



# LM139, LM239, LM339

## Low-power quad voltage comparators

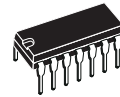
### Features

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

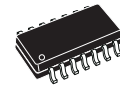
### Description

This family of devices consists of four independent precision-voltage comparators with an offset voltage specification as low as 2 mV maximum for LM339A, LM239A and LM139A. Each comparator has been designed specifically to operate from a single power supply over a wide range of voltages. Operation from split power supplies is also possible.

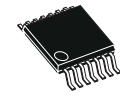
These comparators also have a unique characteristic in that the input common mode voltage range includes ground even though operated from a single power supply voltage.



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



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



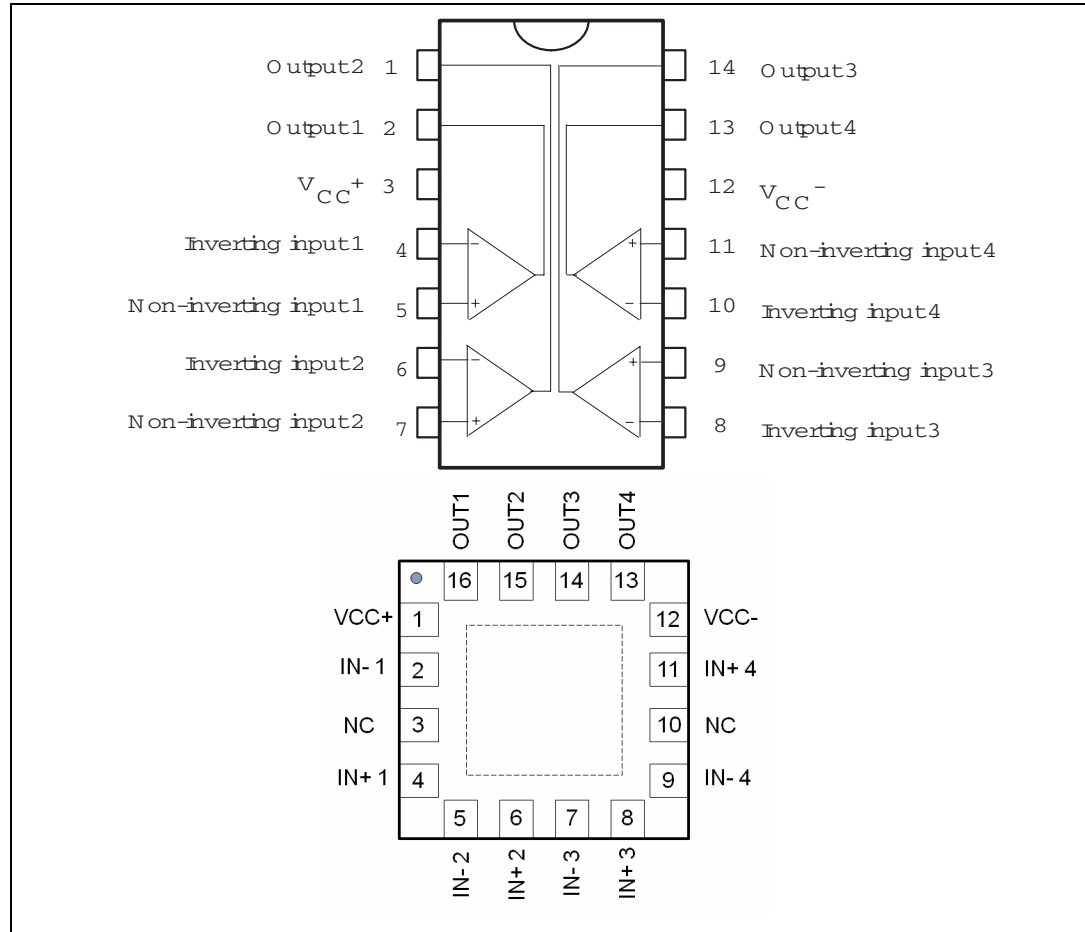
**P**  
**TSSOP14**  
(Thin shrink small outline package)



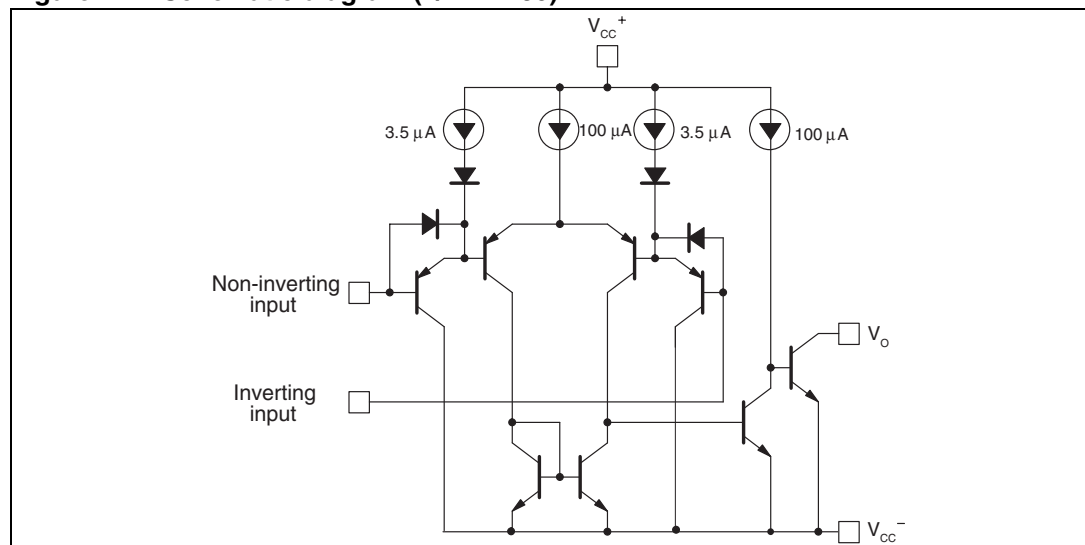
**Q**  
**QFN16 3x3**  
(Plastic micropackage)

## 1 Pin and schematic diagram

**Figure 1. Pin connections (top view)**



**Figure 2. Schematic diagram (1/4 LM139)**



## 2 Absolute maximum ratings and operating conditions

**Table 1. Absolute maximum ratings**

| Symbol     | Parameter                                                                                       | Value                  | Unit                        |
|------------|-------------------------------------------------------------------------------------------------|------------------------|-----------------------------|
| $V_{CC}$   | Supply voltage                                                                                  | $\pm 18$ or 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>                                                   | Infinite               |                             |
| $R_{thja}$ | Thermal resistance junction to ambient <sup>(2)</sup><br>DIP14<br>SO-14<br>TSSOP14<br>QFN16 3x3 | 80<br>105<br>100<br>45 | $^{\circ}\text{C}/\text{W}$ |
| $R_{thjc}$ | Thermal resistance junction to case <sup>(2)</sup><br>DIP14<br>SO-14<br>TSSOP14<br>QFN16 3x3    | 33<br>31<br>32<br>14   | $^{\circ}\text{C}/\text{W}$ |
| $T_{stg}$  | Storage temperature range                                                                       | -65 to +150            | $^{\circ}\text{C}$          |
| $T_j$      | Junction temperature                                                                            | +150                   | $^{\circ}\text{C}$          |
| $T_{LEAD}$ | Lead temperature (soldering 10 seconds)                                                         | 260                    | $^{\circ}\text{C}$          |
| ESD        | Human body model (HBM) <sup>(3)</sup>                                                           | 500                    | V                           |
|            | Machine model (MM) <sup>(4)</sup>                                                               | 100                    |                             |
|            | Charged device model (CDM) <sup>(5)</sup>                                                       | 1500                   |                             |

1. 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  $V_{CC}^{+}$ .
2. Short-circuits can cause excessive heating. These values are typical.
3. 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.
4. 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.
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 ( $T_{amb} = 25^{\circ}\text{C}$ )**

| 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                                                               | 0 to ( $V_{CC}^{+} - 1.5$ )      | V                  |
| $T_{oper}$ | Operating free-air temperature range<br>– LM139, LM139A<br>– LM239, LM239A<br>– LM339, LM339A | -55, +125<br>-40, +105<br>0, +70 | $^{\circ}\text{C}$ |

### 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                                                                                                                                        | LM139A - LM239A<br>LM339A |            |                                    | LM139 - LM239<br>LM339 |            |                                    | Unit                |
|-------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|------------|------------------------------------|------------------------|------------|------------------------------------|---------------------|
|                   |                                                                                                                                                  | Min.                      | Typ.       | Max.                               | Min                    | Typ.       | Max.                               |                     |
| $V_{IO}$          | Input offset voltage <sup>(1)</sup><br>$T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$                                                  |                           | 1          | 2<br>4                             |                        | 1          | 5<br>9                             | mV                  |
| $I_{IO}$          | Input offset current<br>$T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$                                                                 |                           | 3          | 25<br>100                          |                        | 5          | 50<br>150                          | nA                  |
| $I_{IB}$          | Input bias current ( $I^+$ or $I^-$ ) <sup>(2)</sup><br>$T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$                                 |                           | 25         | 100<br>300                         |                        | 25         | 250<br>400                         | nA                  |
| $A_{VD}$          | Large signal voltage gain<br>$V_{CC} = 15\text{ V}$ , $R_L = 15\text{ k}\Omega$ , $V_o = 1\text{ V}$ to $11\text{ V}$                            | 50                        | 200        |                                    | 50                     | 200        |                                    | V/mV                |
| $I_{CC}$          | Supply current (all comparators)<br>$V_{CC} = +5\text{ V}$ , no load<br>$V_{CC} = +30\text{ V}$ , no load                                        |                           | 1.1<br>1.3 | 2<br>2.5                           |                        | 1.1<br>1.3 | 2<br>2.5                           | mA                  |
| $V_{ICM}$         | Input common mode voltage range <sup>(3)</sup><br>$V_{CC} = 30\text{ V}$<br>$T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$             | 0<br>0                    |            | $V_{CC}^+ - 1.5$<br>$V_{CC}^+ - 2$ | 0<br>0                 |            | $V_{CC}^+ - 1.5$<br>$V_{CC}^+ - 2$ | V                   |
| $V_{ID}$          | Differential input voltage <sup>(4)</sup>                                                                                                        |                           |            | $V_{CC}^+$                         |                        |            | $V_{CC}^+$                         | V                   |
| $V_{OL}$          | Low level output voltage<br>$V_{ID} = -1\text{ V}$ , $I_{\text{SINK}} = 4\text{ mA}$<br>$T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$ |                           | 250        | 400<br>700                         |                        | 250        | 400<br>700                         | mV                  |
| $I_{OH}$          | High level output current<br>$V_{CC} = V_o = 30\text{ V}$ , $V_{ID} = 1\text{ V}$<br>$T_{\text{min}} \leq T_{\text{amb}} \leq T_{\text{max}}$    |                           | 0.1        | 1                                  |                        | 0.1        | 1                                  | nA<br>$\mu\text{A}$ |
| $I_{\text{SINK}}$ | Output sink current<br>$V_{ID} = 1\text{ V}$ , $V_o = 1.5\text{ V}$                                                                              | 6                         | 16         |                                    | 6                      | 16         |                                    | mA                  |
| $t_{re}$          | Response time <sup>(5)</sup><br>$R_L = 5.1\text{ k}\Omega$ connected to $V_{CC}^+$                                                               |                           | 1.3        |                                    |                        | 1.3        |                                    | $\mu\text{s}$       |

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

| Symbol           | Parameter                                                                                                                                     | LM139A - LM239A<br>LM339A |      |      | LM139 - LM239<br>LM339 |      |      | Unit |
|------------------|-----------------------------------------------------------------------------------------------------------------------------------------------|---------------------------|------|------|------------------------|------|------|------|
|                  |                                                                                                                                               | Min.                      | Typ. | Max. | Min                    | Typ. | Max. |      |
| t <sub>rel</sub> | Large signal response time<br>$R_L = 5.1\text{ k}\Omega$ connected to $V_{CC}^+$ , $e_i = \text{TTL}$ ,<br>$V_{(\text{ref})} = +1.4\text{ V}$ |                           | 300  |      |                        | 300  |      | ns   |

1. At output switch point,  $V_o \approx 1.4\text{ V}$ ,  $V_{CC}^+$  from 5 V to 30 V, and over the full 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 no loading charge exists on the reference of input lines.
3. The input common-mode voltage of either input signal voltage should not be allowed to go negative by more than 0.3 V. The upper end of the common-mode voltage range is  $V_{CC}^+ - 1.5\text{ V}$ , but either or both inputs can go to +30 V without damage.
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. The response time specified is for a 100 mV input step with 5 mV overdrive. For larger overdrive signals, 300 ns can be obtained.

# 4 Electrical characteristics curves

Figure 3. Supply current vs. supply voltage

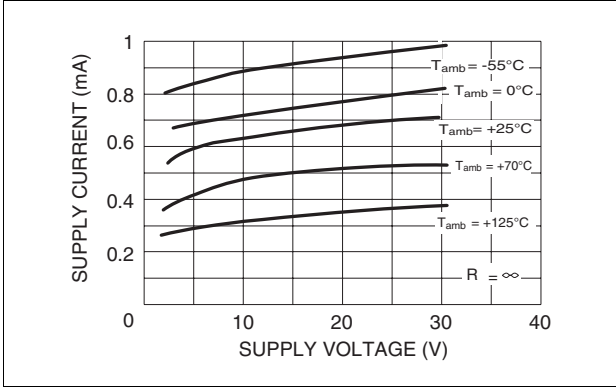


Figure 4. Input current vs. supply voltage

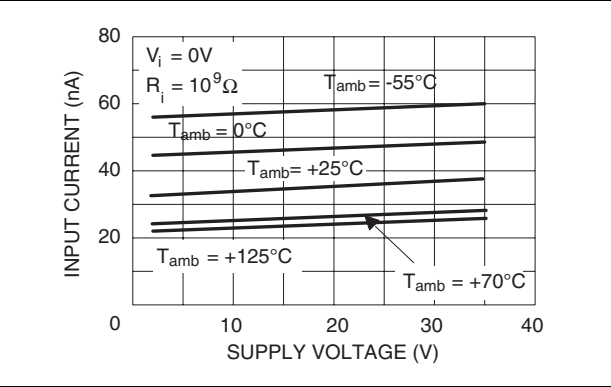


Figure 5. Output saturation voltage vs. output current

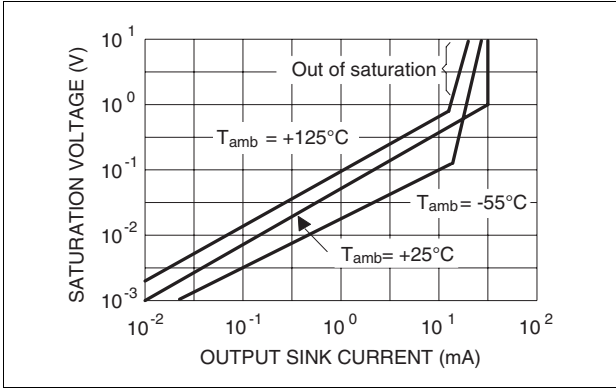


Figure 6. Response time for various input overdrives - negative transition

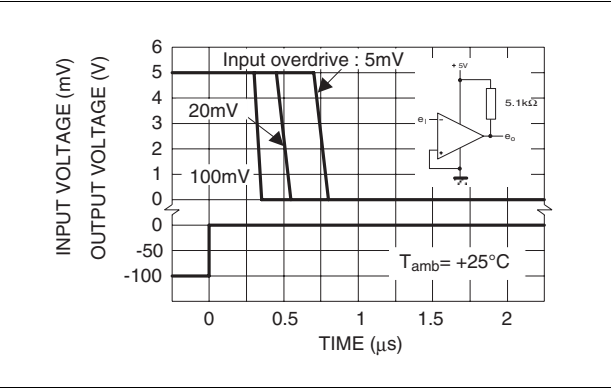
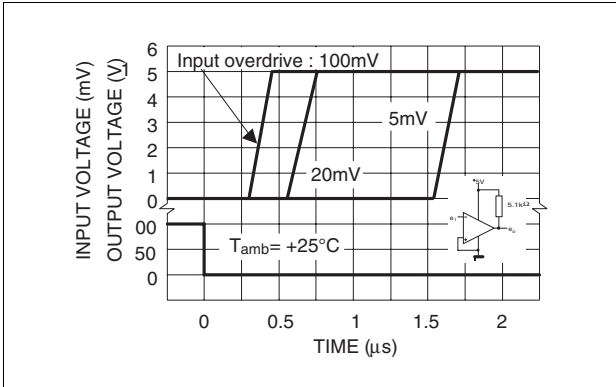


Figure 7. Response time for various input overdrives - positive transition



## 5 Typical applications

Figure 8. Basic comparator

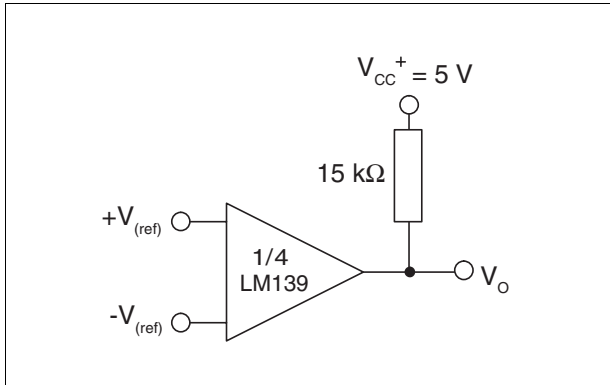


Figure 9. Driving CMOS

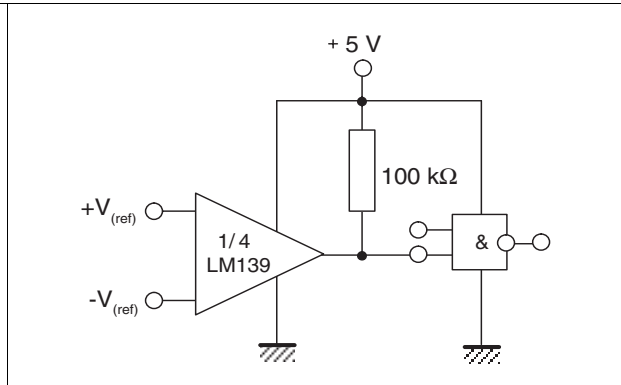


Figure 10. Driving TTL

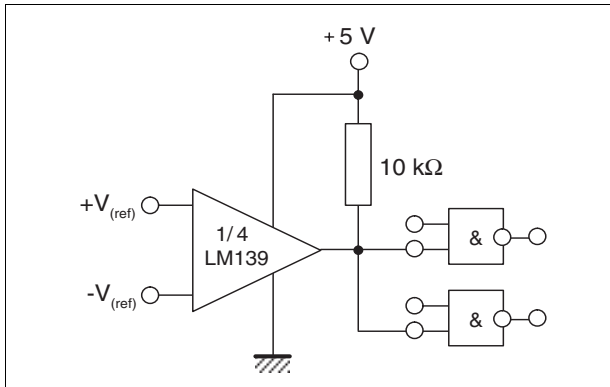


Figure 11. Low frequency op amp

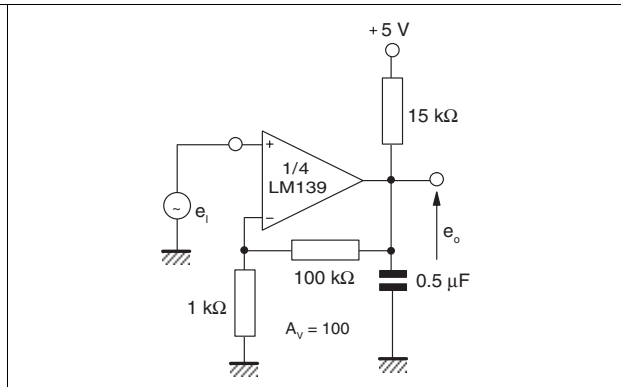


Figure 12. Low frequency op amp

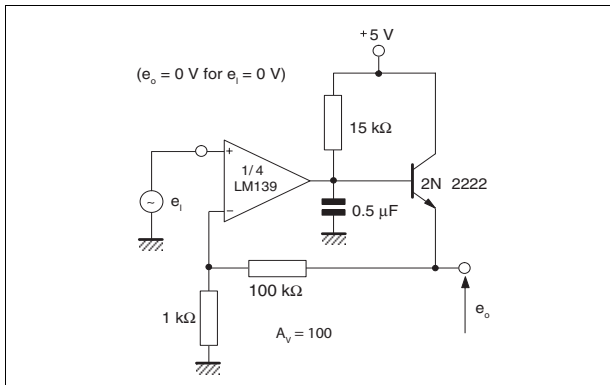


Figure 13. Transducer amplifier

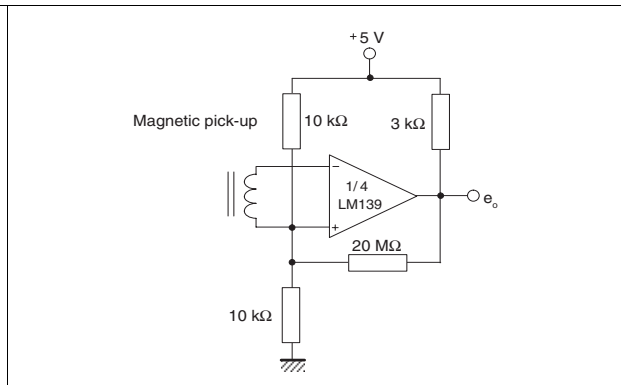


Figure 14. Time delay generator

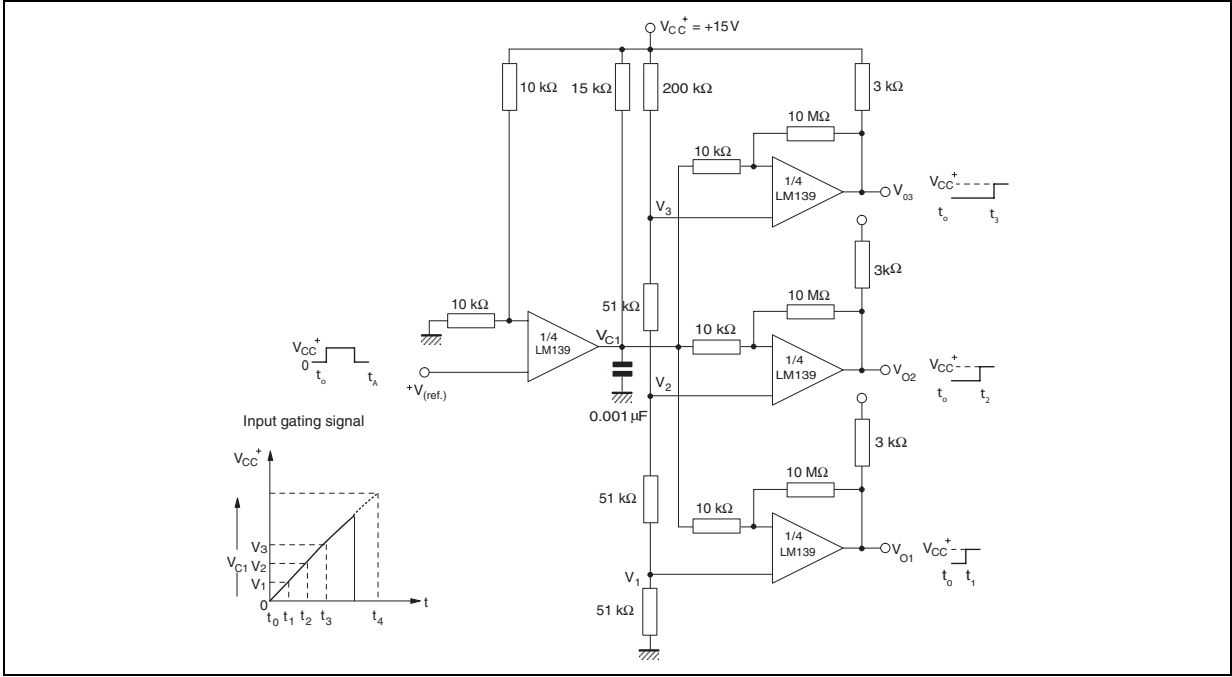


Figure 15. Low frequency op amp with offset adjust

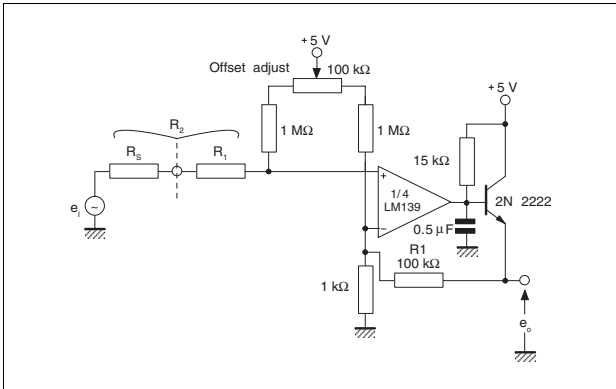


Figure 16. Zero crossing detector (single power supply)

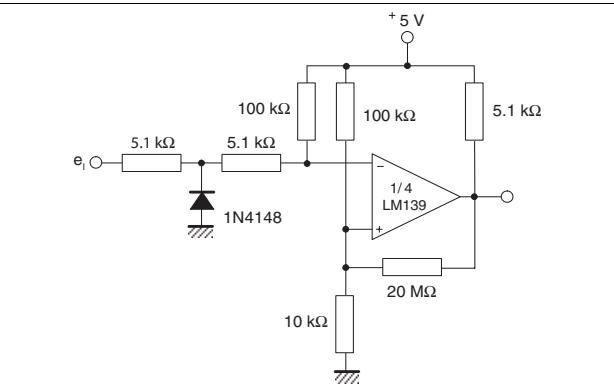


Figure 17. Two-decade high-frequency VCO

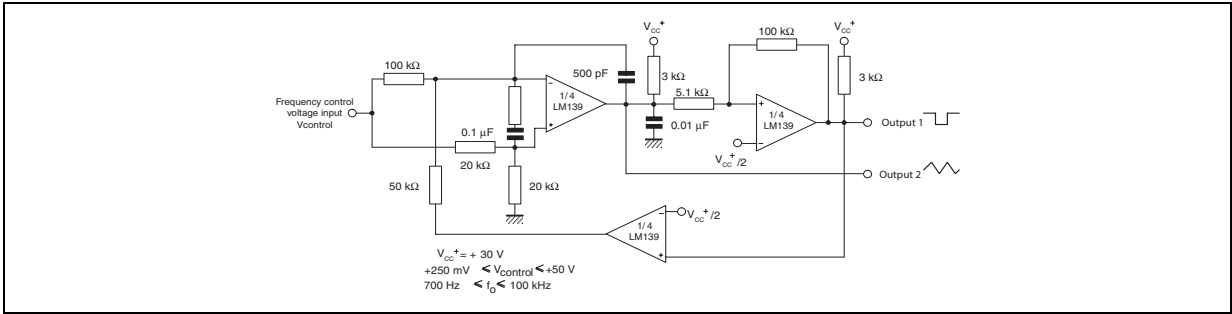


Figure 18. Limit comparator

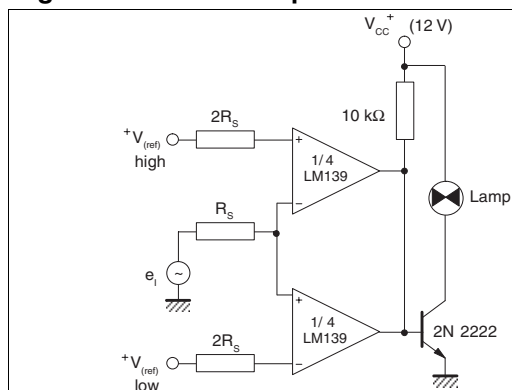


Figure 19. Crystal-controlled oscillator

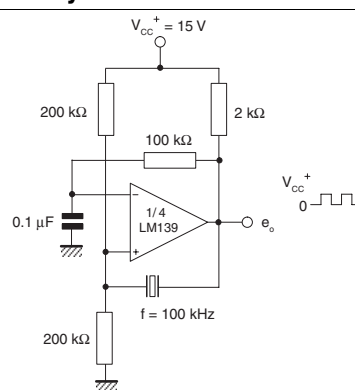


Figure 20. Zero crossing detector

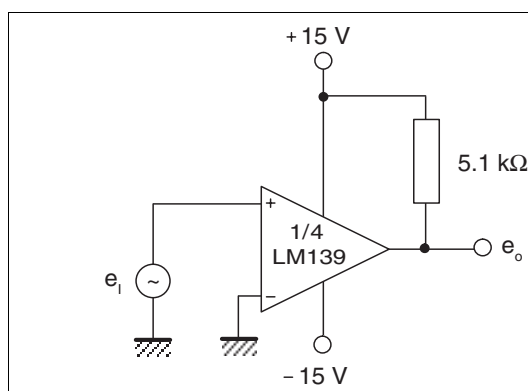
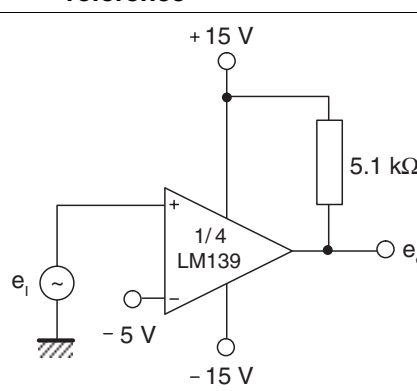


Figure 21. Comparator with a negative reference



## 6 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.

## 6.1 DIP14 package information

Figure 22. DIP14 package mechanical drawing

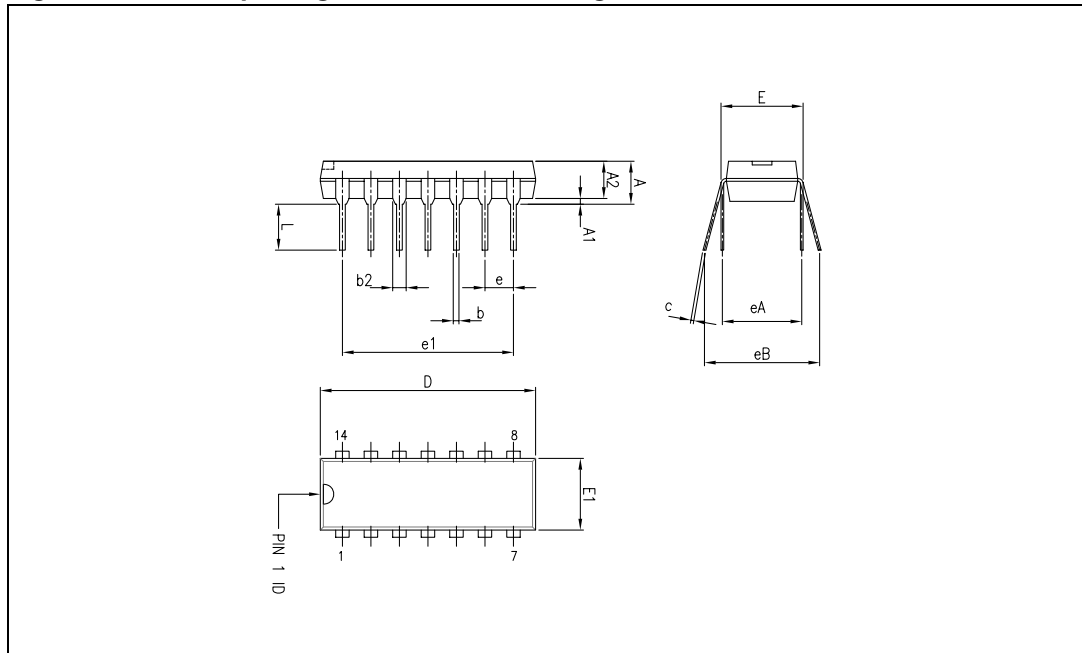


Table 4. DIP14 package mechanical data

| 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  |

## 6.2 SO-14 package information

Figure 23. SO-14 package mechanical drawing

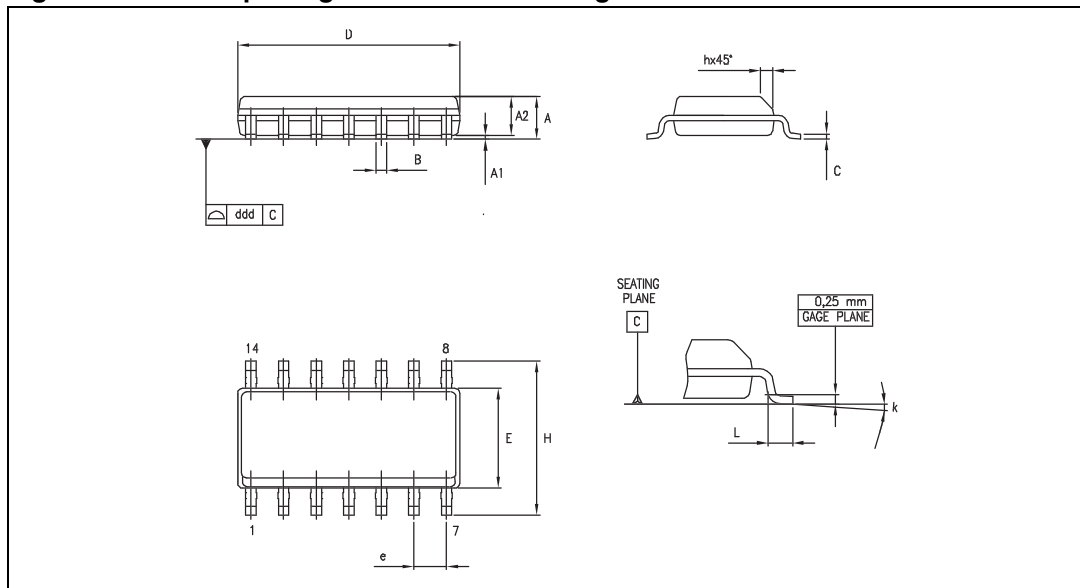
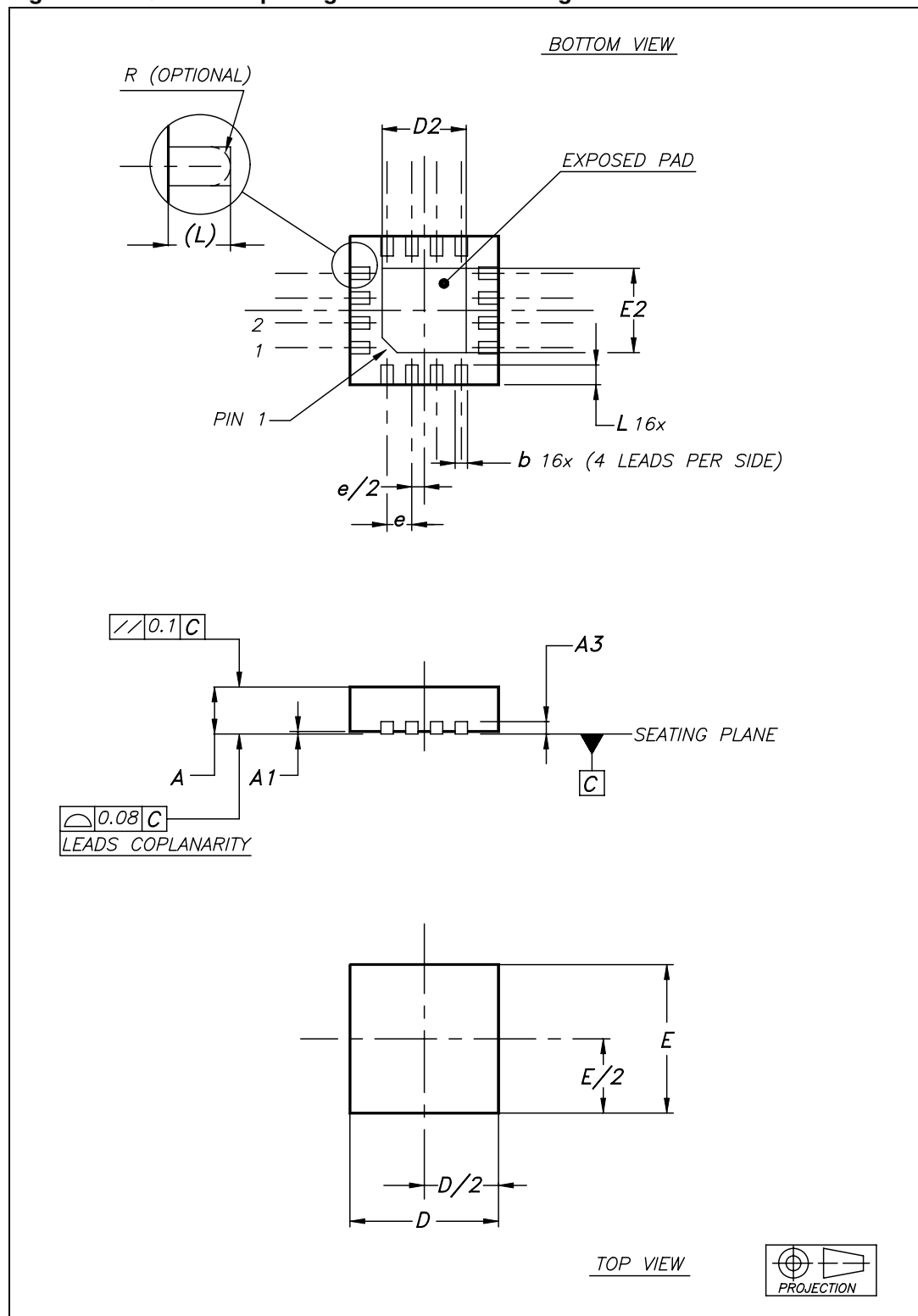


Table 5. SO-14 package mechanical data

| Dimensions |             |      |      |        |      |       |
|------------|-------------|------|------|--------|------|-------|
| Ref.       | Millimeters |      |      | Inches |      |       |
|            | Min.        | Typ. | Max. | Min.   | Typ. | Max.  |
| A          | 1.35        |      | 1.75 | 0.05   |      | 0.068 |
| A1         | 0.10        |      | 0.25 | 0.004  |      | 0.009 |
| A2         | 1.10        |      | 1.65 | 0.04   |      | 0.06  |
| B          | 0.33        |      | 0.51 | 0.01   |      | 0.02  |
| C          | 0.19        |      | 0.25 | 0.007  |      | 0.009 |
| D          | 8.55        |      | 8.75 | 0.33   |      | 0.34  |
| E          | 3.80        |      | 4.0  | 0.15   |      | 0.15  |
| e          |             | 1.27 |      |        | 0.05 |       |
| H          | 5.80        |      | 6.20 | 0.22   |      | 0.24  |
| h          | 0.25        |      | 0.50 | 0.009  |      | 0.02  |
| L          | 0.40        |      | 1.27 | 0.015  |      | 0.05  |
| k          | 8° (max.)   |      |      |        |      |       |
| ddd        |             |      | 0.10 |        |      | 0.004 |

### 6.3 QFN16 3x3 package information

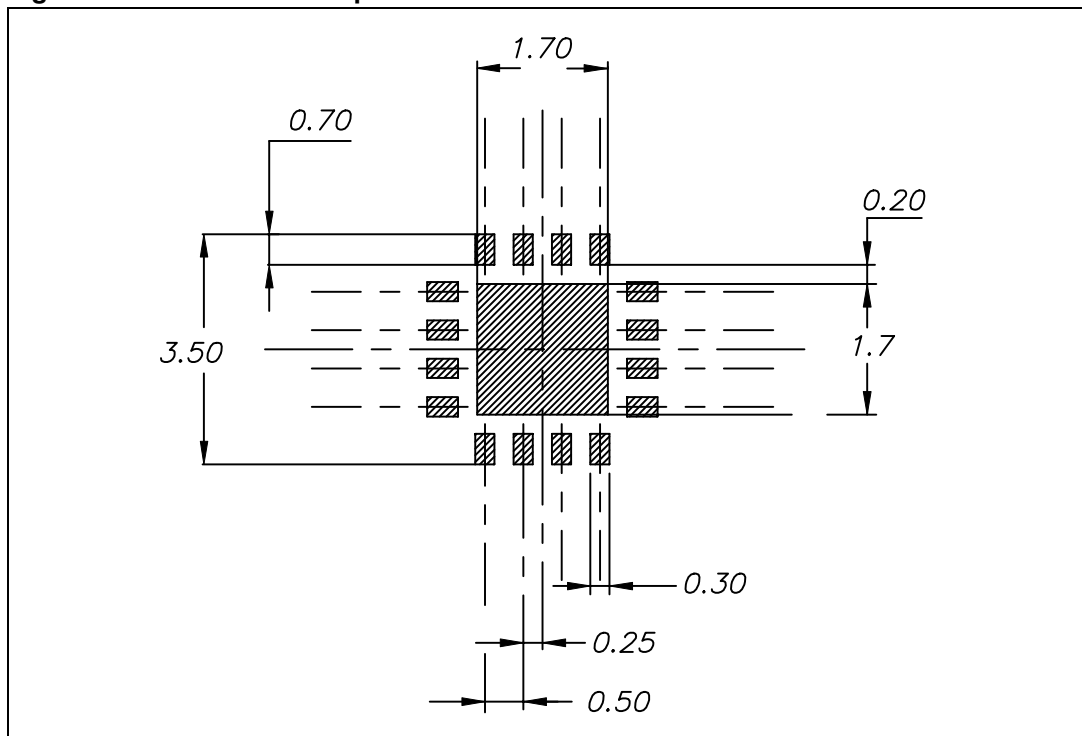
Figure 24. QFN16 3x3 package mechanical drawing



**Table 6. QFN16 3x3 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 25. QFN16 3x3 footprint recommendation**



## 6.4 TSSOP14 package information

Figure 26. TSSOP14 package mechanical drawing

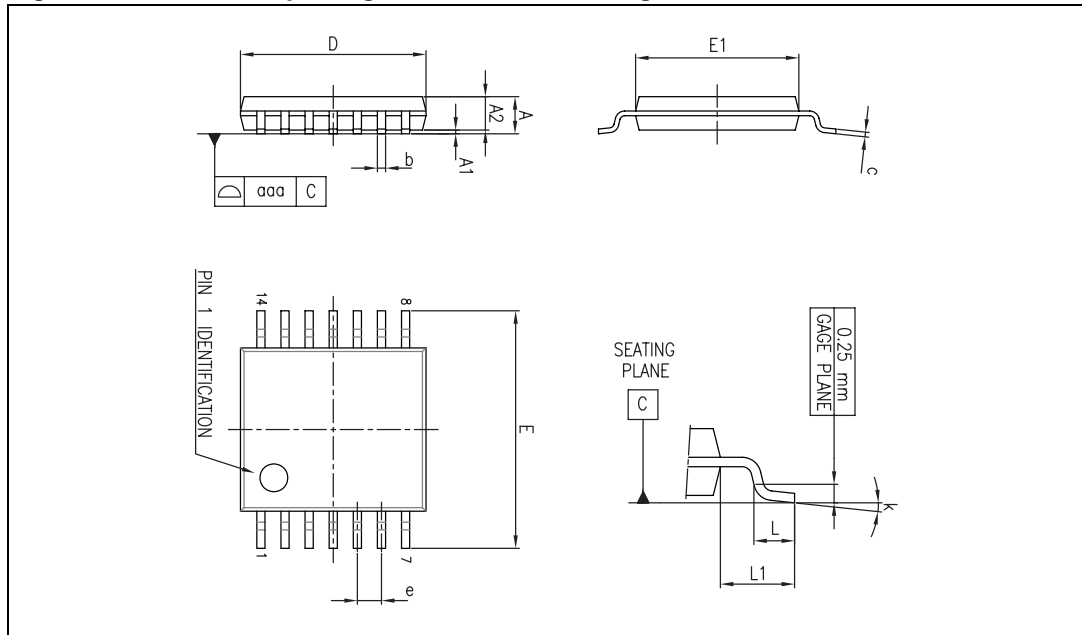


Table 7. TSSOP14 package mechanical data

| 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  |

## 7 Ordering information

**Table 8. Order codes**

| Part number         | Temperature range | Package   | Packing     | Marking           |
|---------------------|-------------------|-----------|-------------|-------------------|
| LM139N<br>LM139AN   | -55° C, +125° C   | DIP14     | Tube        | LM139N<br>LM139AN |
| LM139D<br>LM139AD   |                   | SO-14     | Tube        | 139<br>139A       |
| LM139DT<br>LM139ADT |                   | SO-14     | Tape & reel | 139<br>139A       |
| LM139PT<br>LM139APT |                   | TSSOP14   | Tape & reel | 139<br>139A       |
| LM239N<br>LM239AN   | -40° C, +105° C   | DIP14     | Tube        | LM239N<br>LM239AN |
| LM239D<br>LM239AD   |                   | SO-14     | Tube        | 239<br>239A       |
| LM239DT<br>LM239ADT |                   | SO-14     | Tape & reel | 239<br>239A       |
| LM239PT<br>LM239APT |                   | TSSOP14   | Tape & reel | 239<br>239A       |
| LM239QT             |                   | QFN16 3x3 | Tape & reel | K549              |
| LM339N<br>LM339AN   | 0° C, +70° C      | DIP14     | Tube        | LM339N<br>LM339AN |
| LM339D<br>LM339AD   |                   | SO-14     | Tube        | 339<br>339A       |
| LM339DT<br>LM339ADT |                   | SO-14     | Tape & reel | 339<br>339A       |
| LM339PT<br>LM339APT |                   | TSSOP14   | Tape & reel | 339<br>339A       |
| LM339QT             |                   | QFN16 3x3 | Tape & reel | K551              |

## 8 Revision history

**Table 9. Document revision history**

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                  |
|-------------|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 01-Mar-2003 | 1        | Initial release.                                                                                                                                                                                                                                                                                                         |
| 28-Apr-2009 | 2        | Updated document format.<br>Removed power dissipation from <a href="#">Table 1: Absolute maximum ratings</a> .<br>Added $R_{THJA}$ , $R_{THJC}$ , ESD and $T_{LEAD}$ values to <a href="#">Table 1</a> .<br>Updated package information in <a href="#">Chapter 6</a> .<br>Added <a href="#">Table 8: Order codes</a> .   |
| 13-Jul-2011 | 3        | Added pin connections for QFN16 package in <a href="#">Figure 1 on page 2</a> .<br>Added thermal information for QFN16 package in <a href="#">Table 1 on page 3</a> .<br>Added QFN16 package information in <a href="#">Chapter 6</a> .<br>Added order codes for QFN16 package in <a href="#">Table 8: Order codes</a> . |

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