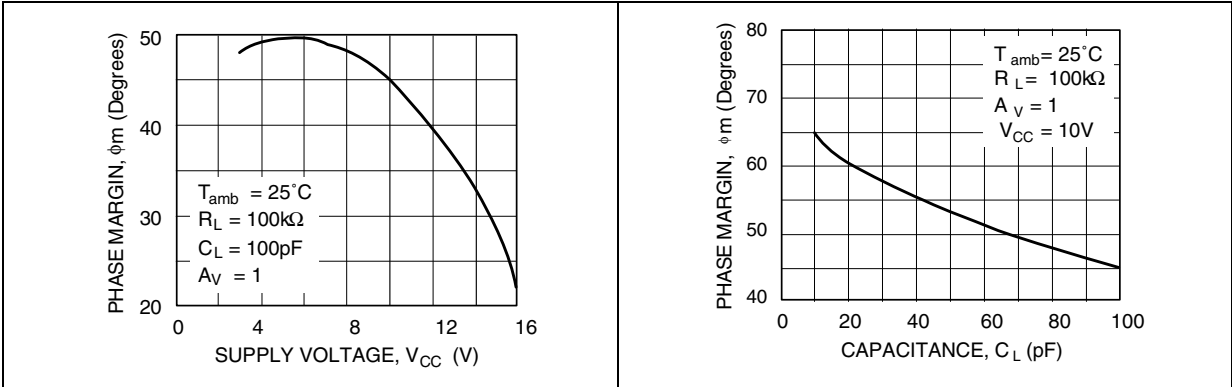
**Figure 7. Low level output voltage versus low level output current**



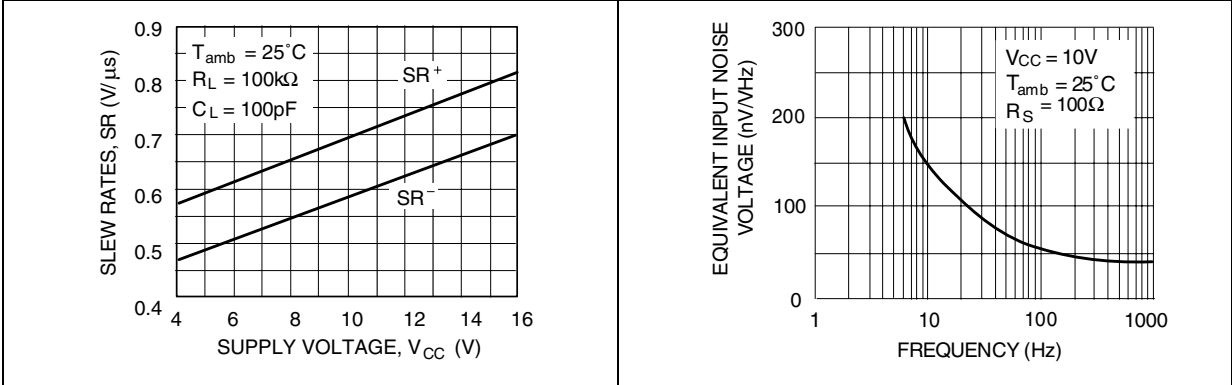
**Figure 8. Open-loop frequency response and phase shift** **Figure 9. Gain bandwidth product versus supply voltage**



**Figure 10. Phase margin versus supply voltage** **Figure 11. Phase margin versus capacitive load**



**Figure 12. Slew rate versus supply voltage** **Figure 13. Input voltage noise versus frequency**



## 4 Package information

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

## 4.1 DIP8 package information

Figure 14. DIP8 package mechanical drawing

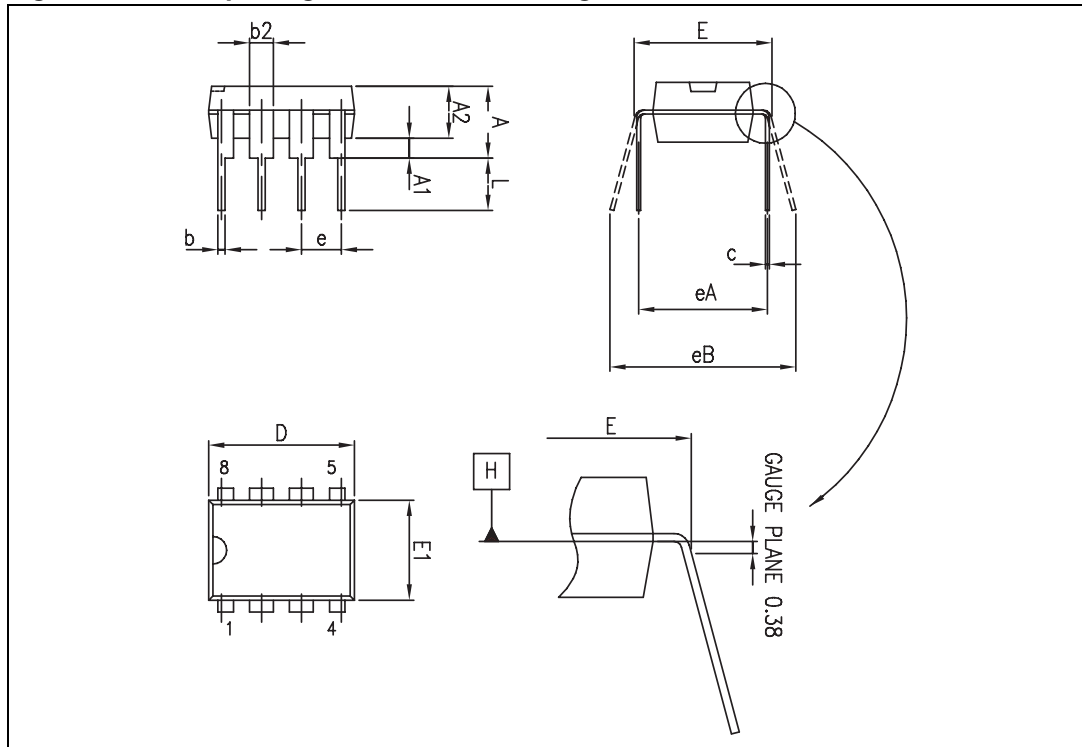


Table 4. DIP8 package mechanical data

| Ref. | Dimensions  |      |       |        |       |       |
|------|-------------|------|-------|--------|-------|-------|
|      | Millimeters |      |       | Inches |       |       |
|      | Min.        | Typ. | Max.  | Min.   | Typ.  | Max.  |
| A    |             |      | 5.33  |        |       | 0.210 |
| A1   | 0.38        |      |       | 0.015  |       |       |
| A2   | 2.92        | 3.30 | 4.95  | 0.115  | 0.130 | 0.195 |
| b    | 0.36        | 0.46 | 0.56  | 0.014  | 0.018 | 0.022 |
| b2   | 1.14        | 1.52 | 1.78  | 0.045  | 0.060 | 0.070 |
| c    | 0.20        | 0.25 | 0.36  | 0.008  | 0.010 | 0.014 |
| D    | 9.02        | 9.27 | 10.16 | 0.355  | 0.365 | 0.400 |
| E    | 7.62        | 7.87 | 8.26  | 0.300  | 0.310 | 0.325 |
| E1   | 6.10        | 6.35 | 7.11  | 0.240  | 0.250 | 0.280 |
| e    |             | 2.54 |       |        | 0.100 |       |
| eA   |             | 7.62 |       |        | 0.300 |       |
| eB   |             |      | 10.92 |        |       | 0.430 |
| L    | 2.92        | 3.30 | 3.81  | 0.115  | 0.130 | 0.150 |

## 4.2 SO-8 package information

Figure 15. SO-8 package mechanical drawing

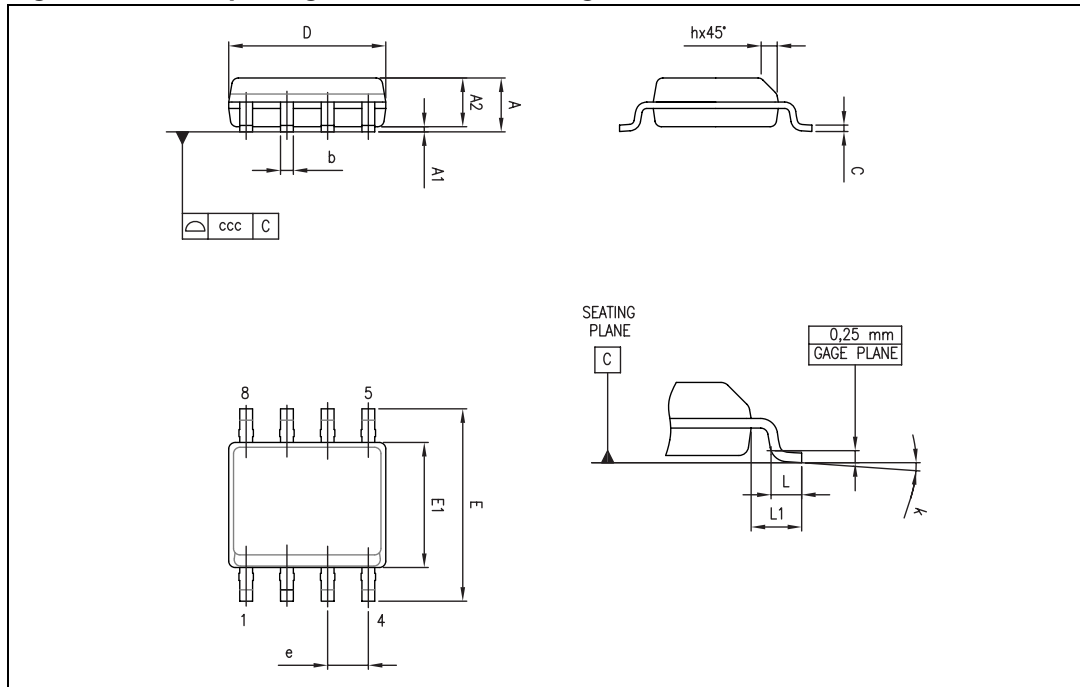


Table 5. SO-8 package mechanical data

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

### 4.3 TSSOP8 package information

Figure 16. TSSOP8 package mechanical drawing

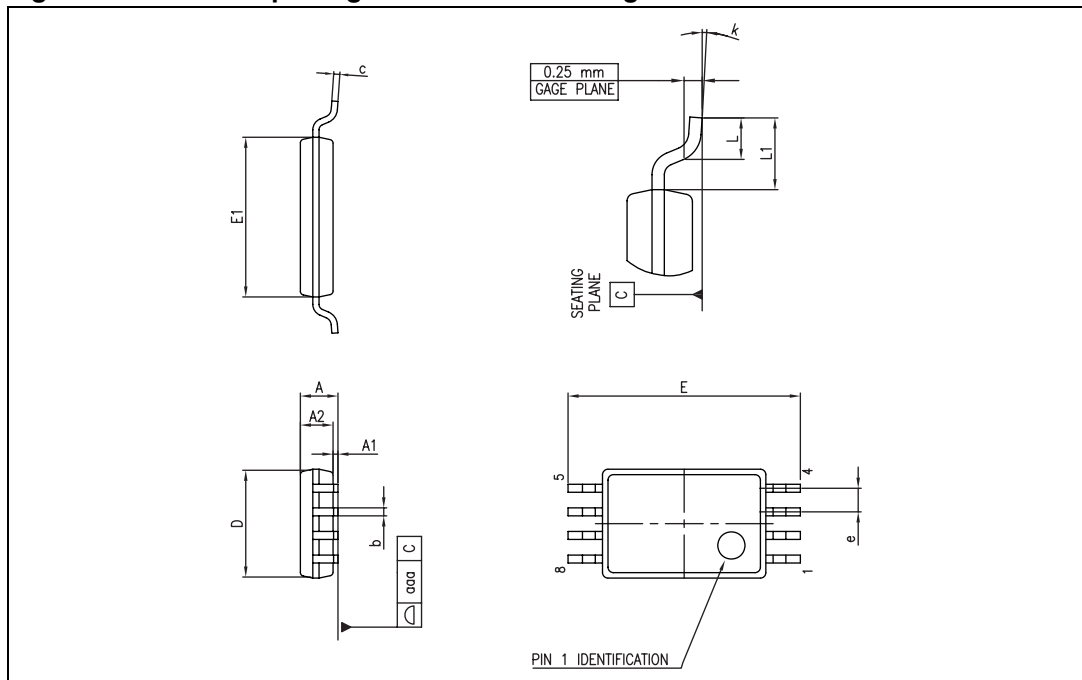


Table 6. TSSOP8 package mechanical data

| 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 |

## 5 Ordering information

**Table 7. Order codes**

| Part number             | Temperature range | Package | Packing             | Marking  |
|-------------------------|-------------------|---------|---------------------|----------|
| TS27M2CD<br>TS27M2CDT   | 0° C to +70° C    | SO-8    | Tube<br>Tape & reel | 27M2C    |
| TS27M2CN                |                   | DIP8    | Tube                | TS27M2CN |
| TS27M2CPT               |                   | TSSOP8  | Tube<br>Tape & reel | 27M2C    |
| TS27M2ACD<br>TS27M2ACDT |                   | SO-8    | Tube<br>Tape & reel | 27M2AC   |
| TS27M2ACN               |                   | DIP8    | Tube                | S27M2ACN |
| TS27M2ACPT              |                   | TSSOP8  | Tape & reel         | 2M2AC    |
| TS27M2BCD<br>TS27M2BCDT |                   | SO-8    | Tube<br>Tape & reel | 27M2BC   |
| TS27M2BCN               |                   | DIP8    | Tube                | S27M2BCN |
| TS27M2BCPT              |                   | TSSOP8  | Tape & reel         | 2M2BC    |
| TS27M2ID<br>TS27M2IDT   | -40° C to +125° C | SO-8    | Tube<br>Tape & reel | 27M2I    |
| TS27M2IN                |                   | DIP8    | Tube                | TS27M2IN |
| TS27M2IPT               |                   | TSSOP8  | Tape & reel         | 27M2I    |
| TS27M2AID<br>TS27M2AIDT |                   | SO-8    | Tube<br>Tape & reel | 27M2AI   |
| TS27M2AIN               |                   | DIP8    | Tube                | S27M2AIN |
| TS27M2AIPT              |                   | TSSOP8  | Tape & reel         | 2M2AI    |
| TS27M2BID<br>TS27M2BIDT |                   | SO-8    | Tube<br>Tape & reel | 27M2BI   |
| TS27M2BIN               |                   | DIP8    | Tube                | S27M2BIN |
| TS27M2BIPT              |                   | TSSOP8  | Tape & reel         | 2M2BI    |

## 6 Revision history

**Table 8. Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                                                           |
|-------------|----------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 01-Nov-2001 | 1        | Initial release.                                                                                                                                                                                                                                                                  |
| 18-Aug-2009 | 2        | Updated document format.<br>Added ESD and Rthja information in <a href="#">Table 1: Absolute maximum ratings</a> .<br>Removed block diagram.<br>Added minimum values for Io, GBP and SR parameters in <a href="#">Table 3</a> .<br>Added order codes in <a href="#">Table 7</a> . |

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