

## Low power quad voltage comparator

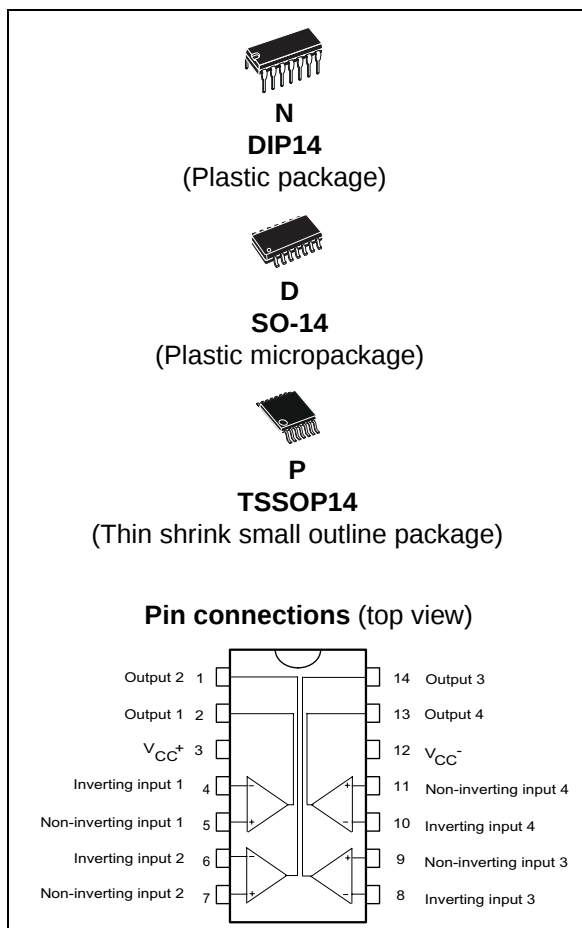
### Features

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

### Description

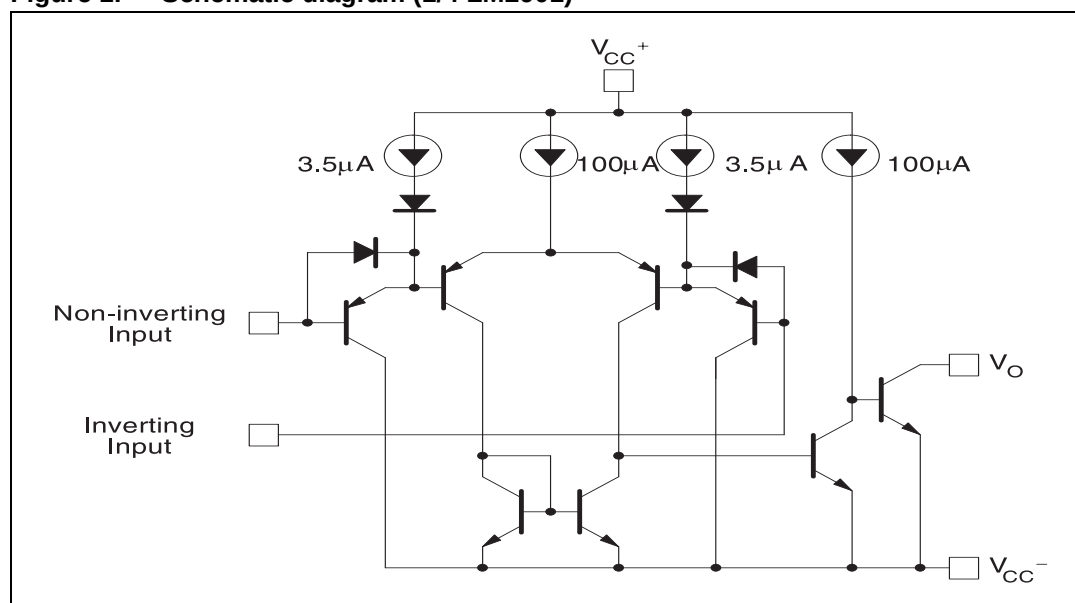
This device consists of four independent precision voltage comparators. All these comparators are designed specifically to operate from a single supply over a wide range of voltages. Operation from split power supplies is also possible.

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.



# 1 Schematic diagram

Figure 1. Schematic diagram (1/4 LM2901)



## 2 Absolute maximum ratings and operating conditions

**Table 1. Absolute maximum ratings**

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

1. Short-circuits from the output to  $V_{CC}^+$  can cause excessive heating and eventual destruction. The maximum output current is approximately 20mA, independent of the magnitude of  $V_{CC}^+$ .
2. Short-circuits can cause excessive heating. Destructive dissipation can result from simultaneous short-circuits on all amplifiers. All values are typical.
3. Human body model: A 100pF capacitor is charged to the specified voltage, then discharged through a 1.5k $\Omega$  resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
4. Machine model: A 200pF 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.
5. 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<br>$\pm 1$ to $\pm 16$                       | V    |
| $V_{icm}$  | Common mode input voltage range<br>$T_{min} \leq T_{amb} \leq T_{max}$ | 0 to ( $V_{CC}^+ - 1.5$ )<br>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  $V_{CC}^+ = 5V$ ,  $V_{CC}^- = GND$ ,  $T_{amb} = 25^\circ C$  (unless otherwise specified)**

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

1. At output switch point,  $V_o \approx 1.4V$ ,  $R_S = 0$  with  $V_{CC}^+$  from 5V to 30V, and over the full input common-mode range (0V to  $V_{CC}^+ - 1.5V$ ).
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 100mV input step with 5mV 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  $-0.3V$  (or 0.3V below the negative power supply, if used).
5. Maximum values are guaranteed by design.

Figure 2. Supply current vs. supply voltage

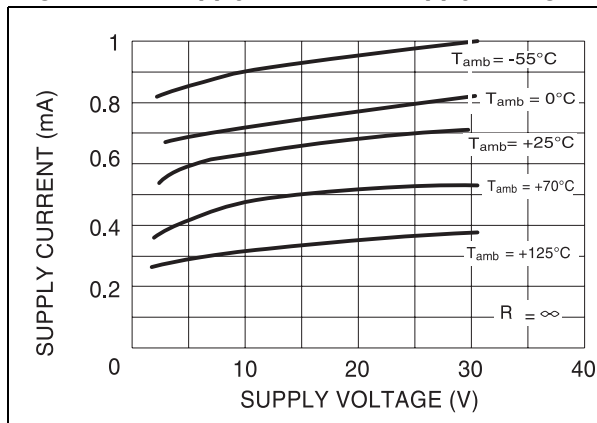


Figure 3. Input current vs. supply voltage

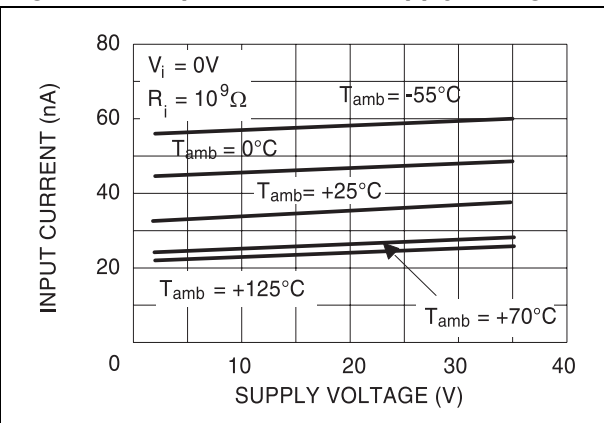


Figure 4. Output saturation voltage vs. output current

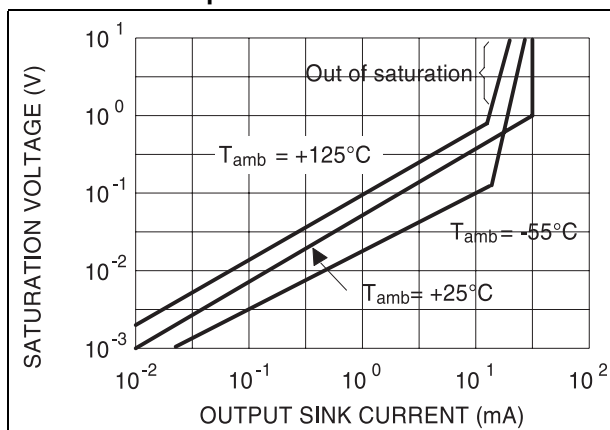


Figure 5. Response time for various input overdrives - negative transition

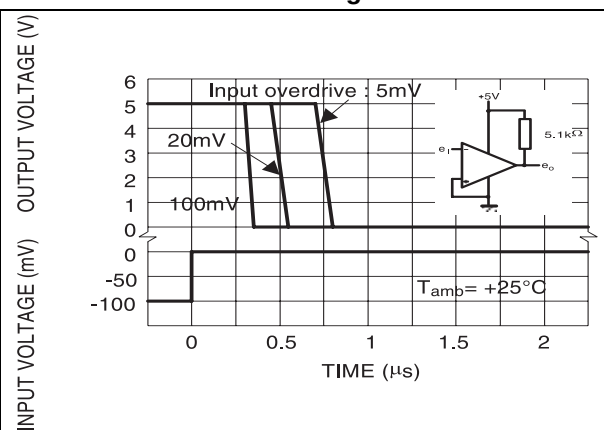
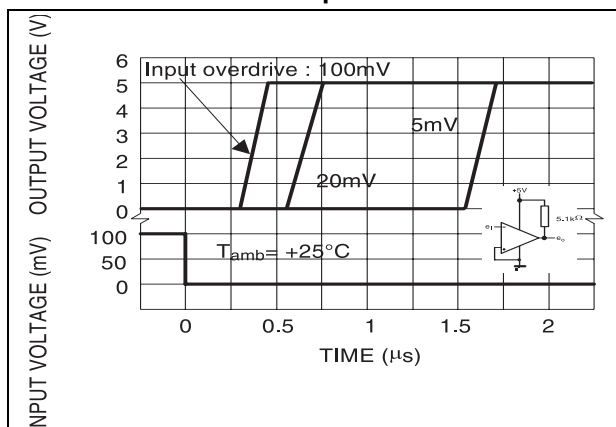


Figure 6. Response time for various input overdrives - positive transition



## 4 Typical applications schematics

Figure 7. Basic comparator

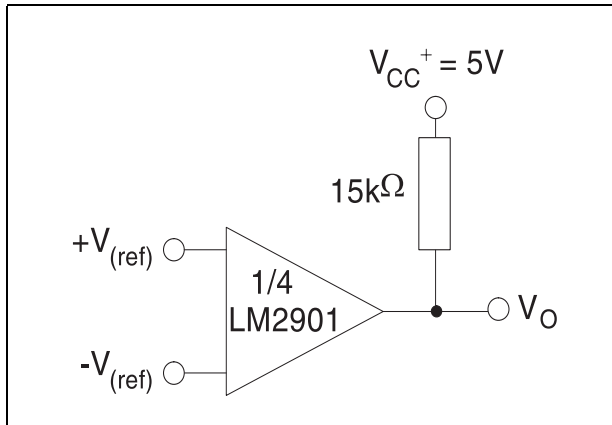


Figure 8. Driving CMOS

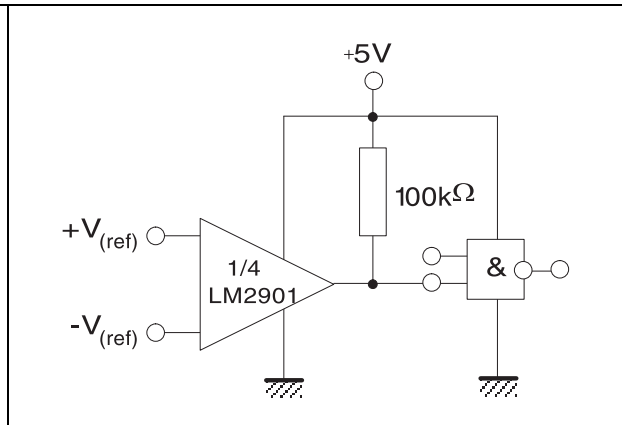


Figure 9. Driving TTL

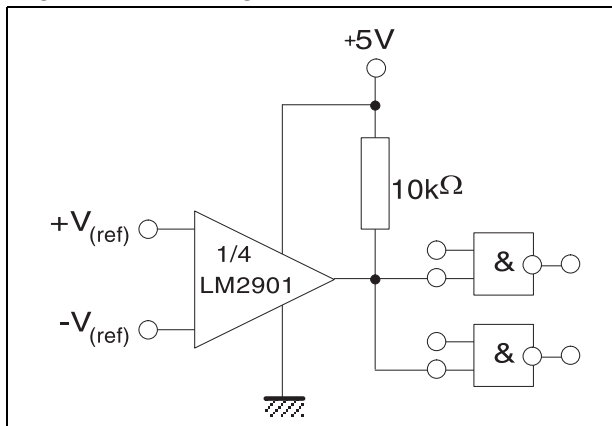


Figure 10. Low frequency op-amp

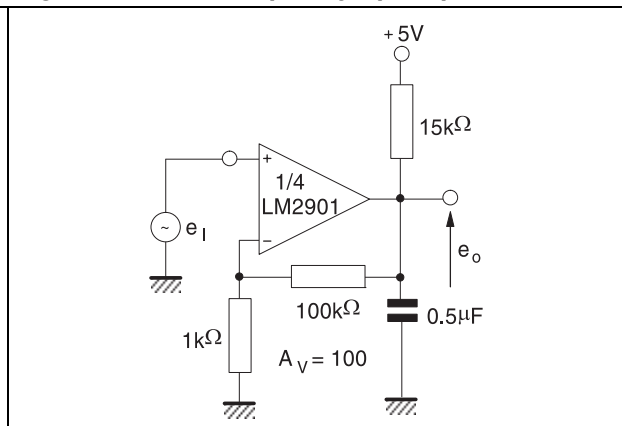


Figure 11. Low frequency op-amp

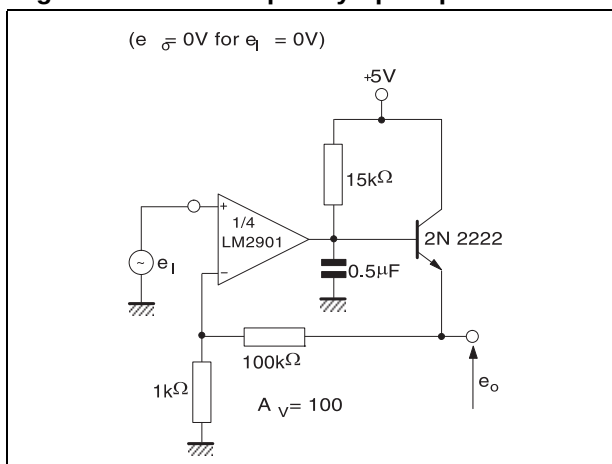
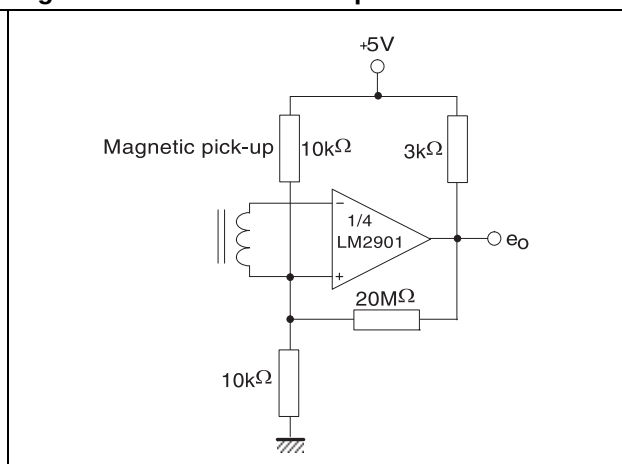


Figure 12. Transducer amplifier



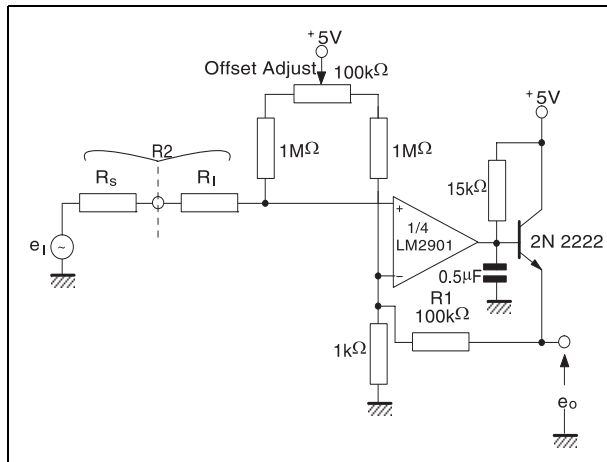
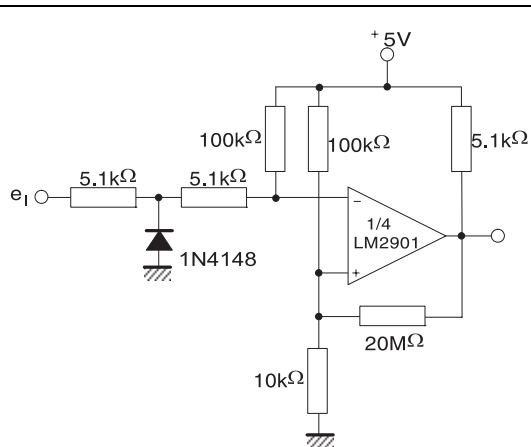
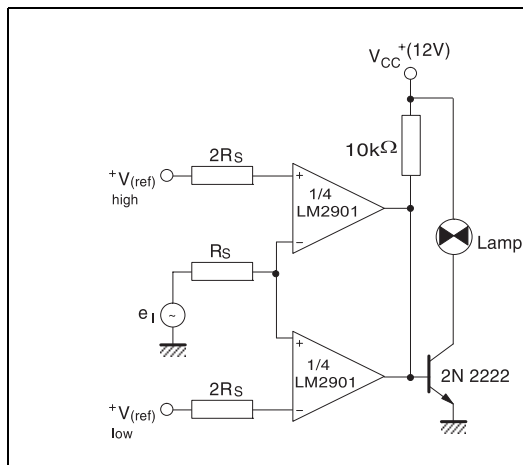
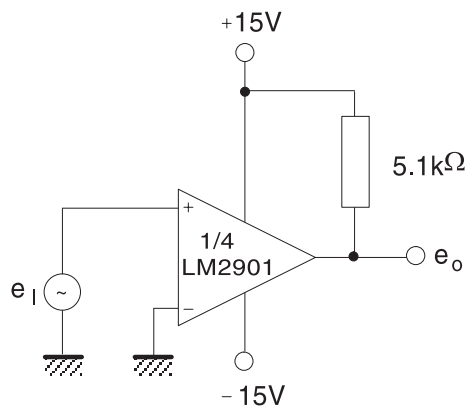
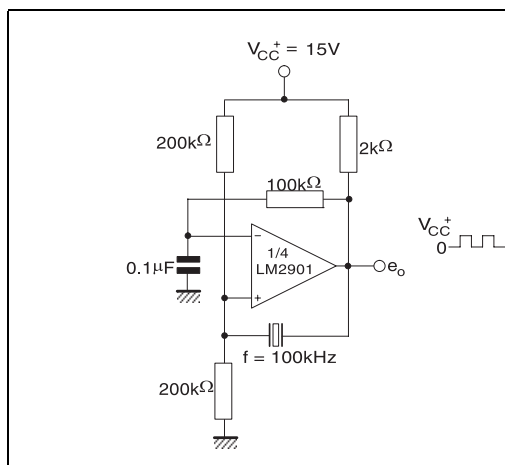
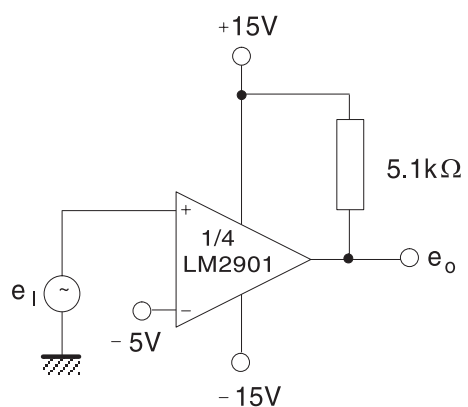
**Figure 13. Low frequency op- amp with offset adjust****Figure 14. Zero crossing detector (single power supply)****Figure 15. Limit comparator****Figure 16. Split-supply applications - zero crossing detector****Figure 17. Crystal controlled oscillator****Figure 18. Comparator with a negative reference**

Figure 19. Time delay generator

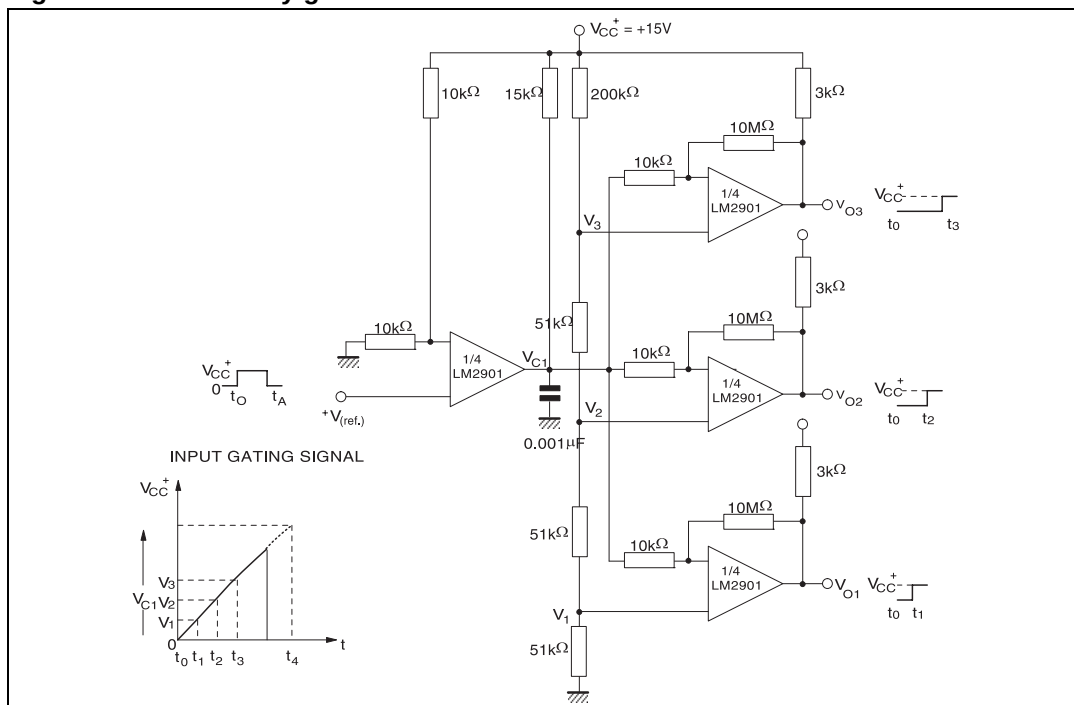
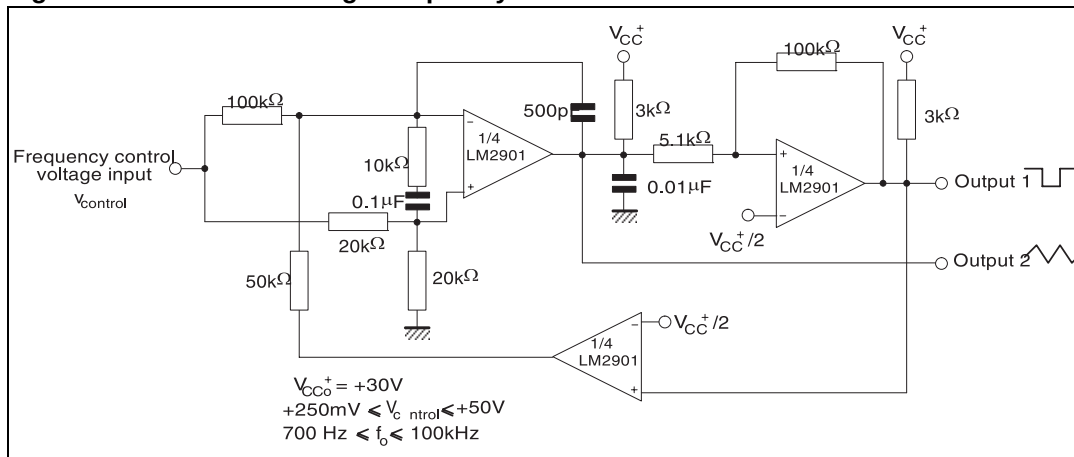


Figure 20. Two-decade high-frequency VCO



## 5 Package information

In order to meet environmental requirements, STMicroelectronics offers these devices in ECOPACK® packages. These packages have a lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an STMicroelectronics trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com).

### 5.1 DIP14 package information

Figure 21. DIP14 package mechanical drawing

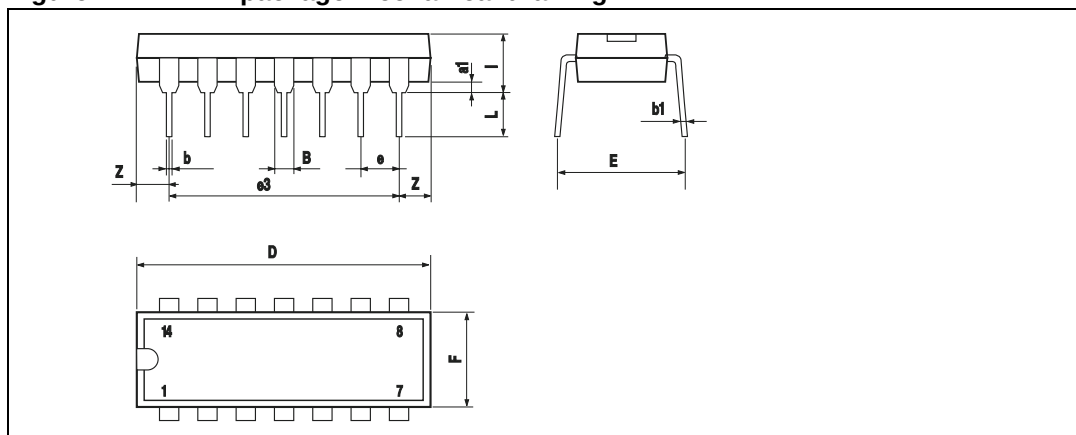


Table 4. DIP14 package mechanical data

| Ref. | Dimensions  |       |      |        |       |       |
|------|-------------|-------|------|--------|-------|-------|
|      | Millimeters |       |      | Inches |       |       |
|      | Min.        | Typ.  | Max. | Min.   | Typ.  | Max.  |
| a1   | 0.51        |       |      | 0.020  |       |       |
| B    | 1.39        |       | 1.65 | 0.055  |       | 0.065 |
| b    |             | 0.5   |      |        | 0.020 |       |
| b1   |             | 0.25  |      |        | 0.010 |       |
| D    |             |       | 20   |        |       | 0.787 |
| E    |             | 8.5   |      |        | 0.335 |       |
| e    |             | 2.54  |      |        | 0.100 |       |
| e3   |             | 15.24 |      |        | 0.600 |       |
| F    |             |       | 7.1  |        |       | 0.280 |
| l    |             |       | 5.1  |        |       | 0.201 |
| L    |             | 3.3   |      |        | 0.130 |       |
| Z    | 1.27        |       | 2.54 | 0.050  |       | 0.100 |

## 5.2 SO-14 package information

Figure 22. SO-14 package mechanical drawing

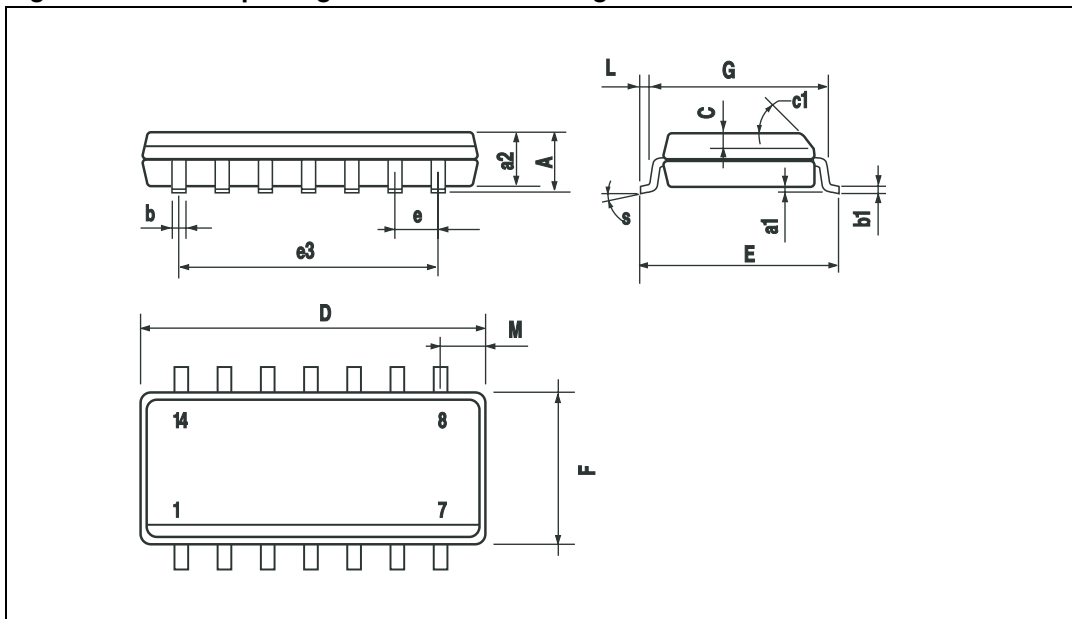


Table 5. SO-14 package mechanical data

| Ref. | Dimensions  |      |      |        |       |       |
|------|-------------|------|------|--------|-------|-------|
|      | Millimeters |      |      | Inches |       |       |
|      | Min.        | Typ. | Max. | Min.   | Typ.  | Max.  |
| A    |             |      | 1.75 |        |       | 0.068 |
| a1   | 0.1         |      | 0.2  | 0.003  |       | 0.007 |
| a2   |             |      | 1.65 |        |       | 0.064 |
| b    | 0.35        |      | 0.46 | 0.013  |       | 0.018 |
| b1   | 0.19        |      | 0.25 | 0.007  |       | 0.010 |
| C    |             | 0.5  |      |        | 0.019 |       |
| c1   | 45° (typ.)  |      |      |        |       |       |
| D    | 8.55        |      | 8.75 | 0.336  |       | 0.344 |
| E    | 5.8         |      | 6.2  | 0.228  |       | 0.244 |
| e    |             | 1.27 |      |        | 0.050 |       |
| e3   |             | 7.62 |      |        | 0.300 |       |
| F    | 3.8         |      | 4.0  | 0.149  |       | 0.157 |
| G    | 4.6         |      | 5.3  | 0.181  |       | 0.208 |
| L    | 0.5         |      | 1.27 | 0.019  |       | 0.050 |
| M    |             |      | 0.68 |        |       | 0.026 |
| S    | 8° (max.)   |      |      |        |       |       |

### 5.3 TSSOP14 package information

Figure 23. TSSOP14 package mechanical drawing

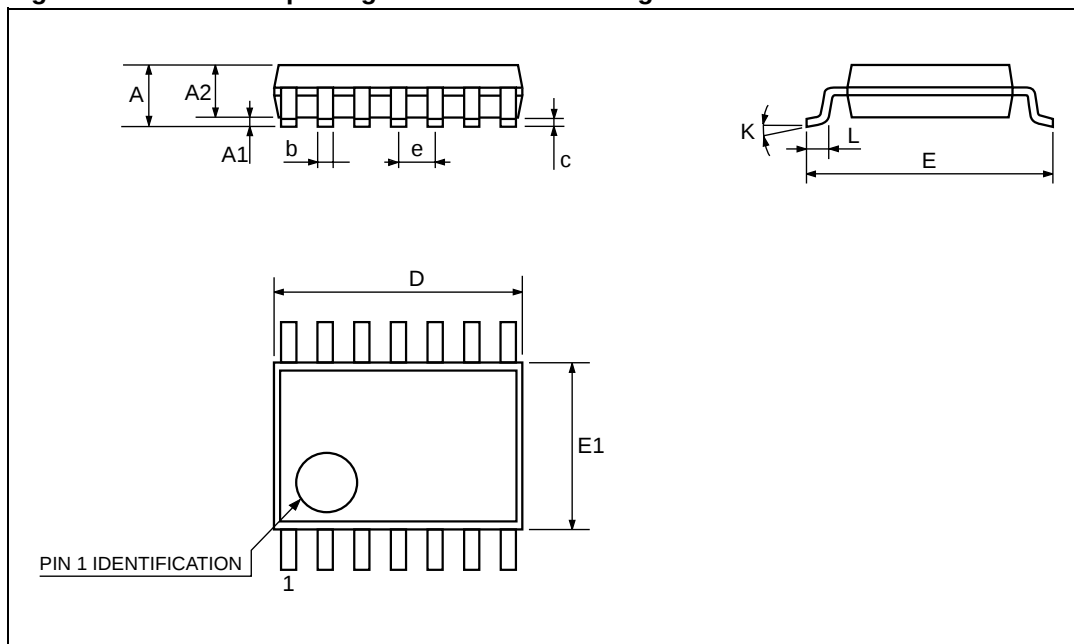


Table 6. TSSOP14 package mechanical data

| Ref. | Dimensions  |          |      |        |            |        |
|------|-------------|----------|------|--------|------------|--------|
|      | Millimeters |          |      | Inches |            |        |
|      | Min.        | Typ.     | Max. | Min.   | Typ.       | Max.   |
| A    |             |          | 1.2  |        |            | 0.047  |
| A1   | 0.05        |          | 0.15 | 0.002  | 0.004      | 0.006  |
| A2   | 0.8         | 1        | 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    | 4.9         | 5        | 5.1  | 0.193  | 0.197      | 0.201  |
| E    | 6.2         | 6.4      | 6.6  | 0.244  | 0.252      | 0.260  |
| E1   | 4.3         | 4.4      | 4.48 | 0.169  | 0.173      | 0.176  |
| e    |             | 0.65 BSC |      |        | 0.0256 BSC |        |
| K    | 0°          |          | 8°   | 0°     |            | 8°     |
| L1   | 0.45        | 0.60     | 0.75 | 0.018  | 0.024      | 0.030  |

## 6 Ordering information

**Table 7. Order codes**

| Order code               | Temperature range             | Package                     | Packing             | Marking |
|--------------------------|-------------------------------|-----------------------------|---------------------|---------|
| LM2901N                  | -40°C to +125°C               | DIP14                       | Tube                | LM2901N |
| LM2901D                  |                               | SO-14                       | Tube or tape & reel | 2901    |
| LM2901DT                 |                               |                             |                     |         |
| LM2901PT                 |                               | TSSOP14                     | Tape & reel         | 2901Y   |
| LM2901YD <sup>(1)</sup>  |                               | SO-14<br>(Automotive grade) | Tube or tape & reel |         |
| LM2901YDT <sup>(1)</sup> |                               |                             |                     |         |
| LM2901YPT <sup>(2)</sup> | TSSOP14<br>(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.
2. Qualification and characterization according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 & Q 002 or equivalent are on-going.

## 7 Revision history

**Table 8. Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                                                                                     |
|-------------|----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Jan-2002    | 1        | Initial release.                                                                                                                                                                                                                                                                                                                                                                            |
| Jul-2005    | 2        | 1 - PPAP references inserted in the datasheet see <a href="#">Table : Order codes on page 1</a> .<br>2 - ESD protection inserted in <a href="#">Table 1 on page 3</a> .                                                                                                                                                                                                                     |
| Oct-2005    | 3        | The following changes were made in this revision:<br>– PPAP part number added in table <a href="#">Order codes on page 1</a> .<br>– Formatting changes throughout.                                                                                                                                                                                                                          |
| 18-Jul-2006 | 4        | ESD HBM value corrected in <a href="#">Table 1 on page 3</a> .                                                                                                                                                                                                                                                                                                                              |
| 19-Dec-2007 | 5        | Added $R_{thja}$ and $R_{thjc}$ parameters to <a href="#">Table 1: Absolute maximum ratings</a> . Added footnotes for ESD parameters.<br>Removed $V_{icm}$ parameter from electrical characteristics in <a href="#">Table 3</a> .<br>Reformatted package information in <a href="#">Section 5</a> .<br>Added footnotes for automotive grade parts in <a href="#">Table 7: Order codes</a> . |

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