

Low-power quad voltage comparator

Features

- Wide single supply voltage range or dual supplies for all devices: +2 V to +36 V or ± 1 V to ± 18 V
- Very low supply current (1.1 mA) independent of supply voltage (1.4 mW/comparator at +5 V)
- Low input bias current: 25 nA typ.
- Low input offset current: ± 5 nA typ.
- Input common-mode voltage range includes negative rail
- Low output saturation voltage: 250 mV typ. ($I_O = 4$ mA)
- Differential input voltage range equal to the supply voltage
- TTL, DTL, ECL, MOS, CMOS compatible outputs

Description

This device consists of four independent precision voltage comparators, which are designed specifically to operate from a single supply over a wide range of voltages. Operation from split power supplies is also possible.

These comparators also have a unique characteristic in that the input common-mode voltage range includes the negative rail even though operated from a single power supply voltage.



N
DIP14
(Plastic package)



D
SO-14
(Plastic micropackage)



P
TSSOP14
(Thin shrink small outline package)



Q4
QFN16 3x3
(Plastic micropackage)

1 Pin connection and schematic diagram

Figure 1. Pin connections (top view)

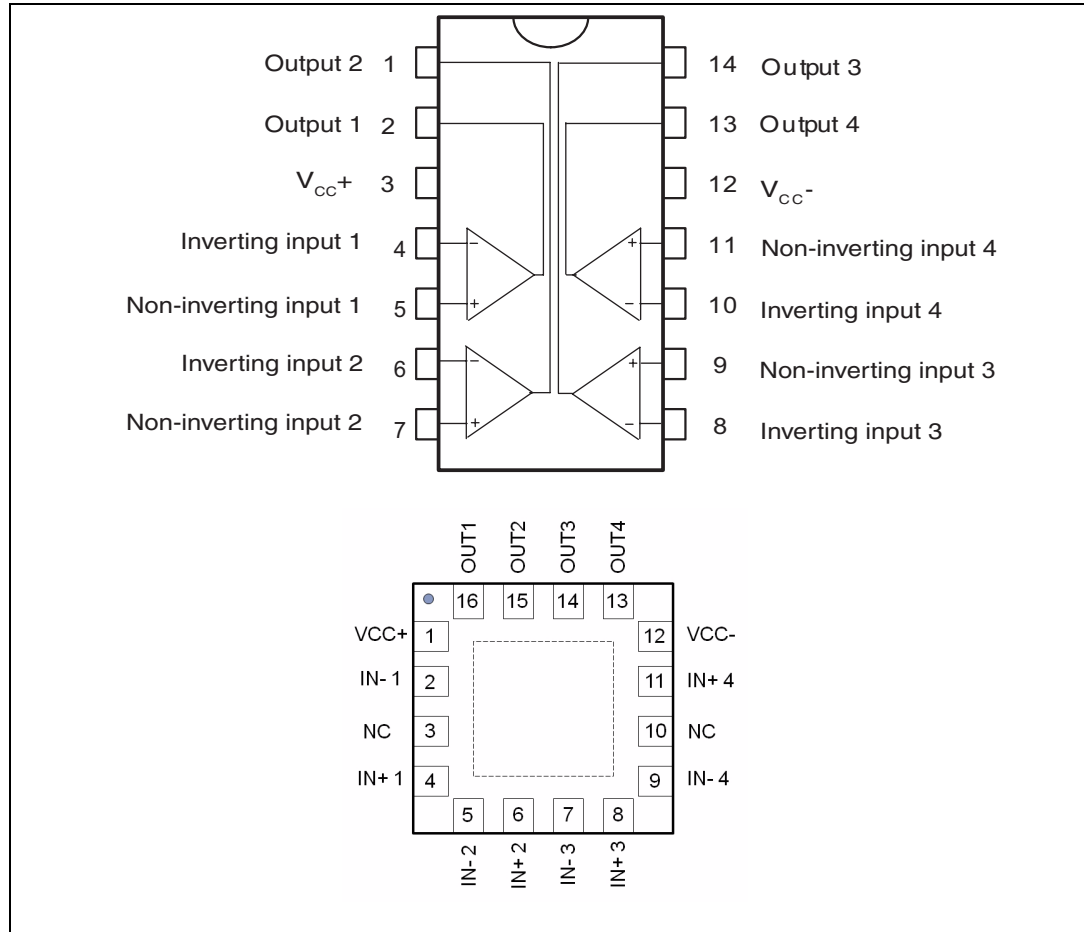
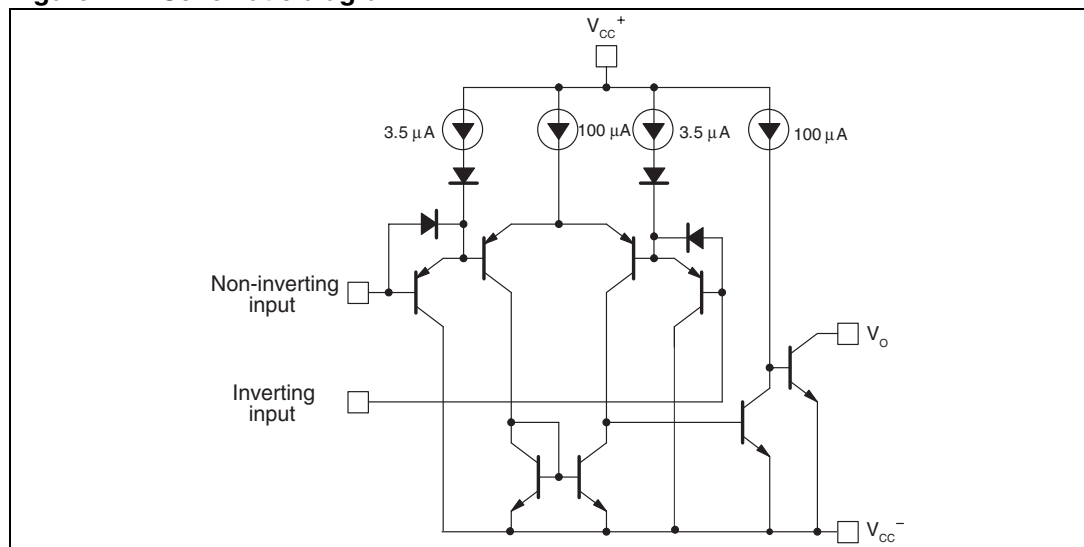


Figure 2. Schematic diagram



2 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings

| Symbol | Parameter | Value | Unit |
|------------|---|----------------|------|
| V_{CC} | Supply voltage | ± 18 to 36 | V |
| V_{id} | Differential input voltage | ± 36 | V |
| V_{in} | Input voltage | -0.3 to +36 | V |
| | Output short-circuit to ground ⁽¹⁾ | | |
| R_{thja} | Thermal resistance junction to ambient ⁽²⁾ | | °C/W |
| | DIP14 | 80 | |
| | SO-14 | 105 | |
| | TSSOP14 QFN16 3x3 | 100 45 | |
| R_{thjc} | Thermal resistance junction to case ⁽²⁾ | | |
| | DIP14 | 33 | |
| | SO-14 | 31 | |
| | TSSOP14 QFN16 3x3 | 32 14 | |
| T_j | Maximum junction temperature | +150 | °C |
| T_{stg} | Storage temperature range | -65 to +150 | °C |
| ESD | HBM: human body model ⁽³⁾ | 500 | V |
| | MM: machine model ⁽⁴⁾ | 100 | V |
| | CDM: charged device model ⁽⁵⁾ | 1500 | V |

- Short-circuits from the output to V_{CC}^+ can cause excessive heating and eventual destruction. The maximum output current is approximately 20 mA, independent of the magnitude of V_{CC}^+ .
- Short-circuits can cause excessive heating. Destructive dissipation can result from simultaneous short-circuits on all amplifiers. All values are typical.
- Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5 k Ω resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
- 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.
- 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 |
|------------|--|--|------|
| V_{CC} | Supply voltage | 2 to 32 ± 1 to ± 16 | V |
| V_{icm} | Common mode input voltage range $T_{min} \leq T_{amb} \leq T_{max}$ | 0 to ($V_{CC}^+ - 1.5$) 0 to ($V_{CC}^+ - 2$) | V |
| T_{oper} | Operating free-air temperature range | -40 to +125 | °C |

3 Electrical characteristics

Table 3. Electrical characteristics at $V_{CC}^+ = 5\text{ V}$, $V_{CC}^- = \text{GND}$, $T_{\text{amb}} = 25^\circ\text{ C}$ (unless otherwise specified)

| Symbol | Parameter | Min. | Typ. | Max. | Unit |
|-------------------|--|------|------------|------------|---------------------|
| V_{io} | Input offset voltage ⁽¹⁾ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$ | | 1 | 7 15 | mV |
| I_{io} | Input offset current $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$ | | 5 | 50 150 | nA |
| I_{ib} | Input bias current (I_{I^+} or I_{I^-}) ⁽²⁾ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$ | | 25 | 250 400 | nA |
| A_{vd} | Large signal voltage gain ($V_{CC} = 15\text{ V}$, $R_L = 15\text{ k}\Omega$, $V_o = 1$ to 11 V) | 25 | 200 | | V/mV |
| I_{CC} | Supply current (all comparators) $V_{CC} = +5\text{ V}$, no load $V_{CC} = +30\text{ V}$, no load | | 1.1 1.3 | 2 2.5 | mA |
| V_{id} | Differential input voltage ⁽³⁾ | | | V_{CC}^+ | V |
| V_{OL} | Low level output voltage $V_{id} = -1\text{ V}$, $I_{\text{sink}} = 4\text{ mA}$ $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$ | | 250 | 400 700 | mV |
| I_{OH} | High level output current ($V_{CC} = V_o = 30\text{ V}$, $V_{id} = 1\text{ V}$) $T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$ | | 0.1 | 1 | nA μA |
| I_{sink} | Output sink current ($V_{id} = -1\text{ V}$, $V_o = 1.5\text{ V}$) | 6 | 16 | | mA |
| t_{res} | Small signal response time ⁽⁴⁾ ($R_L = 5.1\text{ k}\Omega$ connected to V_{CC}^+) | | 1.3 | | μs |
| t_{rel} | Large signal response time ⁽⁵⁾ TTL input ($V_{\text{ref}} = +1.4\text{ V}$, $R_L = 5.1\text{ k}\Omega$ to V_{CC}^+) Output signal at 50% of final value Output signal at 95% of final value | | | 500 1 | ns μs |

1. At output switch point, $V_o \approx 1.4\text{ V}$, $R_S = 0$ with V_{CC}^+ from 5 V to 30 V , and over the full input common-mode range (0 V to $V_{CC}^+ - 1.5\text{ V}$).
2. The direction of the input current is out of the IC due to the PNP input stage. This current is essentially constant, independent of the state of the output, so there is no loading charge on the reference of input lines.
3. The response time specified is for a 100 mV input step with 5 mV overdrive.
4. Positive excursions of input voltage may exceed the power supply level. As long as the other voltage remains within the common-mode range, the comparator will provide a proper output state. The low input voltage state must not be less than -0.3 V (or 0.3 V below the negative power supply, if used).
5. Maximum values are guaranteed by design.

Figure 3. Supply current vs. supply voltage

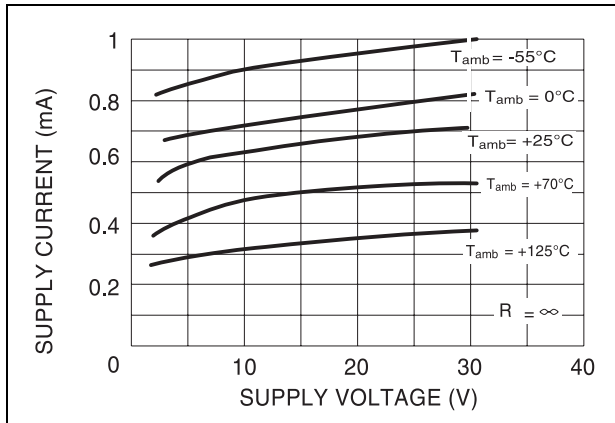


Figure 4. Input current vs. supply voltage

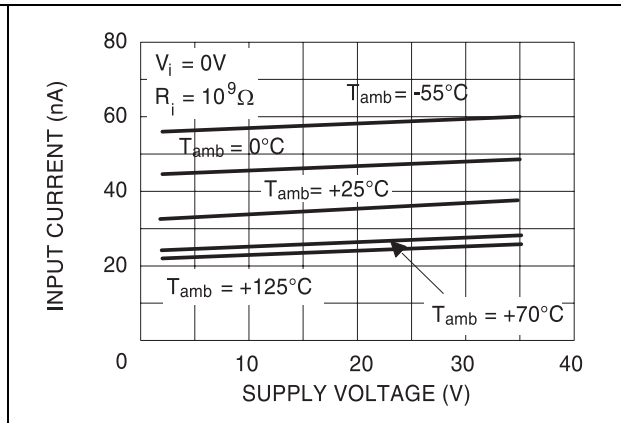


Figure 5. Output saturation voltage vs. output current

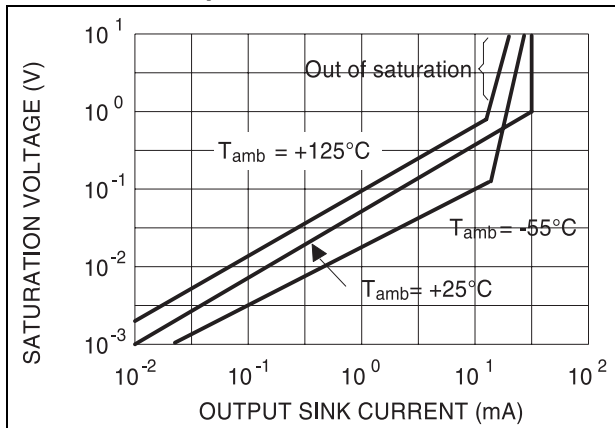


Figure 6. Response time for various input overdrives - negative transition

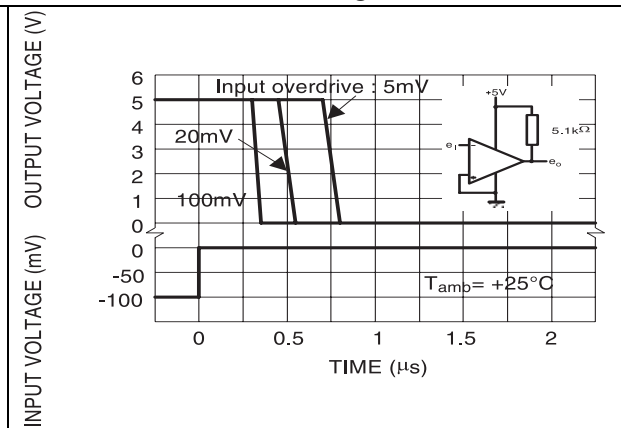
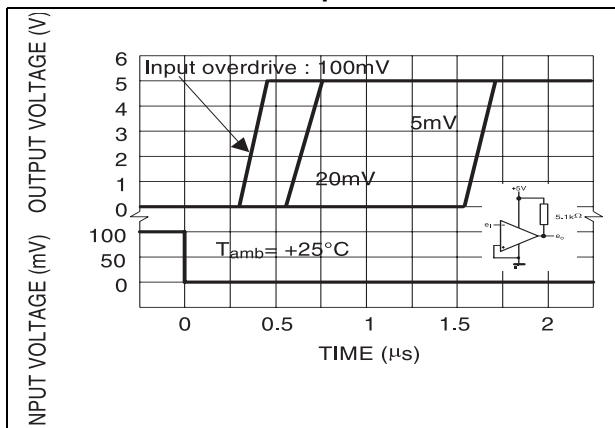


Figure 7. Response time for various input overdrives - positive transition



4 Typical application schematics

Figure 8. Basic comparator

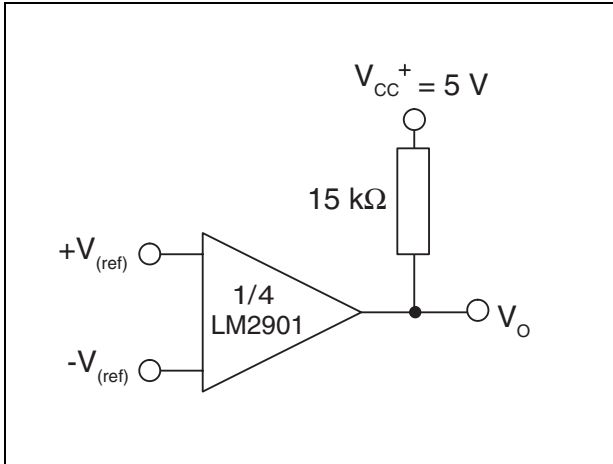


Figure 9. Driving CMOS

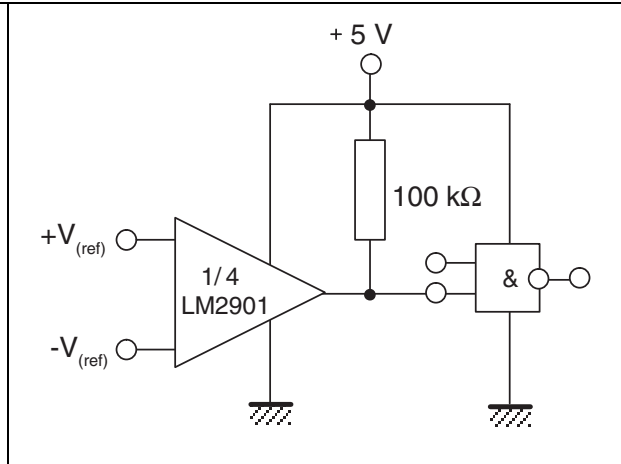


Figure 10. Driving TTL

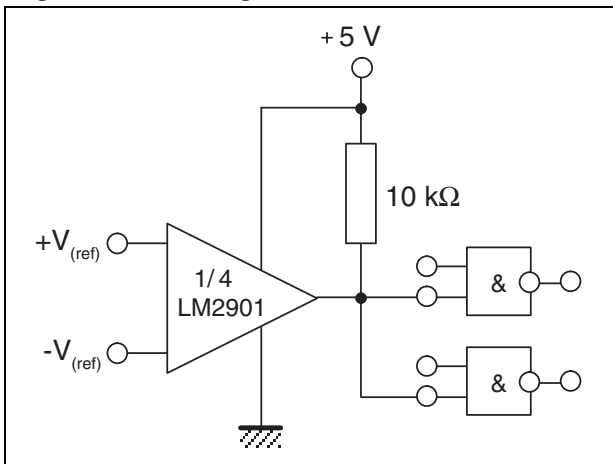


Figure 11. Low frequency op-amp

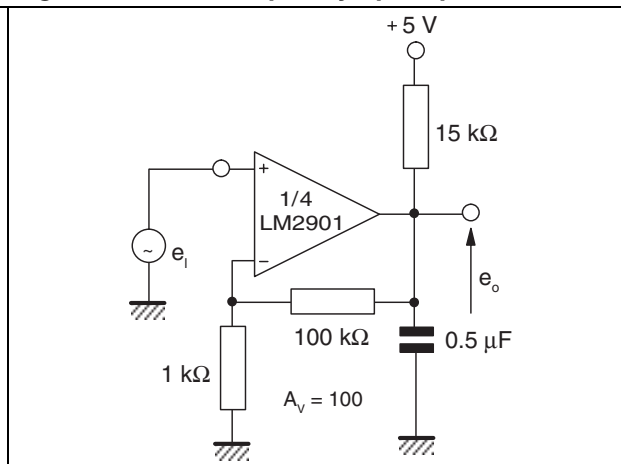


Figure 12. Low frequency op-amp with boost

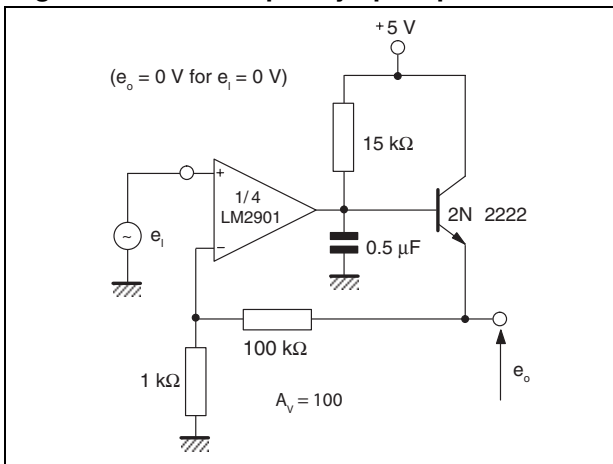


Figure 13. Transducer amplifier

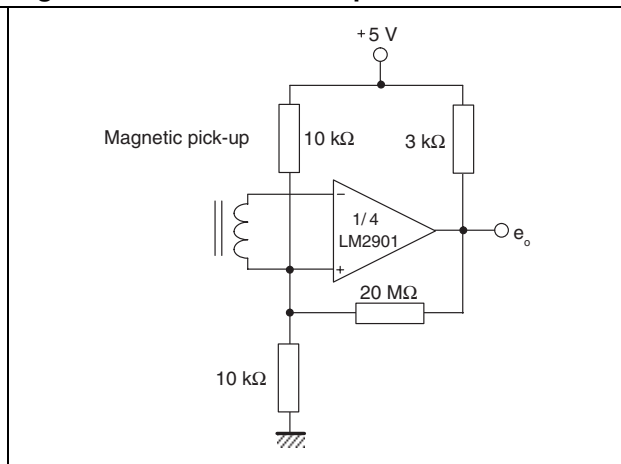


Figure 14. Low frequency op-amp with offset adjust

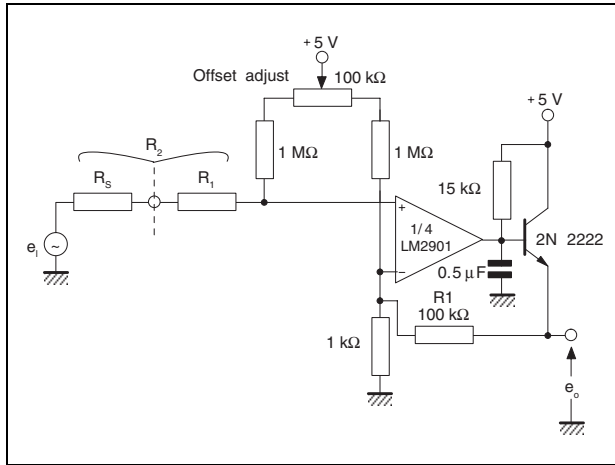


Figure 15. Zero crossing detector (single power supply)

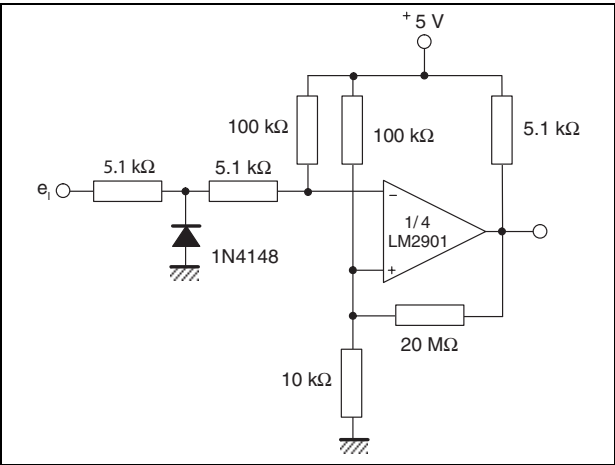


Figure 16. Limit comparator

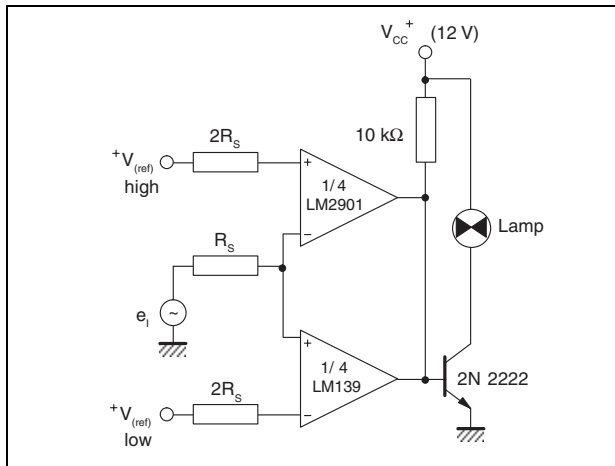


Figure 17. Split-supply applications - zero crossing detector

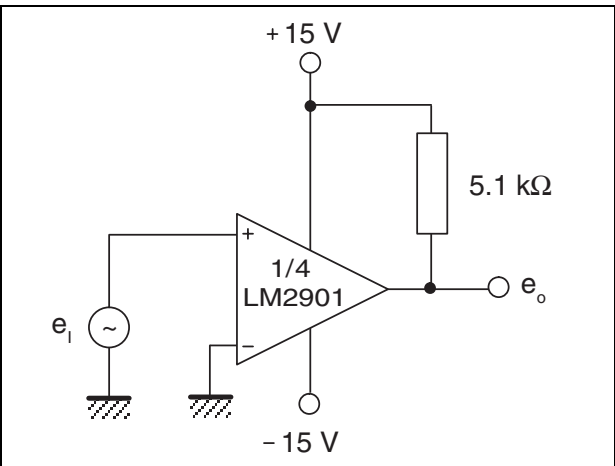


Figure 18. Crystal controlled oscillator

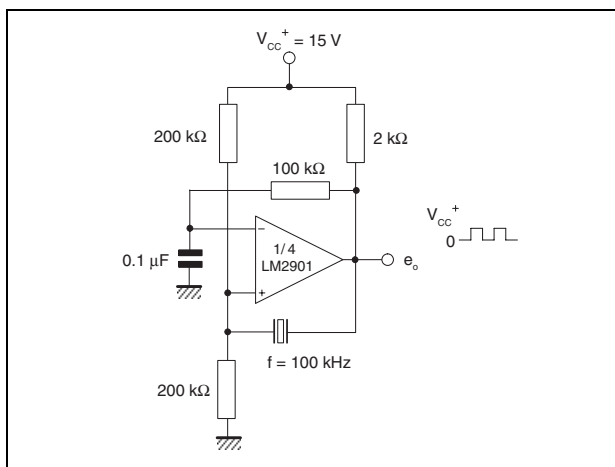


Figure 19. Comparator with a negative reference

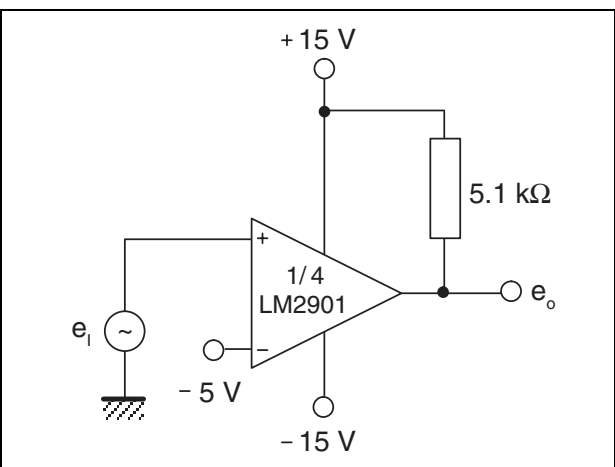


Figure 20. Time delay generator

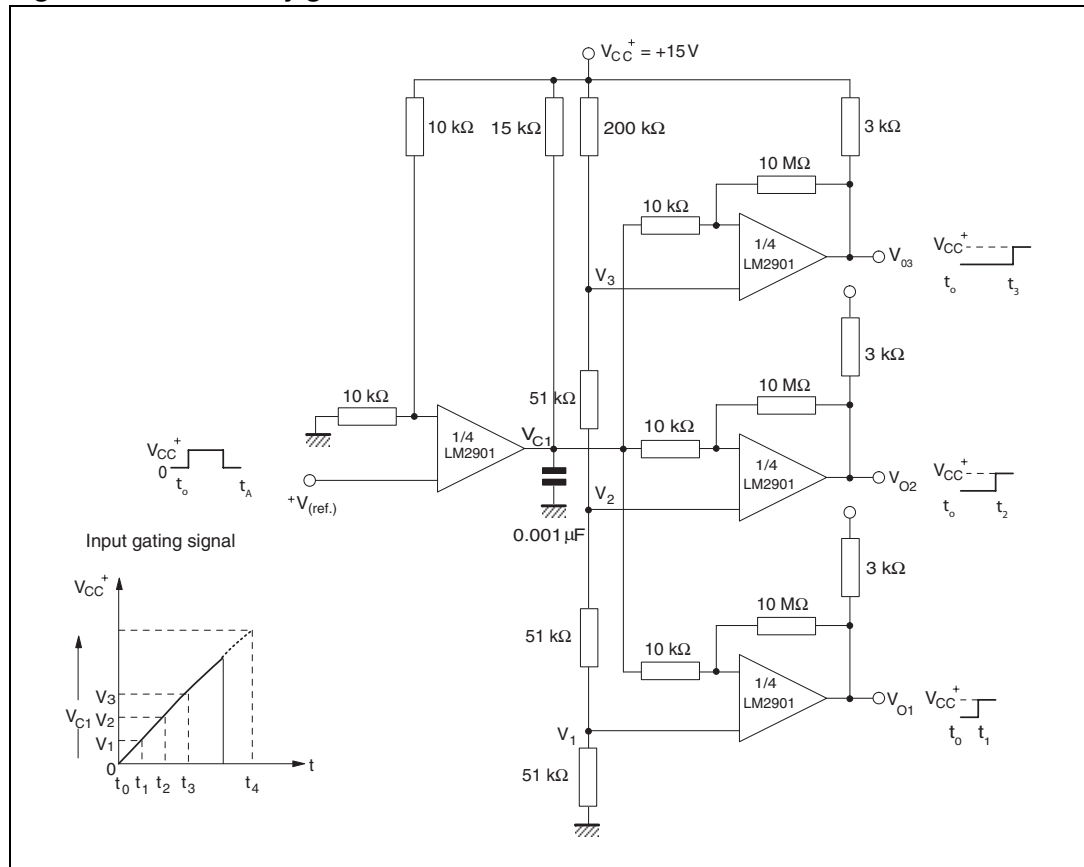
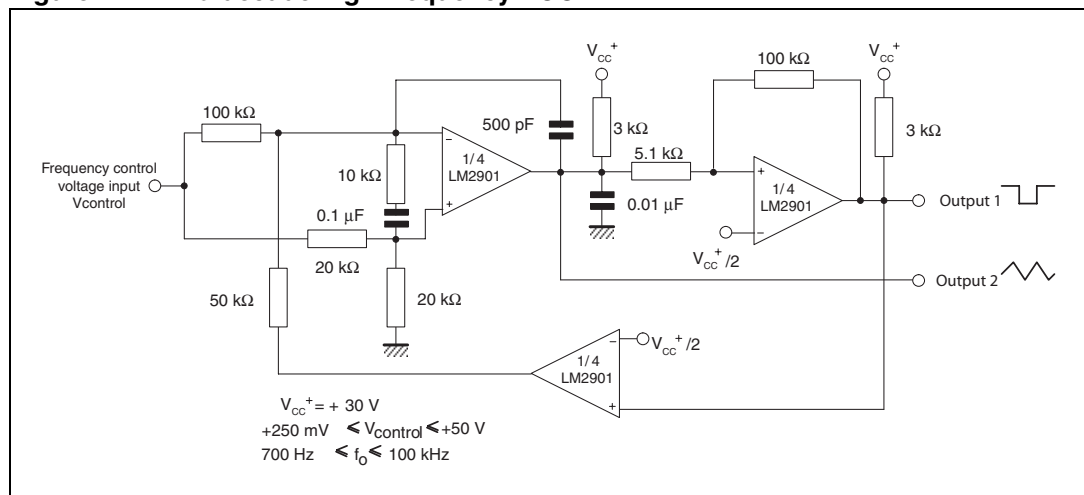


Figure 21. Two-decade high-frequency VCO



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 22. DIP14 package mechanical drawing

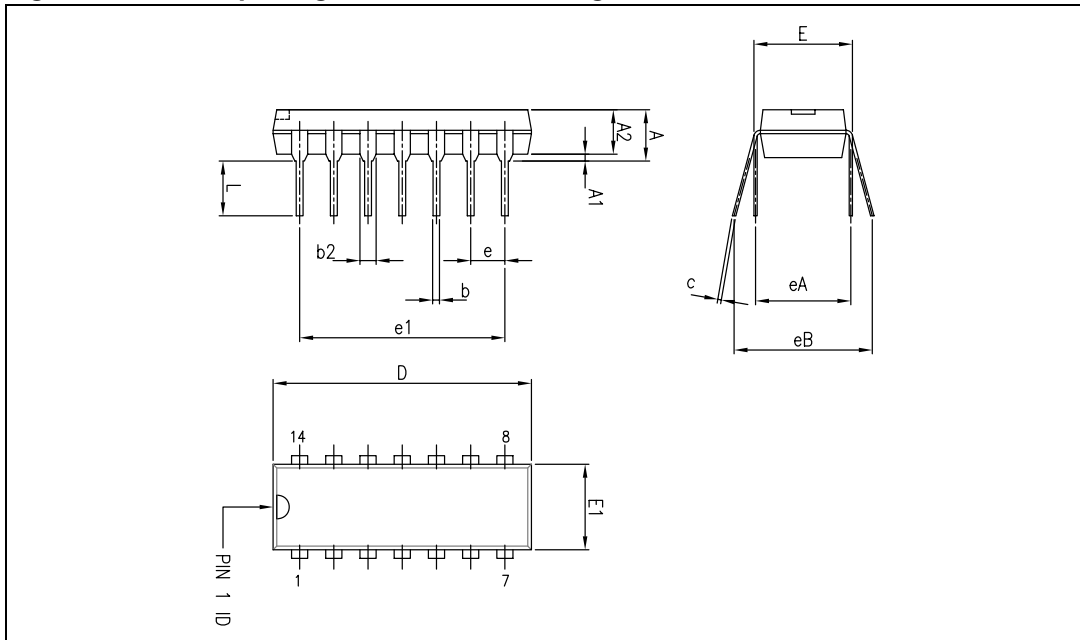


Table 4. DIP14 package mechanical data

| 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 QFN16 3 x 3 package information

Figure 23. QFN16 3 x 3 mm package mechanical drawing

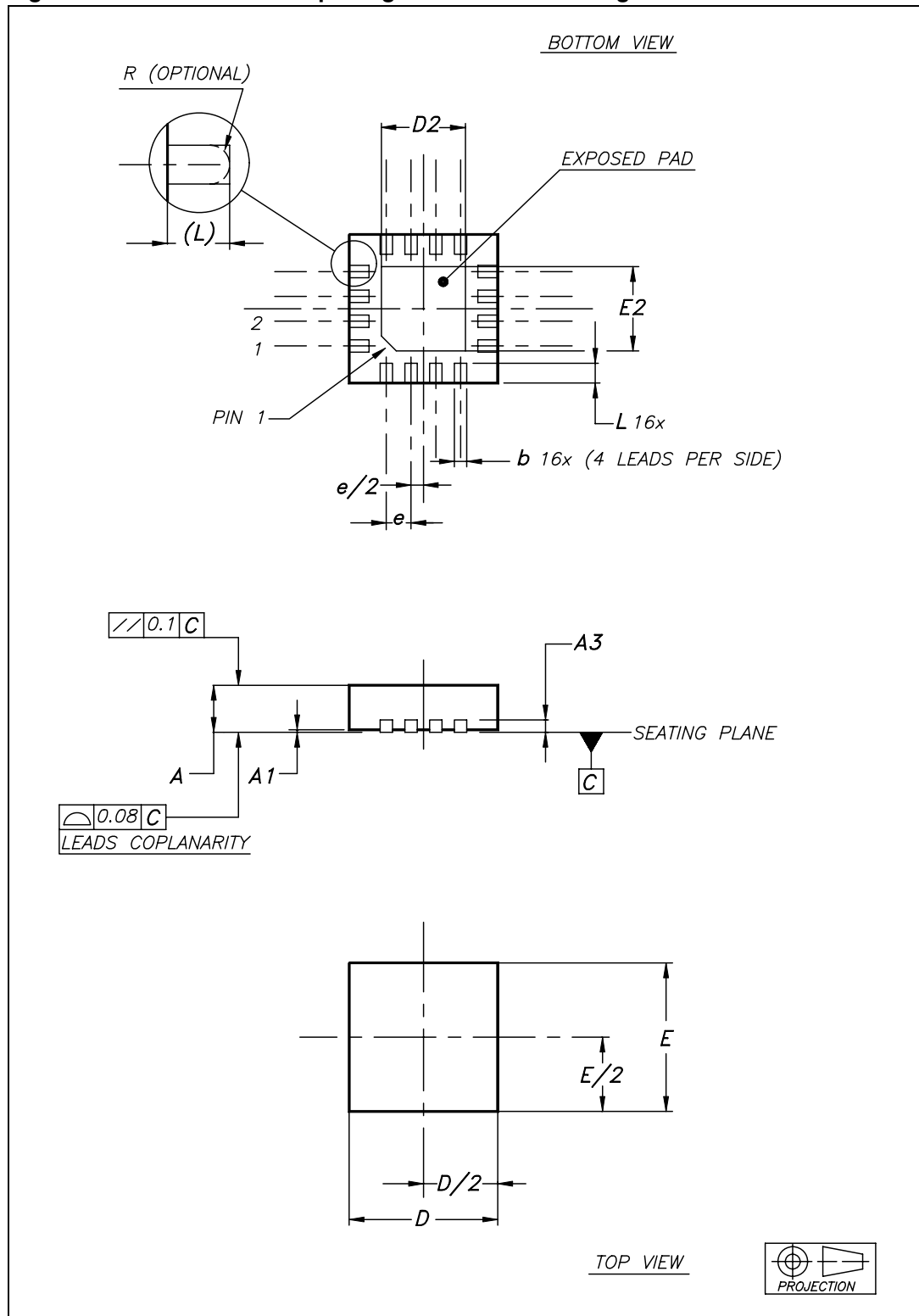
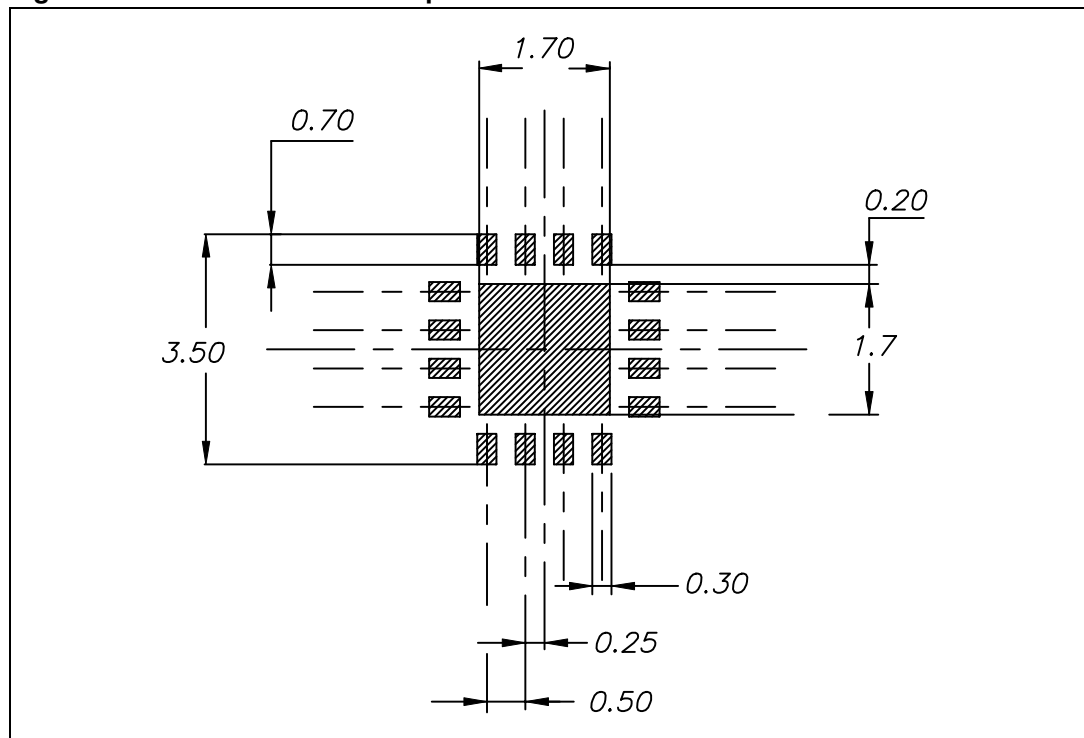


Table 5. QFN16 3 x 3 mm package mechanical data (pitch 0.5 mm)

| Ref. | Dimensions | | | | | |
|------|-------------|------|------|--------|-------|-------|
| | Millimeters | | | Inches | | |
| | Min. | Typ. | Max. | Min. | Typ. | Max. |
| A | 0.80 | 0.90 | 1.00 | 0.031 | 0.035 | 0.039 |
| A1 | 0 | | 0.05 | 0 | | 0.002 |
| A3 | | 0.20 | | | 0.008 | |
| b | 0.18 | | 0.30 | 0.007 | | 0.012 |
| D | 2.90 | 3.00 | 3.10 | 0.114 | 0.118 | 0.122 |
| D2 | 1.50 | | 1.80 | 0.059 | | 0.071 |
| E | 2.90 | 3.00 | 3.10 | 0.114 | 0.118 | 0.122 |
| E2 | 1.50 | | 1.80 | 0.059 | | 0.071 |
| e | | 0.50 | | | 0.020 | |
| L | 0.30 | | 0.50 | 0.012 | | 0.020 |

Figure 24. QFN16 3 x 3 mm footprint recommendation



5.3 SO-14 package information

Figure 25. SO-14 package mechanical drawing

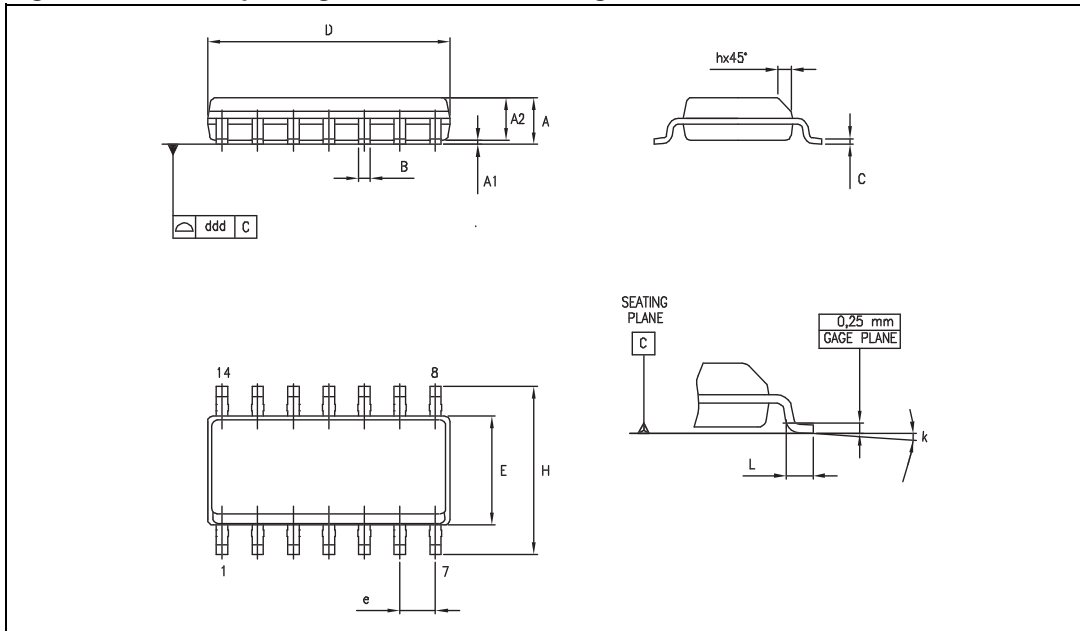


Table 6. SO-14 package mechanical data

| 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 |

5.4 TSSOP14 package information

Figure 26. TSSOP14 package mechanical drawing

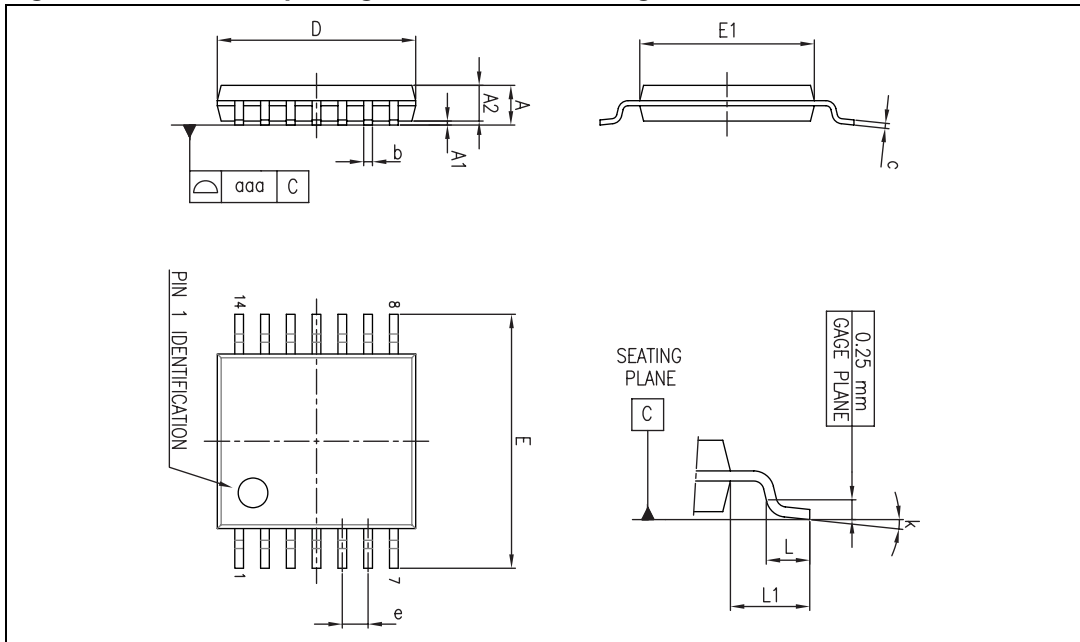


Table 7. TSSOP14 package mechanical data

| 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 8. Order codes

| Order code | Temperature range | Package | Packing | Marking |
|--------------------------|-------------------|-------------------------------|---------------------|---------|
| LM2901N | -40°C to +125°C | DIP14 | Tube | LM2901N |
| LM2901D LM2901DT | | SO-14 | Tube or tape & reel | 2901 |
| LM2901PT | | TSSOP14 | Tape & reel | |
| LM2901Q4T | | QFN16 3x3 | Tape & reel | K5I |
| LM2901YDT ⁽¹⁾ | | SO-14 (Automotive grade) | Tape & reel | 2901Y |
| LM2901YPT ⁽¹⁾ | | TSSOP14 (Automotive grade) | Tape & reel | |

1. Qualified and characterized according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q 002 or equivalent.

7 Revision history

Table 9. Document revision history

| Date | Revision | Changes |
|-------------|----------|---|
| 01-Jan-2002 | 1 | Initial release. |
| 01-Jul-2005 | 2 | 1 - PPAP references inserted in the datasheet see Table : Order codes on page 1 . 2 - ESD protection inserted in Table 1 on page 3 . |
| 01-Oct-2005 | 3 | The following changes were made in this revision: – PPAP part number added in table Order codes on page 1 . – Formatting changes throughout. |
| 18-Jul-2006 | 4 | ESD HBM value corrected in Table 1 on page 3 . |
| 19-Dec-2007 | 5 | Added R_{thja} and R_{thjc} parameters to Table 1: Absolute maximum ratings . Added footnotes for ESD parameters. Removed V_{icm} parameter from electrical characteristics in Table 3 . Reformatted package information in Section 5 . Added footnotes for automotive grade parts in Table 8: Order codes . |
| 30-Apr-2009 | 6 | Document reformatted. Updated package information in Chapter 5: Package information . Removed note 2 under Table 8: Order codes . |
| 06-Feb-2012 | 7 | Added QFN16 3 x 3 package in Chapter 5 . Removed LM2901YD order code from Table 8 . |

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