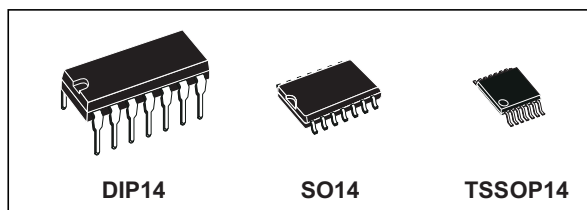




# THE DATASHEET OF M74HC04B1R





### Description

The M74HC04 is a high-speed CMOS hex inverter manufactured using silicon gate C<sup>2</sup>MOS technology.

The internal circuit is composed of 3 stages including a buffer output which enables high noise immunity and stable output.

All inputs are equipped with protection circuits to guard against static discharge and transient excess voltage.

### Features

- High speed:  
 $t_{PD} = 8 \text{ ns (typ.) at } V_{CC} = 6 \text{ V}$
- Low power dissipation:  
 $I_{CC} = 1 \mu\text{A (max.) at } T_A = 25 \text{ }^\circ\text{C}$
- High noise immunity:  
 $V_{NIH} = V_{NIL} = 28\% V_{CC} \text{ (min.)}$
- Symmetrical output impedance:  
 $|I_{OH}| = I_{OL} = 4 \text{ mA (min) at } V_{CC} = 4.5 \text{ V}$
- Balanced propagation delays:  
 $t_{PLH} @ t_{PHL}$
- Wide operating voltage range:  
 $V_{CC} \text{ (OPR)} = 2 \text{ V to } 6 \text{ V}$
- Pin and function compatible with 74 series 04
- ESD performance
  - CDM: 1 kV
  - HBM: 2 kV
  - MM: 200 V

**Table 1. Device summary**

| Order code                    | Temperature range | Package                    | Packaging     | Marking   |
|-------------------------------|-------------------|----------------------------|---------------|-----------|
| M74HC04B1R                    | -55 °C to +125 °C | DIP14                      | Tube          | M74HC04B1 |
| M74HC04YRM13TR <sup>(1)</sup> | -40 °C to +125 °C | SO14 (automotive grade)    | Tape and reel | 74HC04Y   |
| M74HC04RM13TR                 | -55 °C to +125 °C | SO14                       | Tape and reel | 74HC04    |
| M74HC04TTR                    | -55 °C to +125 °C | TSSOP14                    | Tape and reel | HC04      |
| M74HC04YTTR <sup>(1)</sup>    | -40 °C to +125 °C | TSSOP14 (automotive grade) | Tape and reel | HC04Y     |

1. Qualification and characterization according to AEC Q100 and Q003 or equivalent, advanced screening according to AEC Q001 and Q002 or equivalent.

# Contents

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# 1 Pin information

Figure 1. Pin connections and IEC logic symbols

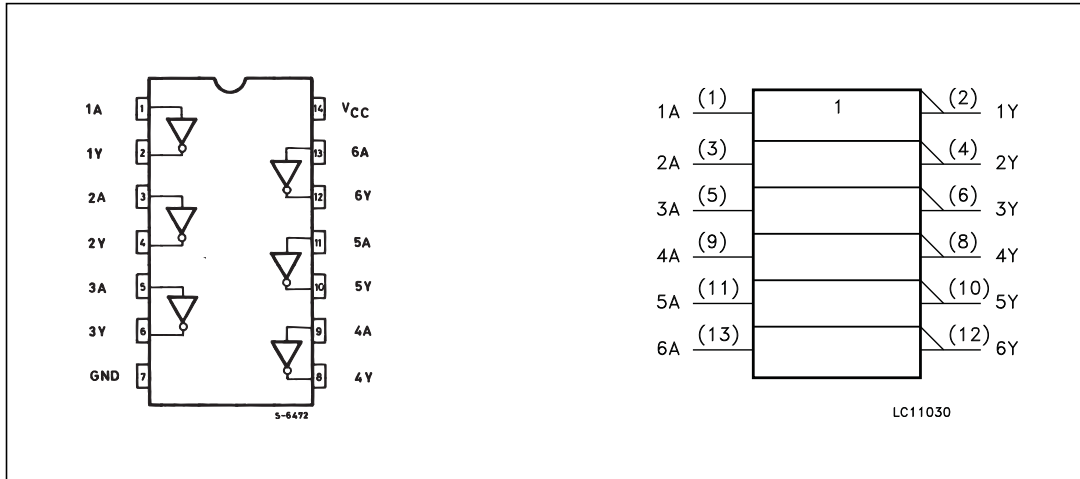


Table 2. Pin description

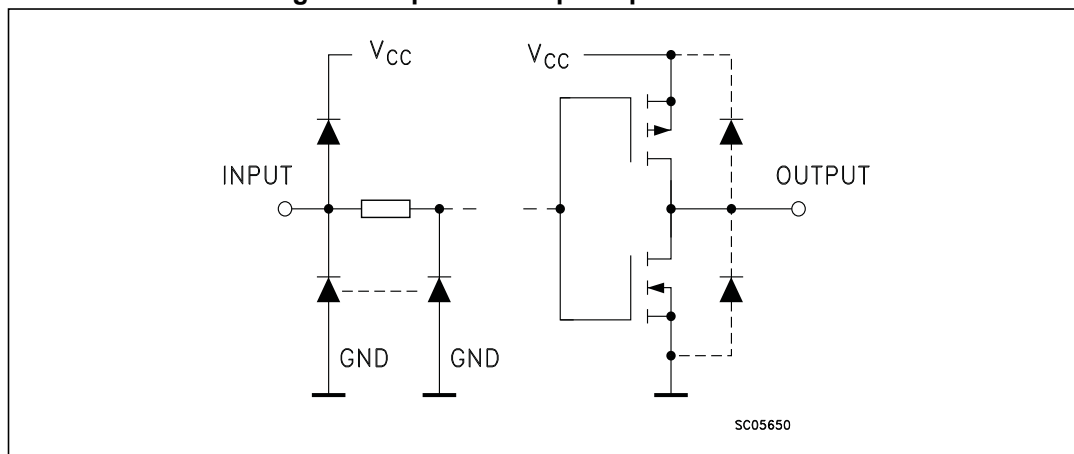
| Pin number         | Symbol          | Name and function       |
|--------------------|-----------------|-------------------------|
| 1, 3, 5, 9, 11, 13 | 1A to 6A        | Data inputs             |
| 2, 4, 6, 8, 10, 12 | 1Y to 6Y        | Data outputs            |
| 7                  | GND             | Ground (0 V)            |
| 14                 | V <sub>CC</sub> | Positive supply voltage |

## 2 Functional description

Table 3. Truth table

| A | Y |
|---|---|
| L | H |
| H | L |

Figure 2. Input and output equivalent circuit



### 3 Electrical characteristics

Stressing the device above the ratings listed in the “Absolute maximum ratings” table may cause permanent damage to the device. These are stress ratings only, and operation of the device at these or any other conditions above those indicated in the operating sections of this specification are not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

**Table 4. Absolute maximum ratings**

| Symbol                | Parameter                     | Value                  | Unit |
|-----------------------|-------------------------------|------------------------|------|
| $V_{CC}$              | Supply voltage                | -0.5 to +7             | V    |
| $V_I$                 | DC input voltage              | -0.5 to $V_{CC} + 0.5$ | V    |
| $V_O$                 | DC output voltage             | -0.5 to $V_{CC} + 0.5$ | V    |
| $I_{IK}$              | DC input diode current        | $\pm 20$               | mA   |
| $I_{OK}$              | DC output diode current       | $\pm 20$               | mA   |
| $I_O$                 | DC output current             | $\pm 25$               | mA   |
| $I_{CC}$ or $I_{GND}$ | DC $V_{CC}$ or ground current | $\pm 50$               | mA   |
| $P_D$                 | Power dissipation             | 500 <sup>(1)</sup>     | mW   |
| $T_{stg}$             | Storage temperature           | -65 to +150            | °C   |
| $T_L$                 | Lead temperature (10 sec)     | 300                    | °C   |

1. 500 mW at 65 °C; derate to 300 mW by 10 mW/°C from 65 °C to 85 °C

**Table 5. Recommended operating conditions**

| Symbol        | Parameter                | Value            | Unit      |    |
|---------------|--------------------------|------------------|-----------|----|
| $V_{CC}$      | Supply voltage           | 2 to 6           | V         |    |
| $V_I$         | Input voltage            | 0 to $V_{CC}$    | V         |    |
| $V_O$         | Output voltage           | 0 to $V_{CC}$    | V         |    |
| $T_{op}$      | Operating temperature    | -55 to 125       | °C        |    |
| $t_r$ , $t_f$ | Input rise and fall time | $V_{CC} = 2.0$ V | 0 to 1000 | ns |
|               |                          | $V_{CC} = 4.5$ V | 0 to 500  | ns |
|               |                          | $V_{CC} = 6.0$ V | 0 to 400  | ns |

Table 6. DC specifications

| Symbol          | Parameter                 | Test condition      |   | Value                 |      |       |             |      |              | Unit |      |
|-----------------|---------------------------|---------------------|---|-----------------------|------|-------|-------------|------|--------------|------|------|
|                 |                           | V <sub>CC</sub> (V) |   | T <sub>A</sub> = 25°C |      |       | -40 to 85°C |      | -55 to 125°C |      |      |
|                 |                           |                     |   | Min.                  | Typ. | Max.  | Min.        | Max. | Min.         |      | Max. |
| V <sub>IH</sub> | High-level input voltage  | 2.0                 |   | 1.5                   |      |       | 1.5         |      | 1.5          |      | V    |
|                 |                           | 4.5                 |   | 3.15                  |      |       | 3.15        |      | 3.15         |      |      |
|                 |                           | 6.0                 |   | 4.2                   |      |       | 4.2         |      | 4.2          |      |      |
| V <sub>IL</sub> | Low-level input voltage   | 2.0                 |   |                       |      | 0.5   |             | 0.5  |              | 0.5  | V    |
|                 |                           | 4.5                 |   |                       |      | 1.35  |             | 1.35 |              | 1.35 |      |
|                 |                           | 6.0                 |   |                       |      | 1.8   |             | 1.8  |              | 1.8  |      |
| V <sub>OH</sub> | High-level output voltage | 2.0                 | I <sub>O</sub> = -20 μA                 | 1.9                   | 2.0  |       | 1.9         |      | 1.9          |      | V    |
|                 |                           | 4.5                 | I <sub>O</sub> = -20 μA                 | 4.4                   | 4.5  |       | 4.4         |      | 4.4          |      |      |
|                 |                           | 6.0                 | I <sub>O</sub> = -20 μA                 | 5.9                   | 6.0  |       | 5.9         |      | 5.9          |      |      |
|                 |                           | 4.5                 | I <sub>O</sub> = -4.0 mA                | 4.18                  | 4.31 |       | 4.13        |      | 4.10         |      |      |
|                 |                           | 6.0                 | I <sub>O</sub> = -5.2 mA                | 5.68                  | 5.8  |       | 5.63        |      | 5.60         |      |      |
| V <sub>OL</sub> | Low-level output voltage  | 2.0                 | I <sub>O</sub> = 20 μA                  |                       | 0.0  | 0.1   |             | 0.1  |              | 0.1  | V    |
|                 |                           | 4.5                 | I <sub>O</sub> = 20 μA                  |                       | 0.0  | 0.1   |             | 0.1  |              | 0.1  |      |
|                 |                           | 6.0                 | I <sub>O</sub> = 20 μA                  |                       | 0.0  | 0.1   |             | 0.1  |              | 0.1  |      |
|                 |                           | 4.5                 | I <sub>O</sub> = 4.0 mA                 |                       | 0.17 | 0.26  |             | 0.33 |              | 0.40 |      |
|                 |                           | 6.0                 | I <sub>O</sub> = 5.2 mA                 |                       | 0.18 | 0.26  |             | 0.33 |              | 0.40 |      |
| I <sub>I</sub>  | Input leakage current     | 6.0                 | V <sub>I</sub> = V <sub>CC</sub> or GND |                       |      | ± 0.1 |             | ± 1  |              | ± 1  | μA   |
| I <sub>CC</sub> | Quiescent supply current  | 6.0                 | V <sub>I</sub> = V <sub>CC</sub> or GND |                       |      | 1     |             | 10   |              | 20   | μA   |

**Table 7. AC electrical characteristics**  
( $C_L = 50$  pF, input  $t_r = t_f = 6$  ns)

| Symbol                            | Parameter              | Test condition      |  | Value                 |      |      |             |      |              | Unit |      |
|-----------------------------------|------------------------|---------------------|--|-----------------------|------|------|-------------|------|--------------|------|------|
|                                   |                        | V <sub>CC</sub> (V) |  | T <sub>A</sub> = 25°C |      |      | -40 to 85°C |      | -55 to 125°C |      |      |
|                                   |                        |                     |  | Min.                  | Typ. | Max. | Min.        | Max. | Min.         |      | Max. |
| t <sub>RLH</sub> t <sub>fHL</sub> | Output transition time | 2.0                 |  |                       | 38   | 75   |             | 95   |              | 110  | ns   |
|                                   |                        | 4.5                 |  |                       | 8    | 15   |             | 19   |              | 22   |      |
|                                   |                        | 6.0                 |  |                       | 6    | 13   |             | 16   |              | 19   |      |
| t <sub>PLH</sub> t <sub>PHL</sub> | Propagation delay time | 2.0                 |  |                       | 45   | 95   |             | 120  |              | 145  | ns   |
|                                   |                        | 4.5                 |  |                       | 9    | 19   |             | 24   |              | 29   |      |
|                                   |                        | 6.0                 |  |                       | 8    | 16   |             | 20   |              | 25   |      |

**Table 8. Capacitive characteristics**

| Symbol          | Parameter                                    | Test condition      |  | Value                 |      |      |             |      |              | Unit |      |
|-----------------|--|---------------------|--|-----------------------|------|------|-------------|------|--------------|------|------|
|                 |  | V <sub>CC</sub> (V) |  | T <sub>A</sub> = 25°C |      |      | -40 to 85°C |      | -55 to 125°C |      |      |
|                 |  |                     |  | Min.                  | Typ. | Max. | Min.        | Max. | Min.         |      | Max. |
| C <sub>IN</sub> | Input capacitance                            | 5.0                 |  |                       | 5    | 10   |             | 10   |              | 10   | pF   |
| C <sub>PD</sub> | Power dissipation capacitance <sup>(1)</sup> | 5.0                 |  |                       | 22   |      |             |      |              |      | pF   |

1. CPD is defined as the value of the IC's internal equivalent capacitance which is calculated from the operating current consumption without load. (Refer to the test circuit). Average operating current can be obtained by the following equation:  
 $I_{CC(opr)} = C_{PD} \times V_{CC} \times f_{IN} + I_{CC}/6$  (per gate)

Figure 3. Test circuit

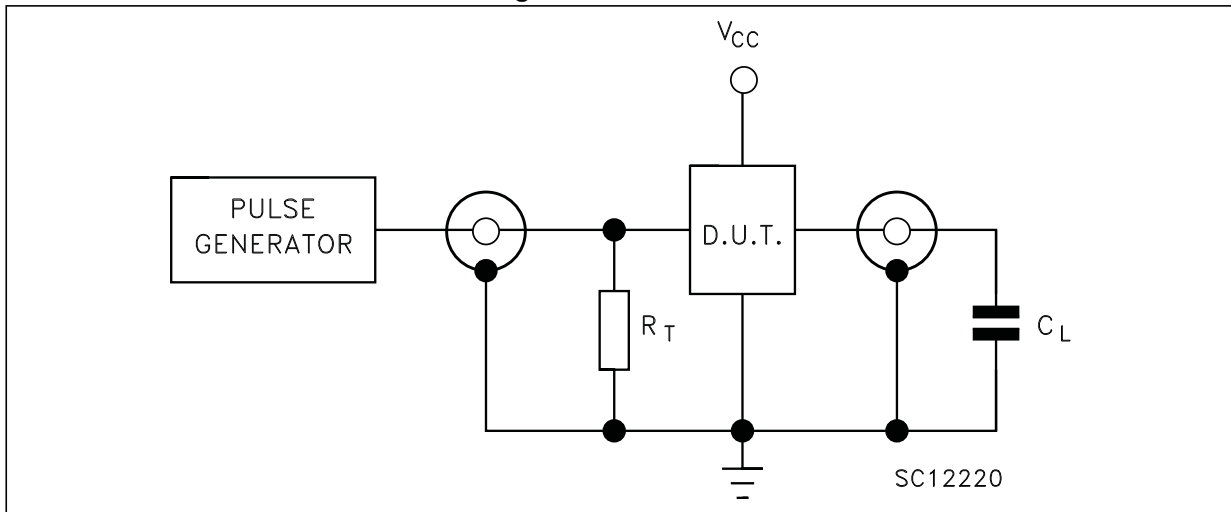
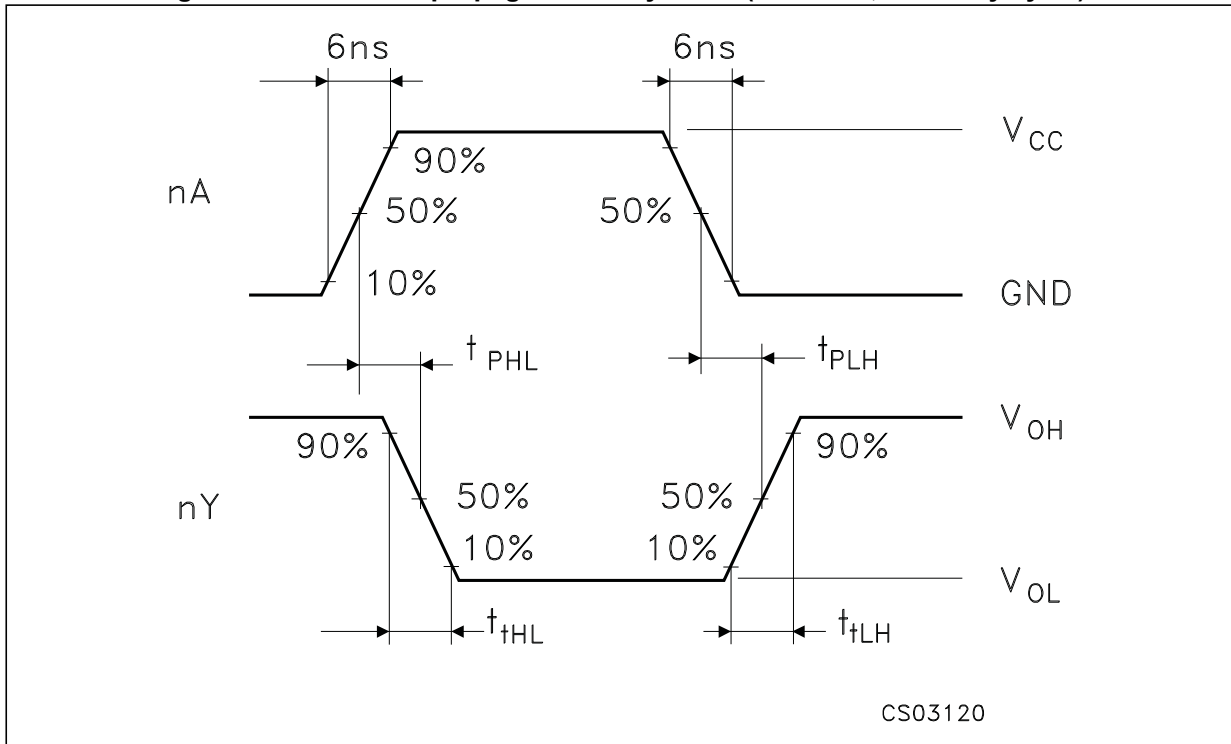


Figure 4. Waveforms: propagation delay times (f = 1 MHz; 50% duty cycle)



## 4 Package information

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

### 4.1 DIP14 package information

Figure 5. Plastic DIP14 package mechanical outline

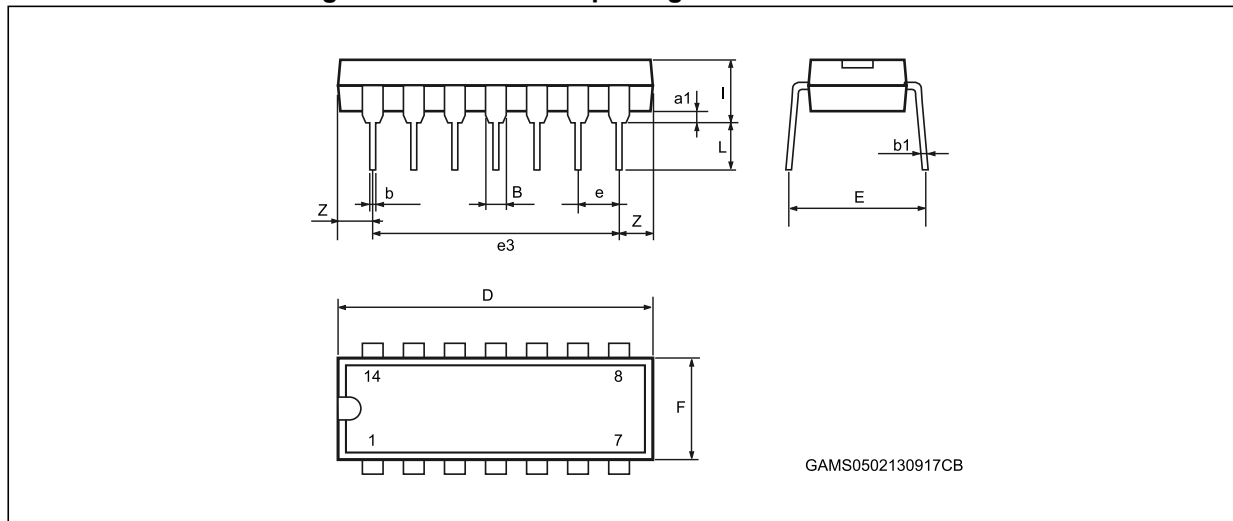


Table 9. Plastic DIP14 package mechanical data

| Dimension | mm.  |       |      | 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 |

### 4.2 SO14 package information

Figure 6. Plastic SO14 package mechanical outline

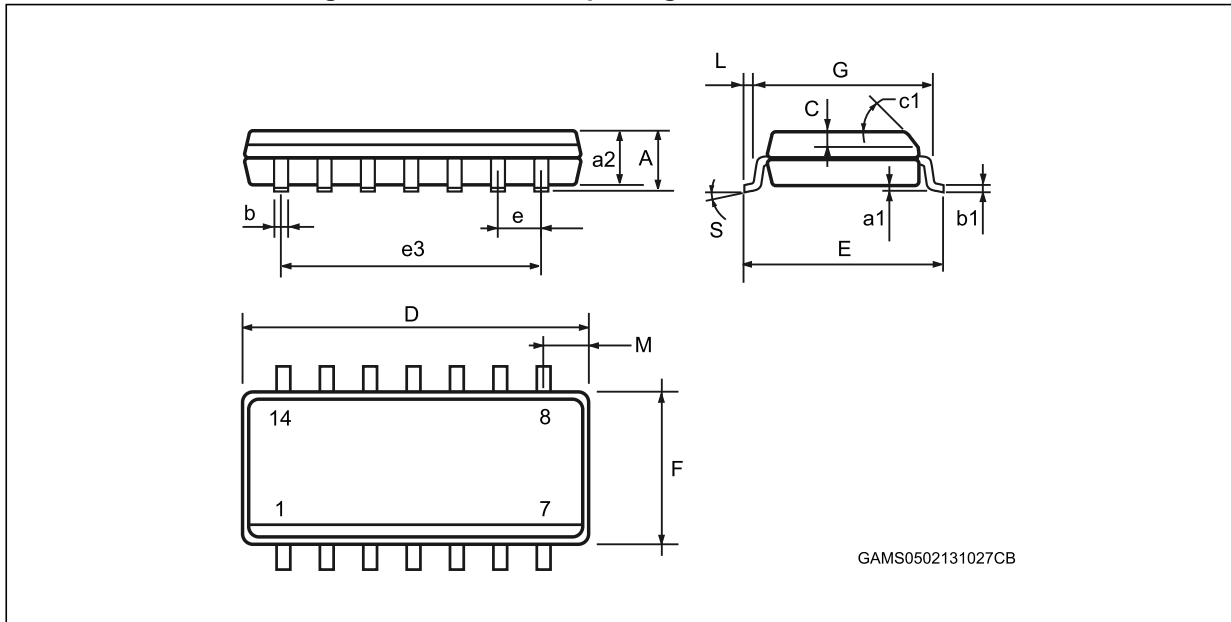


Table 10. SO14 package mechanical data

| Ref. | mm.        |      |      | 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.)  |      |      |        |       |       |

### 4.3 TSSOP14 package information

Figure 7. TSSOP14 package mechanical outline

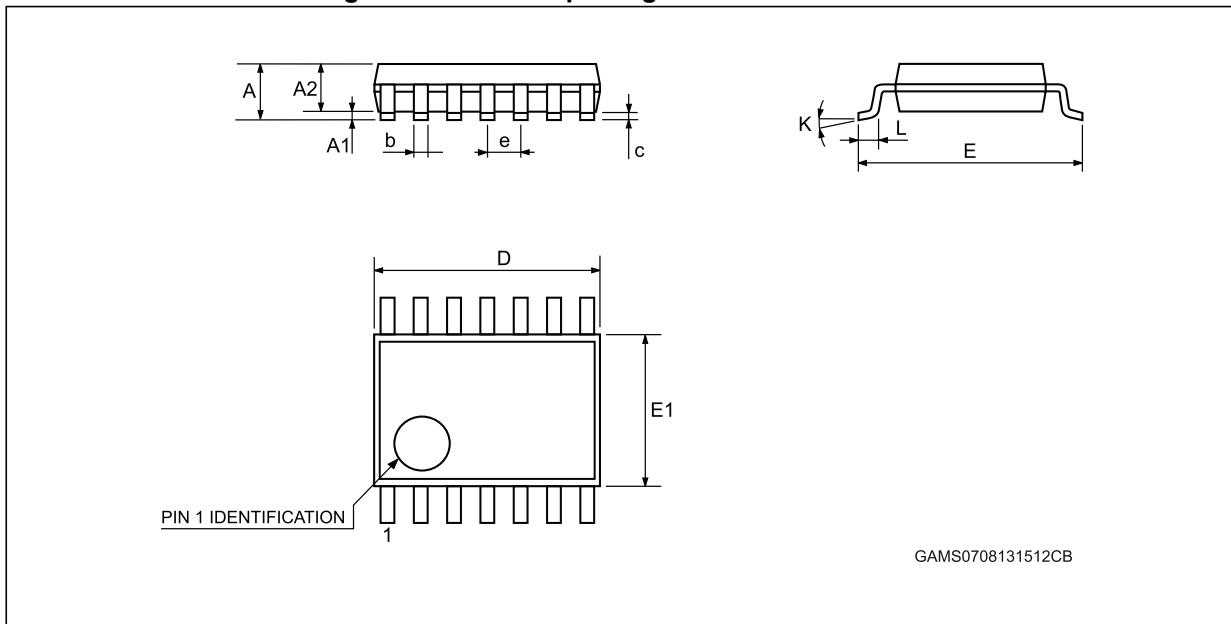


Table 11. TSSOP14 package mechanical data

| Ref. | mm.  |          |      | 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°     |
| L    | 0.45 | 0.60     | 0.75 | 0.018  | 0.024      | 0.030  |

## 5 Revision history

Table 12. Document revision history

| Date        | Revision | Changes   |
|-------------|----------|---|
| 11-Sep-2013 | 3        | Added ESD information to <i>Features</i><br>Added automotive grade order codes, temperature ranges, and marking information to <i>Table 1: Device summary</i><br>Revised document presentation<br>Minor textual updates |

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