



## Low power quad operational amplifier

### Features

- Wide gain bandwidth: 1.3MHz
- Input common-mode voltage range includes negative rail
- Large voltage gain: 100dB
- Very low supply current per amp: 375 $\mu$ A
- Low input bias current: 20nA
- Low input offset current: 2nA
- Wide power supply range:
  - Single supply: +3V to +30V
  - Dual supplies:  $\pm$ 1.5V to  $\pm$ 15V

### Description

This circuit consists of four independent, high gain, internally frequency compensated operational amplifiers designed especially for automotive and industrial control systems.

It operates from a single power supply over a wide range of voltages. Operation from split power supplies is also possible and the low power supply current drain is independent of the magnitude of the power supply voltage.



**N**  
**DIP14**  
(Plastic package)



**D**  
**SO-14**  
(Plastic micropackage)



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

# 1 Schematic diagram

Figure 1. Schematic diagram (1/4 LM2902)

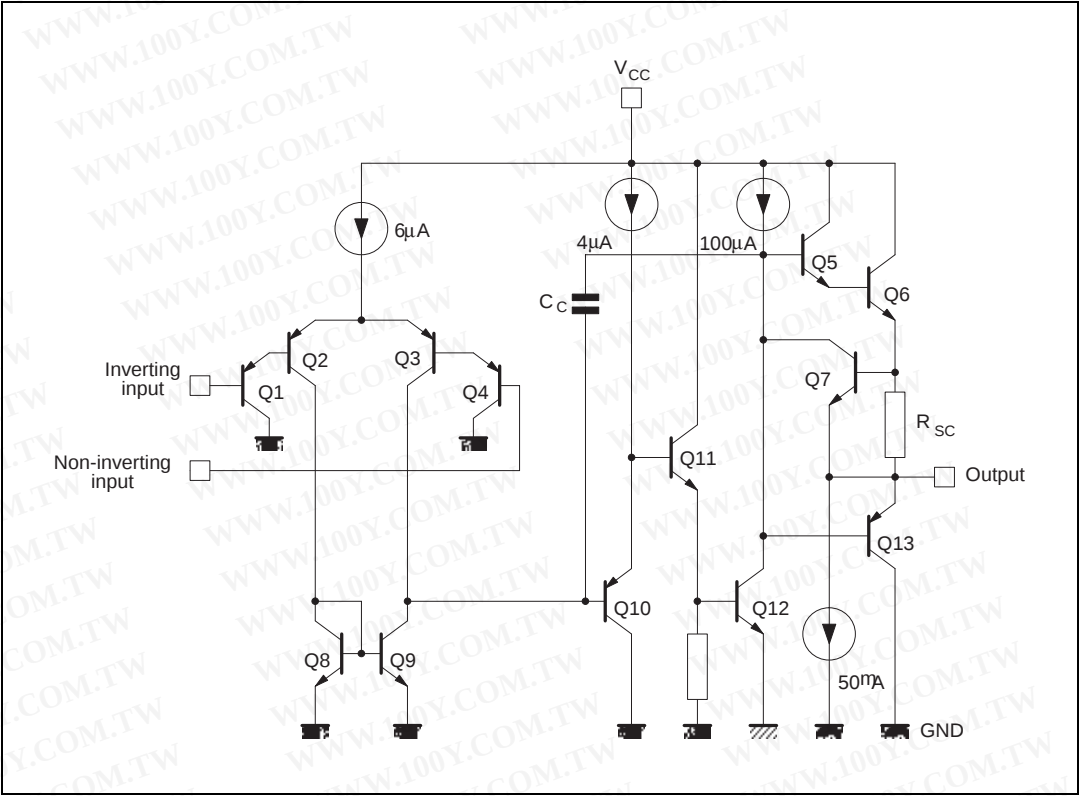
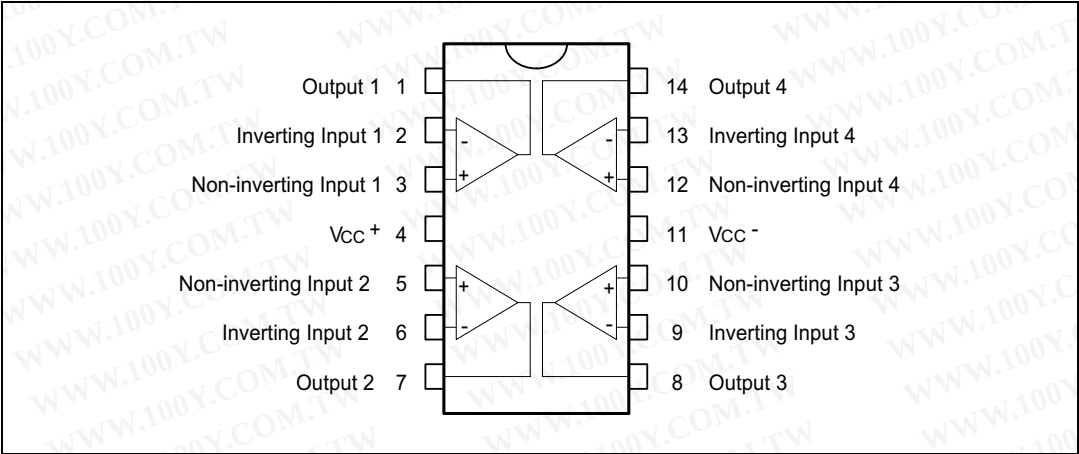


Figure 2. Pin connections (top view)



## 2 Absolute maximum ratings

Table 1. Absolute maximum ratings (AMR)

| Symbol     | Parameter                                                                          | Value            | Unit |
|------------|------------------------------------------------------------------------------------|------------------|------|
| $V_{CC}$   | Supply voltage <sup>(1)</sup>                                                      | $\pm 16$ to 33   | V    |
| $V_{id}$   | Differential input voltage <sup>(2)</sup>                                          | +32              | V    |
| $V_{in}$   | Input voltage                                                                      | -0.3 to +32      | V    |
|            | Output short-circuit duration <sup>(3)</sup>                                       | Infinite         | s    |
| $T_j$      | Maximum junction temperature                                                       | 150              | °C   |
| $I_{in}$   | Input current <sup>(4)</sup>                                                       | 50               | mA   |
| $T_{stg}$  | Storage temperature range                                                          | -65 to +150      | °C   |
| $R_{thja}$ | Thermal resistance junction to ambient <sup>(5)</sup><br>SO-14<br>TSSOP14<br>DIP14 | 105<br>100<br>80 | °C/W |
| $R_{thjc}$ | Thermal resistance junction to case <sup>(5)</sup><br>SO-14<br>TSSOP14<br>DIP14    | 31<br>32<br>33   | °C/W |
| ESD        | HBM: human body model <sup>(6)</sup>                                               | 370              | V    |
|            | MM: machine model <sup>(7)</sup>                                                   | 150              | V    |
|            | CDM: charged device model <sup>(8)</sup>                                           | 1500             | V    |

1. All voltage 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. Short-circuit 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  $V_{CC}^+$ .
4. This input current only exists when the voltage at any of the input leads is driven negative. It is due to the collector-base junction of the input PNP transistor becoming forward biased and thereby acting as input diodes clamps. In addition to this diode action, there is also NPN parasitic action on the IC chip. This transistor action can cause the output voltages of the op-amps to go to the  $V_{CC}$  voltage level (or to ground for a large overdrive) for the time duration than an input is driven negative. This is not destructive and normal output will set up again for input voltage higher than -0.3V.
5.  $R_{thja/c}$  are typical values.
6. 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.
7. 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.
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.

### 3 Operating conditions

Table 2. Operating conditions

| Symbol     | Parameter                                                              | Value                                  | Unit |
|------------|------------------------------------------------------------------------|----------------------------------------|------|
| $V_{CC}$   | Supply voltage                                                         | 3 to 30                                | V    |
| $V_{icm}$  | Common mode input voltage range<br>$T_{min} \leq T_{amb} \leq T_{max}$ | $V_{CC}^{+} - 1.5$<br>$V_{CC}^{+} - 2$ | V    |
| $T_{oper}$ | Operating free-air temperature range                                   | -40 to +125                            | °C   |

## 4 Electrical characteristics

**Table 3.**  $V_{CC}^+ = 5V$ ,  $V_{CC}^- = \text{Ground}$ ,  $V_O = 1.4V$ ,  $T_{\text{amb}} = 25^\circ\text{C}$  (unless otherwise specified)

| Symbol            | Parameter                                                                                                                                                                                                                                                                      | Min.                             | Typ.                         | Max.                     | Unit                         |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------|------------------------------|--------------------------|------------------------------|
| $V_{io}$          | Input offset voltage <sup>(1)</sup><br>$T_{\min} \leq T_{\text{amb}} \leq T_{\max}$                                                                                                                                                                                            |                                  | 2                            | 7<br>9                   | mV                           |
| $DV_{io}$         | Input offset voltage drift                                                                                                                                                                                                                                                     |                                  | 7                            | 30                       | $\mu\text{V}/^\circ\text{C}$ |
| $I_{io}$          | Input offset current<br>$T_{\min} \leq T_{\text{amb}} \leq T_{\max}$                                                                                                                                                                                                           |                                  | 2                            | 30<br>40                 | nA                           |
| $DI_{io}$         | Input offset current drift                                                                                                                                                                                                                                                     |                                  | 10                           | 200                      | $\text{pA}/^\circ\text{C}$   |
| $I_{ib}$          | Input bias current <sup>(2)</sup><br>$T_{\min} \leq T_{\text{amb}} \leq T_{\max}$                                                                                                                                                                                              |                                  | 20                           | 150<br>300               | nA                           |
| $A_{vd}$          | Large signal voltage gain<br>$V_{CC}^+ = +15V$ , $R_L = 2k\Omega$ , $V_O = 1.4V$ to $11.4V$<br>$T_{\min} \leq T_{\text{amb}} \leq T_{\max}$                                                                                                                                    | 50<br>25                         | 100                          |                          | V/mV                         |
| SVR               | Supply voltage rejection ratio ( $R_S \leq 10k\Omega$ )<br>$T_{\min} \leq T_{\text{amb}} \leq T_{\max}$                                                                                                                                                                        | 65<br>65                         | 110                          |                          | dB                           |
| $I_{cc}$          | Supply current, all amps, no load<br>$V_{CC}^+ = +5V$<br>$V_{CC}^+ = +30V$<br>$T_{\min} \leq T_{\text{amb}} \leq T_{\max}$<br>$V_{CC}^+ = +5V$<br>$V_{CC}^+ = +30V$                                                                                                            |                                  | 0.7<br>1.5<br><br>0.8<br>1.5 | 1.2<br>3<br><br>1.2<br>3 | mA                           |
| CMR               | Common-mode rejection ratio ( $R_S \leq 10k\Omega$ )<br>$T_{\min} \leq T_{\text{amb}} \leq T_{\max}$                                                                                                                                                                           | 70<br>60                         | 80                           |                          | dB                           |
| $I_O$             | Output short-circuit current ( $V_{id} = +1V$ )<br>$V_{CC}^+ = +15V$ , $V_O = +2V$                                                                                                                                                                                             | 20                               | 40                           | 70                       | mA                           |
| $I_{\text{sink}}$ | Output sink current ( $V_{id} = -1V$ )<br>$V_{CC}^+ = +15V$ , $V_O = +2V$<br>$V_{CC}^+ = +15V$ , $V_O = +0.2V$                                                                                                                                                                 | 10<br>12                         | 20<br>50                     |                          | mA<br>$\mu\text{A}$          |
| $V_{OH}$          | High level output voltage<br>$V_{CC}^+ = +30V$<br>$R_L = 2k\Omega$<br>$T_{\min} \leq T_{\text{amb}} \leq T_{\max}$<br>$R_L = 10k\Omega$<br>$T_{\min} \leq T_{\text{amb}} \leq T_{\max}$<br>$V_{CC}^+ = +5V$ , $R_L = 2k\Omega$<br>$T_{\min} \leq T_{\text{amb}} \leq T_{\max}$ | 26<br>26<br>27<br>27<br>3<br>3.5 | 27<br><br>28                 |                          | V                            |
| $V_{OL}$          | Low level output voltage ( $R_L = 10k\Omega$ )<br>$T_{\min} \leq T_{\text{amb}} \leq T_{\max}$                                                                                                                                                                                 |                                  | 5                            | 20<br>20                 | mV                           |
| SR                | Slew rate<br>$V_{CC}^+ = 15V$ , $V_{in} = 0.5$ to $3V$ , $R_L = 2k\Omega$ , $C_L = 100\text{pF}$ , unity gain                                                                                                                                                                  |                                  | 0.4                          |                          | V/ $\mu\text{s}$             |

**Table 3.**  $V_{CC}^+ = 5V$ ,  $V_{CC}^- = \text{Ground}$ ,  $V_O = 1.4V$ ,  $T_{amb} = 25^\circ C$  (unless otherwise specified)

| Symbol          | Parameter                                                                                                                         | Min. | Typ.  | Max. | Unit                   |
|-----------------|-----------------------------------------------------------------------------------------------------------------------------------|------|-------|------|------------------------|
| GBP             | Gain bandwidth product<br>$V_{CC}^+ = 30V$ , $V_{in} = 10mV$ , $R_L = 2k\Omega$ , $C_L = 100pF$                                   |      | 1.3   |      | MHz                    |
| THD             | Total harmonic distortion<br>$f = 1kHz$ , $A_V = 20dB$ , $R_L = 2k\Omega$ , $V_O = 2V_{pp}$ ,<br>$C_L = 100pF$ , $V_{CC}^+ = 30V$ |      | 0.015 |      | %                      |
| $e_n$           | Equivalent input noise voltage<br>$f = 1kHz$ , $R_S = 100\Omega$ , $V_{CC}^+ = 30V$                                               |      | 40    |      | $\frac{nV}{\sqrt{Hz}}$ |
| $V_{O1}/V_{O2}$ | Channel separation <sup>(3)</sup><br>$1kHz \leq f \leq 20kHz$                                                                     |      | 120   |      | dB                     |

- $V_O = 1.4V$ ,  $R_S = 0\Omega$ ,  $5V < V_{CC}^+ < 30V$ ,  $0V < V_{ic} < V_{CC}^+ - 1.5V$ .
- The direction of the input current is out of the IC. This current is essentially constant, independent of the state of the output, so there is no change in the loading charge on the input lines.
- Due to the proximity of external components ensure stray capacitance does not cause coupling between these external parts. This typically can be detected as this type of capacitance increases at higher frequencies.

Figure 3. Input bias current vs.  $T_{amb}$

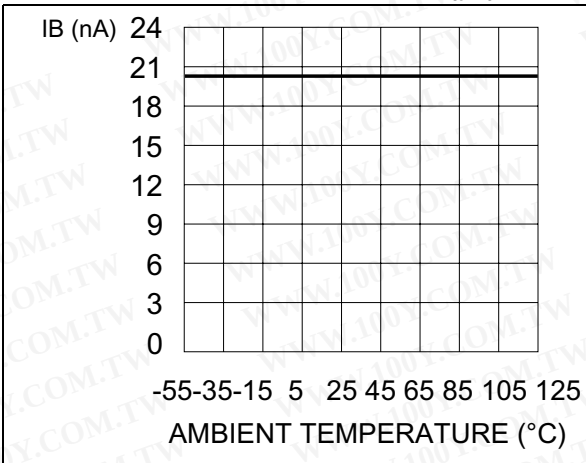


Figure 4. Input voltage range

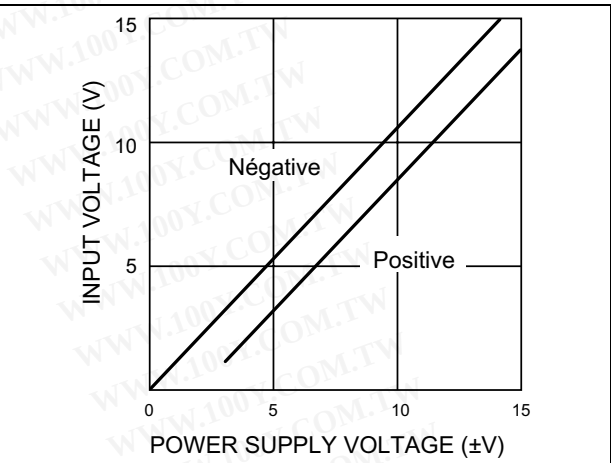


Figure 5. Current limiting

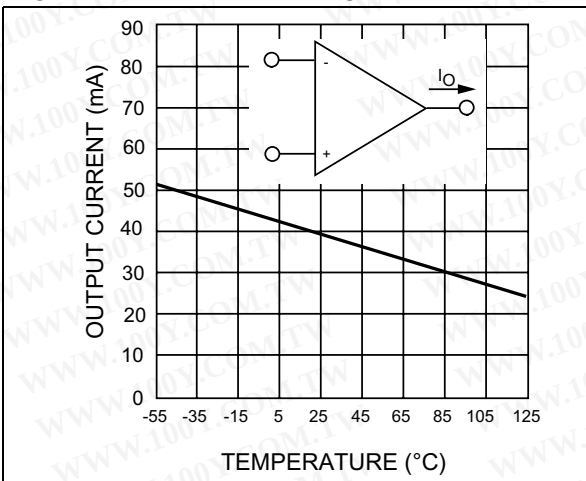


Figure 6. Supply current

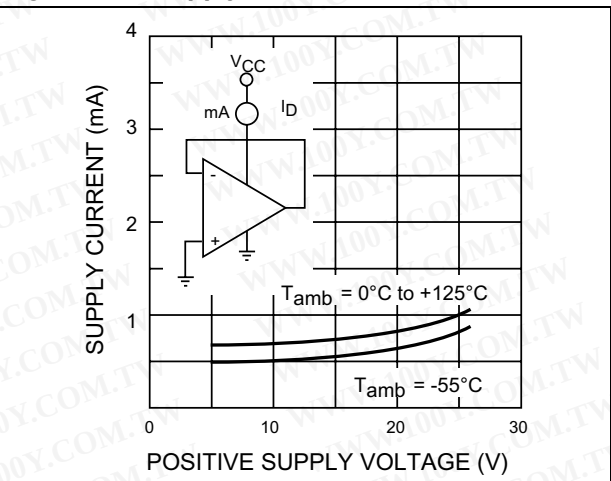


Figure 7. Gain bandwidth product

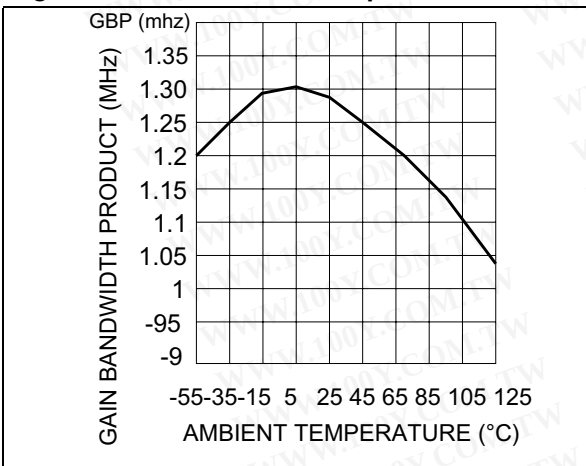


Figure 8. Voltage follower pulse response

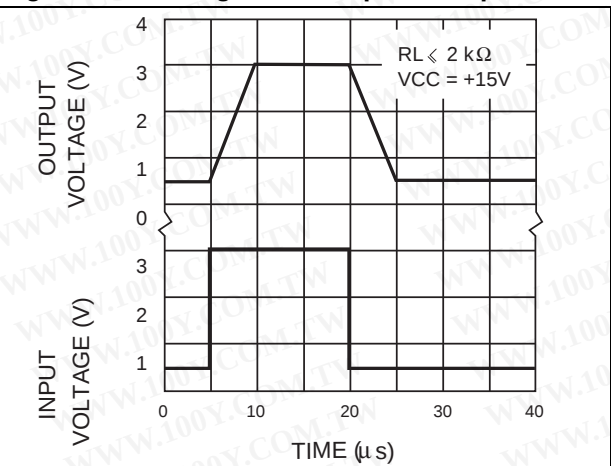


Figure 9. Common mode rejection ratio

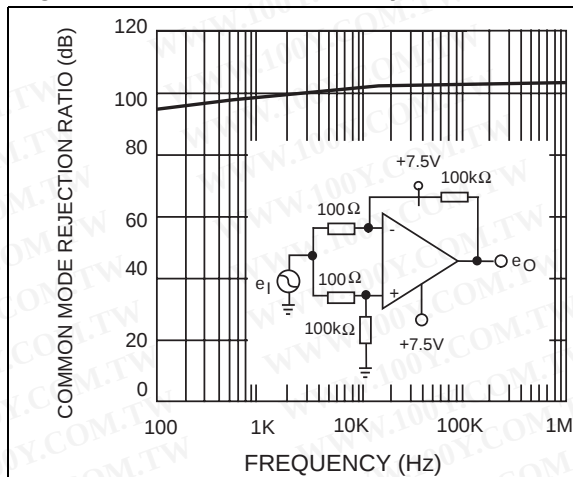


Figure 10. Output characteristics

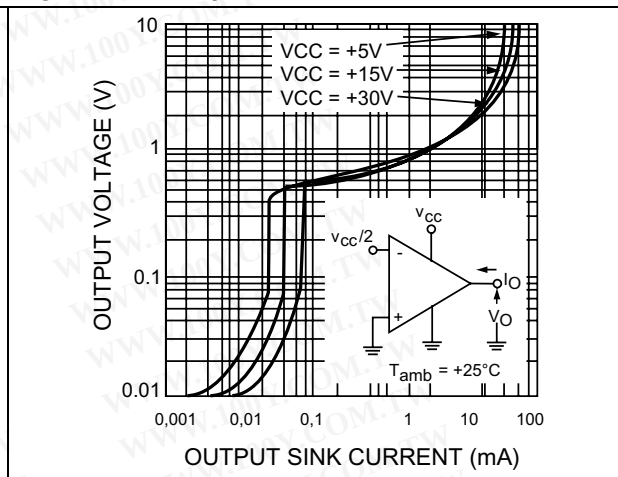


Figure 11. Open loop frequency response

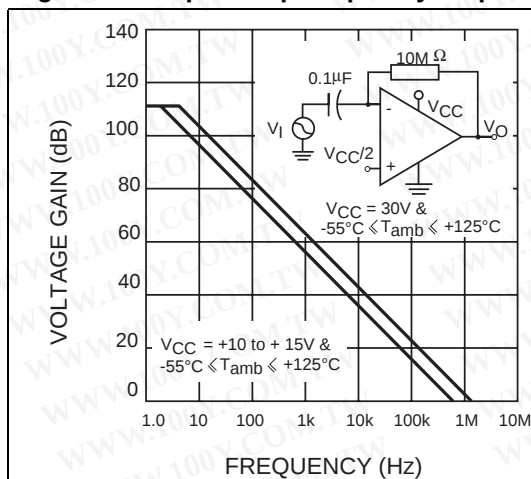


Figure 12. Voltage follower pulse response

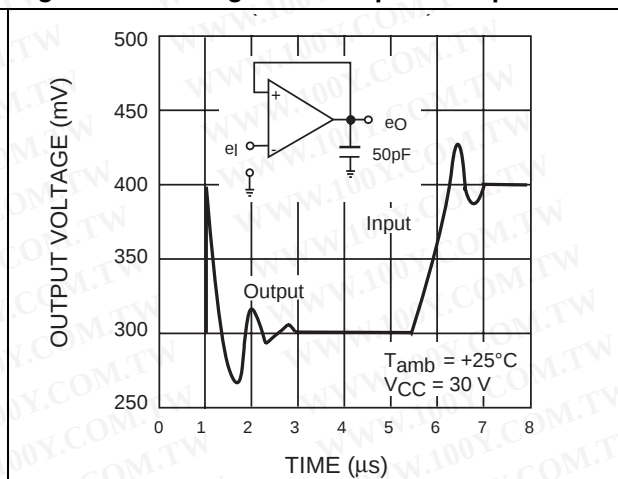


Figure 13. Large signal frequency response

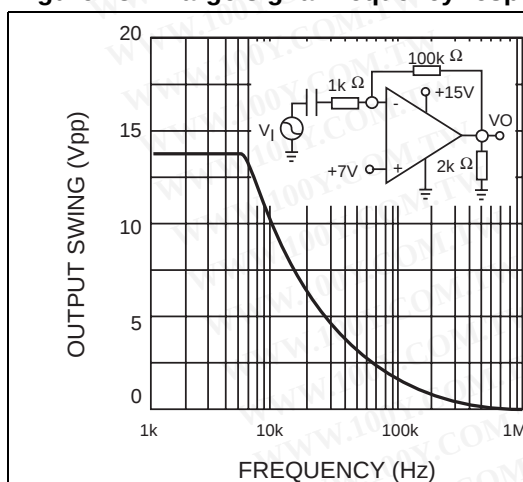


Figure 14. Output characteristics

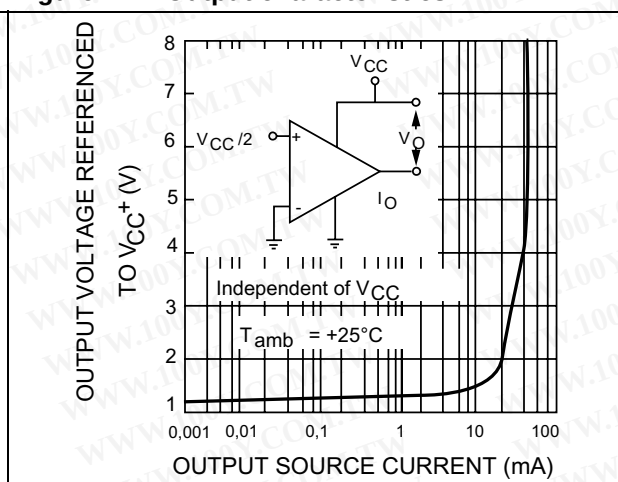


Figure 15. Input current

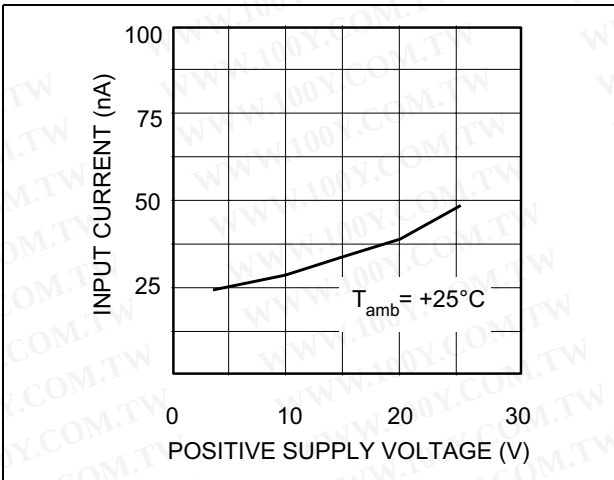


Figure 16. Voltage gain

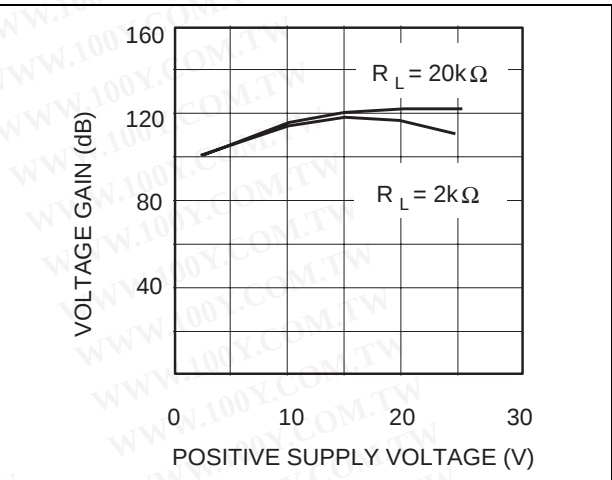


Figure 17. Power supply and common mode rejection ratio

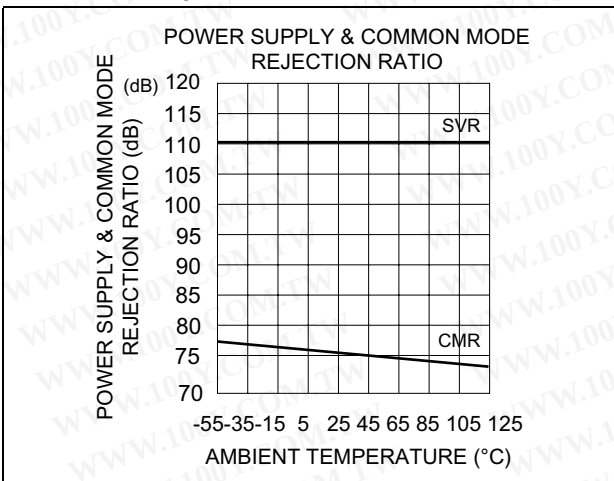
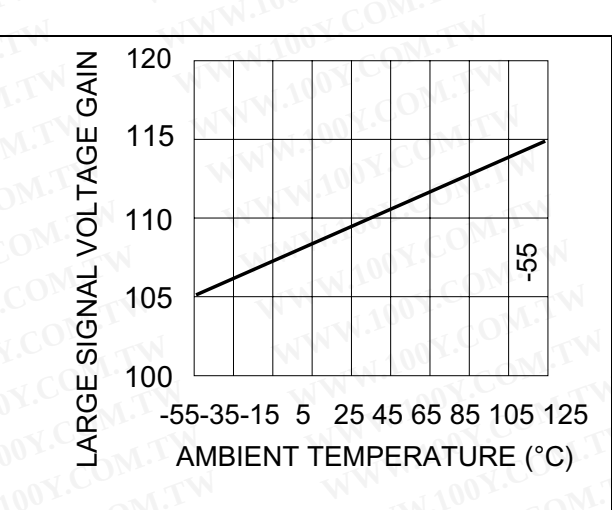


Figure 18. Large signal voltage gain



## 5 Typical single-supply applications

Figure 19. AC coupled inverting amplifier

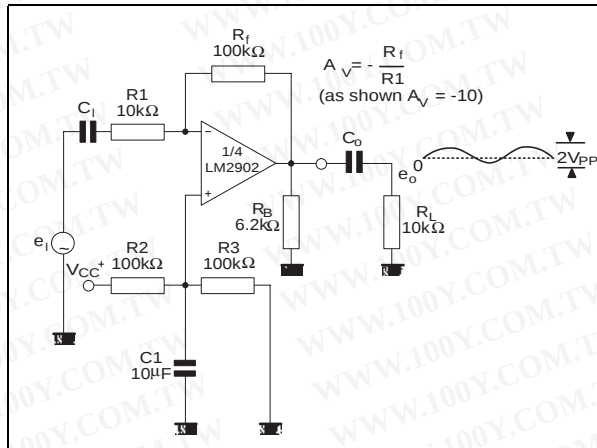


Figure 20. AC coupled non-inverting amplifier

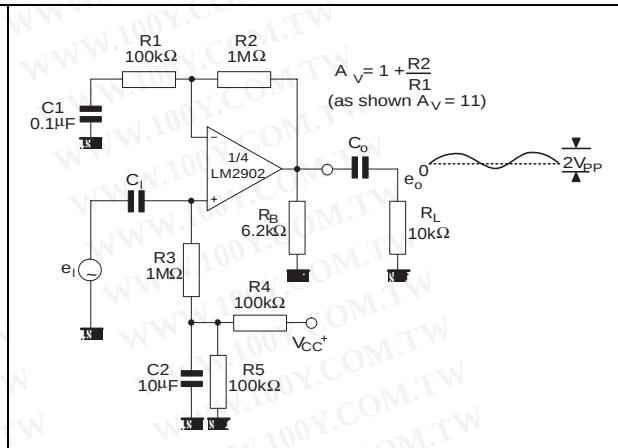


Figure 21. Non-inverting DC gain

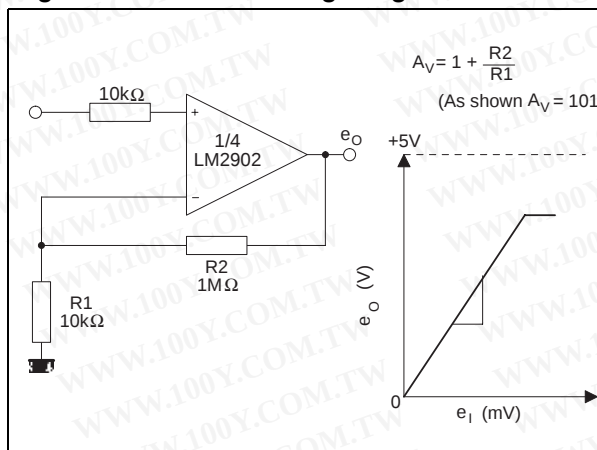


Figure 22. DC summing amplifier

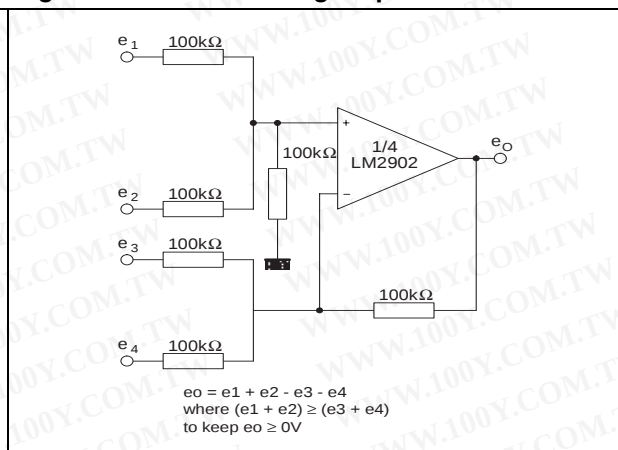


Figure 23. Active bandpass filter

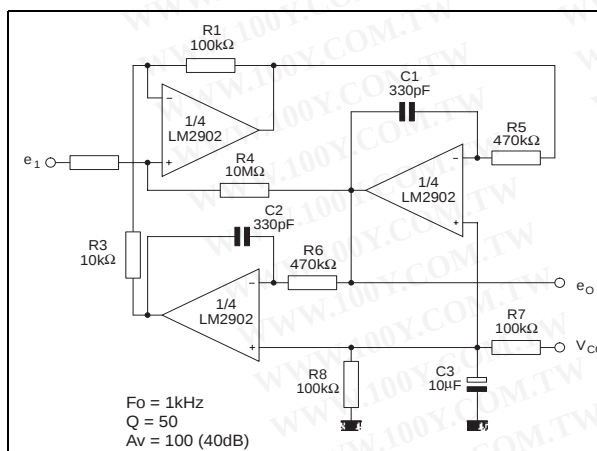
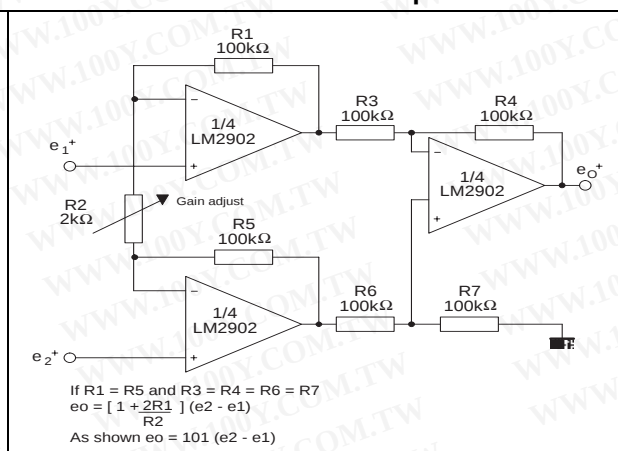
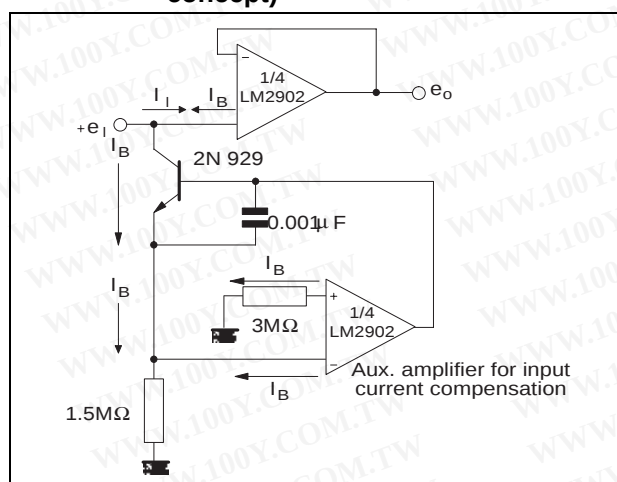
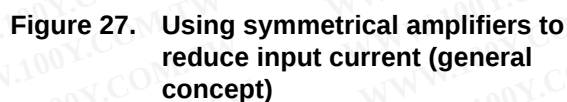


Figure 24. High input Z adjustable gain DC instrumentation amplifier



**Figure 26. Low drift peak detector**



## 6 Package information

In order to meet environmental requirements, ST 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 ST trademark. ECOPACK specifications are available at: [www.st.com](http://www.st.com).

### 6.1 DIP14 package information

Figure 28. DIP14 package mechanical drawing

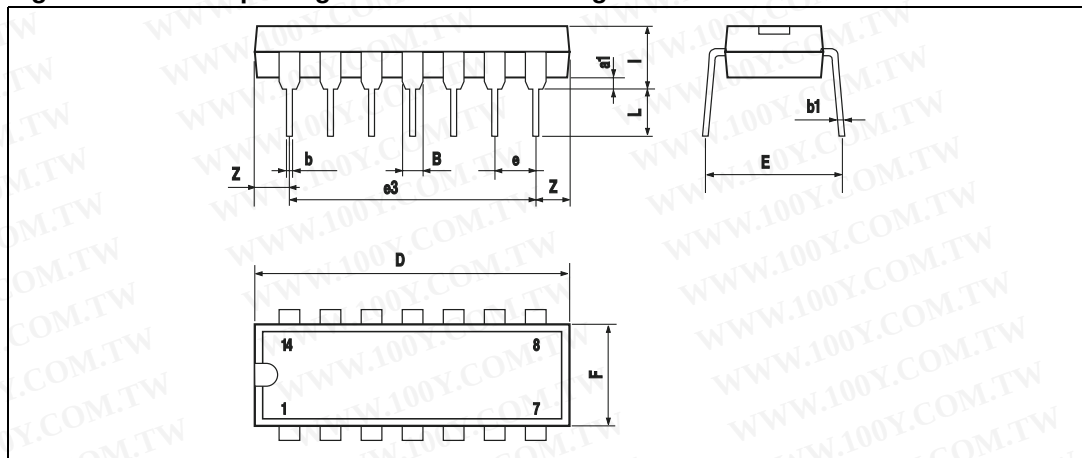


Table 4. DIP14 package mechanical data

| Ref. | 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 |
| I    |             |       | 5.1  |        |       | 0.201 |
| L    |             | 3.3   |      |        | 0.130 |       |
| Z    | 1.27        |       | 2.54 | 0.050  |       | 0.100 |

## 6.2 SO-14 package information

Figure 29. SO-14 package mechanical drawing

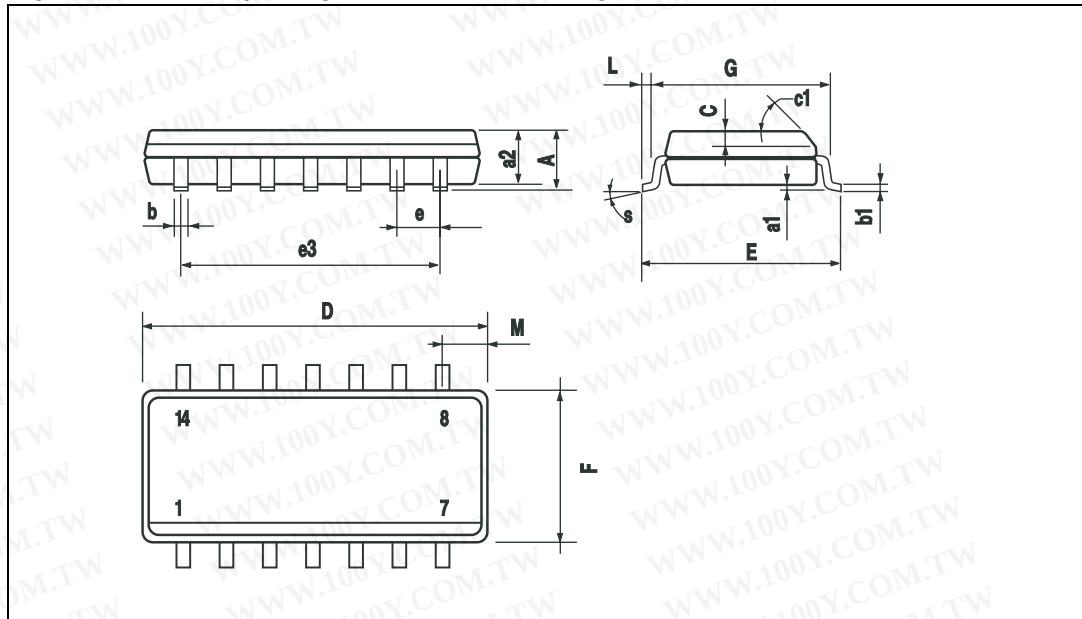


Table 5. SO-14 package mechanical data

| 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.)   |      |      |        |       |       |

### 6.3 TSSOP14 package information

Figure 30. TSSOP14 package mechanical drawing

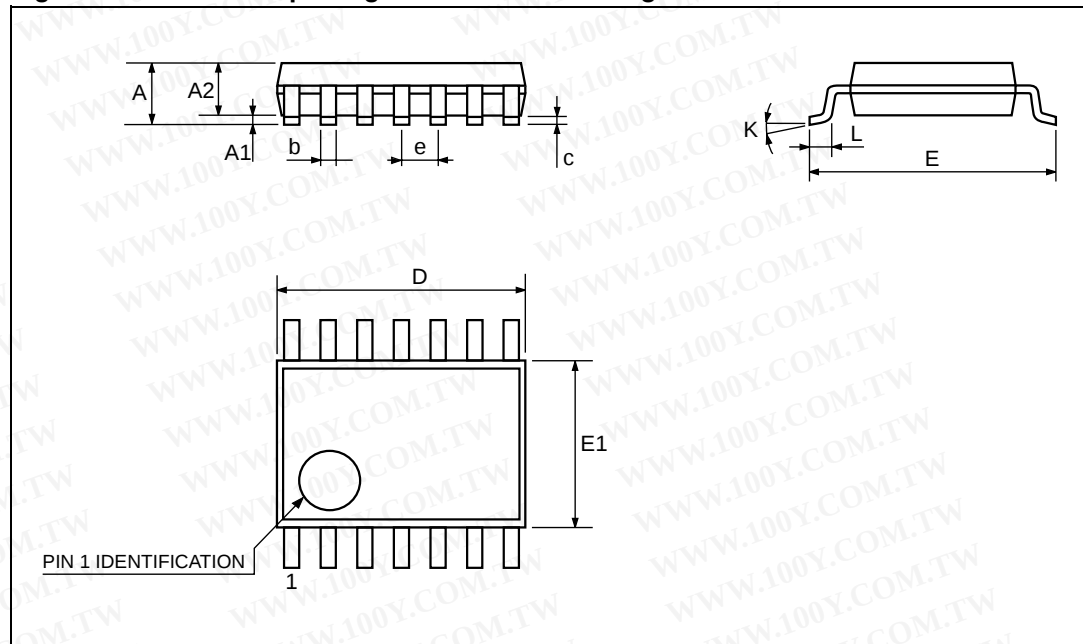


Table 6. TSSOP14 package mechanical data

| 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  |

## 7 Ordering information

**Table 7. Order codes**

| Order code                                          | Temperature range | Package                                  | Packing                | Marking |
|-----------------------------------------------------|-------------------|------------------------------------------|------------------------|---------|
| LM2902N                                             | -40°C, +125°C     | DIP14                                    | Tube                   | LM2902N |
| LM2902D<br>LM2902DT                                 |                   | SO-14                                    | Tube or<br>tape & reel | 2902    |
| LM2902PT                                            |                   | TSSOP14<br>(Thin shrink outline package) | Tape & reel            |         |
| LM2902YD <sup>(1)</sup><br>LM2902YDT <sup>(1)</sup> |                   | SO-14<br>(Automotive grade level)        | Tube or<br>tape & reel | 2902Y   |
| LM2902YPT <sup>(2)</sup>                            |                   | TSSOP14<br>(Automotive grade level)      | 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.

## 8 Revision history

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-------------|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 30-Nov-2001 | 1        | Initial release.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
| 1-Jul-2005  | 2        | PPAP references inserted in the datasheet, see <a href="#">Table 7: Order codes</a> .<br>ESD protection inserted in <a href="#">Table 1 on page 3</a> .                                                                                                                                                                                                                                                                                                                                               |
| 31-Oct-2005 | 3        | An error in the device description was corrected on page 1.<br>PPAP reference inserted in the datasheet see <a href="#">Table 7: Order codes</a> .<br>Minor grammatical and formatting changes throughout.                                                                                                                                                                                                                                                                                            |
| 18-Jun-2007 | 4        | Values for thermal resistance junction to ambient and ESD HBM corrected in <a href="#">Table 1: Absolute maximum ratings (AMR)</a> .<br>Values for thermal resistance junction to case added in <a href="#">Table 1: Absolute maximum ratings (AMR)</a> .<br><a href="#">Table 2: Operating conditions</a> added.<br>Electrical characteristics figure captions updated.<br><a href="#">Section 6: Package information</a> updated.<br><a href="#">Table 7: Order codes</a> moved to end of document. |
| 18-Dec-2007 | 5        | Removed power dissipation parameter from AMR table and added maximum junction temperature.<br>Updated footnotes for automotive grade order codes.<br>Updated format of package information.                                                                                                                                                                                                                                                                                                           |

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