

### 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

|          |   |           |
|----------|---|-----------|
| <b>1</b> | <b>Pin information</b> .....            | <b>3</b>  |
| <b>2</b> | <b>Functional description</b> .....     | <b>4</b>  |
| <b>3</b> | <b>Electrical characteristics</b> ..... | <b>5</b>  |
| <b>4</b> | <b>Package information</b> .....        | <b>9</b>  |
| 4.1      | DIP14 package information .....         | 9         |
| 4.2      | SO14 package information .....          | 10        |
| 4.3      | TSSOP14 package information .....       | 11        |
| <b>5</b> | <b>Revision history</b> .....           | <b>12</b> |



# 1 Pin information

Figure 1. Pin connections and IEC logic symbols

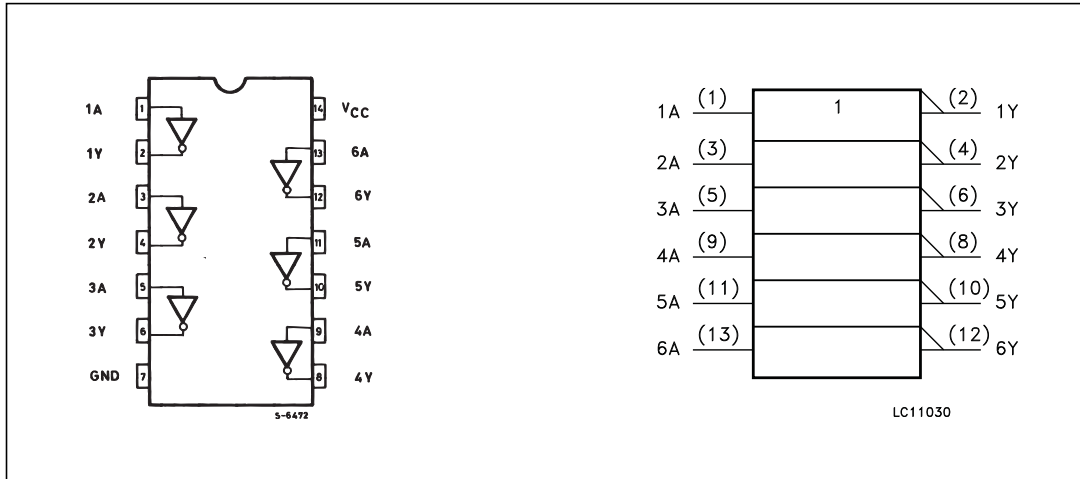


Table 2. Pin description

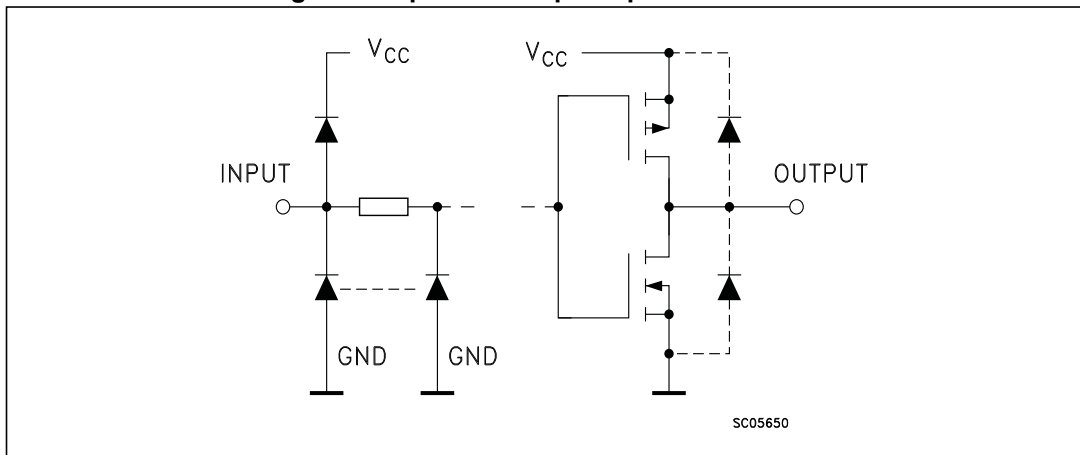
| Pin number         | Symbol          | Name and function       |
|--------------------|-----------------|-------------------------|
| 1, 3, 5, 9, 11, 13 | 1A to 6A        | Data inputs             |
| 2, 4, 6, 8, 10, 12 | 1Y to 6Y        | Data outputs            |
| 7                  | GND             | 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 |      |
|-----------------------------------|------------------------|----------------|--|--------------------------|------|------|-----------------------------|------|------------------------------|------|------|
|                                   |                        | $V_{CC}$ (V)   |  | $T_A = 25^\circ\text{C}$ |      |      | $-40$ to $85^\circ\text{C}$ |      | $-55$ to $125^\circ\text{C}$ |      |      |
|                                   |                        |                |  | Min.                     | Typ. | Max. | Min.                        | Max. | Min.                         |      | Max. |
| $t_{\text{rLH}}$ $t_{\text{fHL}}$ | Output transition time | 2.0            |  |                          | 38   | 75   |                             | 95   |                              | 110  | ns   |
|                                   |                        | 4.5            |  |                          | 8    | 15   |                             | 19   |                              | 22   |      |
|                                   |                        | 6.0            |  |                          | 6    | 13   |                             | 16   |                              | 19   |      |
| $t_{\text{PLH}}$ $t_{\text{PHL}}$ | 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 |      |
|-----------------|--|----------------|--|--------------------------|------|------|-----------------------------|------|------------------------------|------|------|
|                 |  | $V_{CC}$ (V)   |  | $T_A = 25^\circ\text{C}$ |      |      | $-40$ to $85^\circ\text{C}$ |      | $-55$ to $125^\circ\text{C}$ |      |      |
|                 |  |                |  | Min.                     | Typ. | Max. | Min.                        | Max. | Min.                         |      | Max. |
| $C_{\text{IN}}$ | Input capacitance                            | 5.0            |  |                          | 5    | 10   |                             | 10   |                              | 10   | pF   |
| $C_{\text{PD}}$ | 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:  
 $I_{\text{CC(opr)}} = C_{\text{PD}} \times V_{\text{CC}} \times f_{\text{IN}} + I_{\text{CC}}/6$  (per gate)

Figure 3. Test circuit

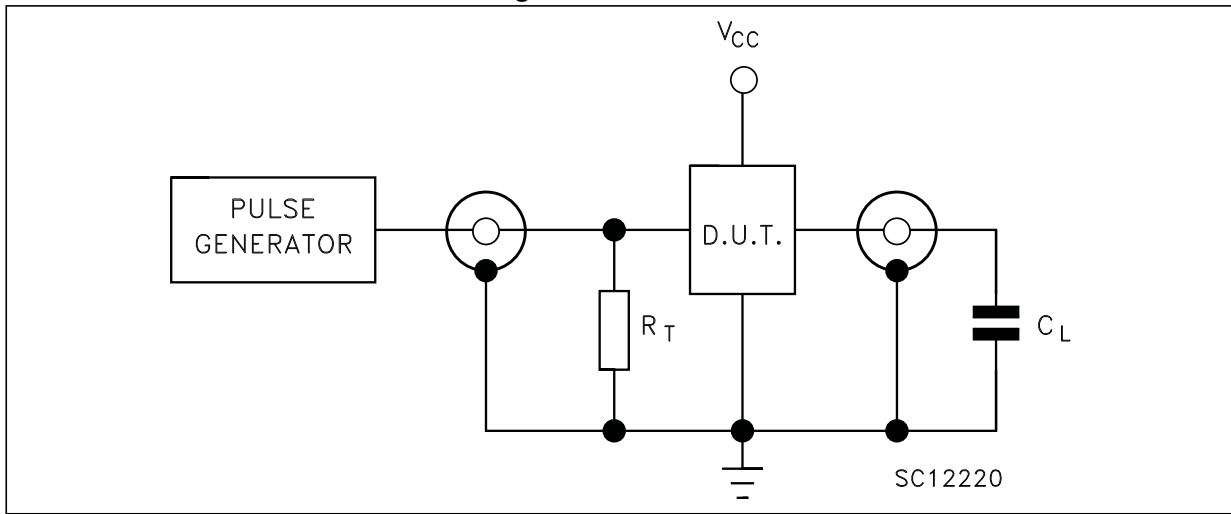
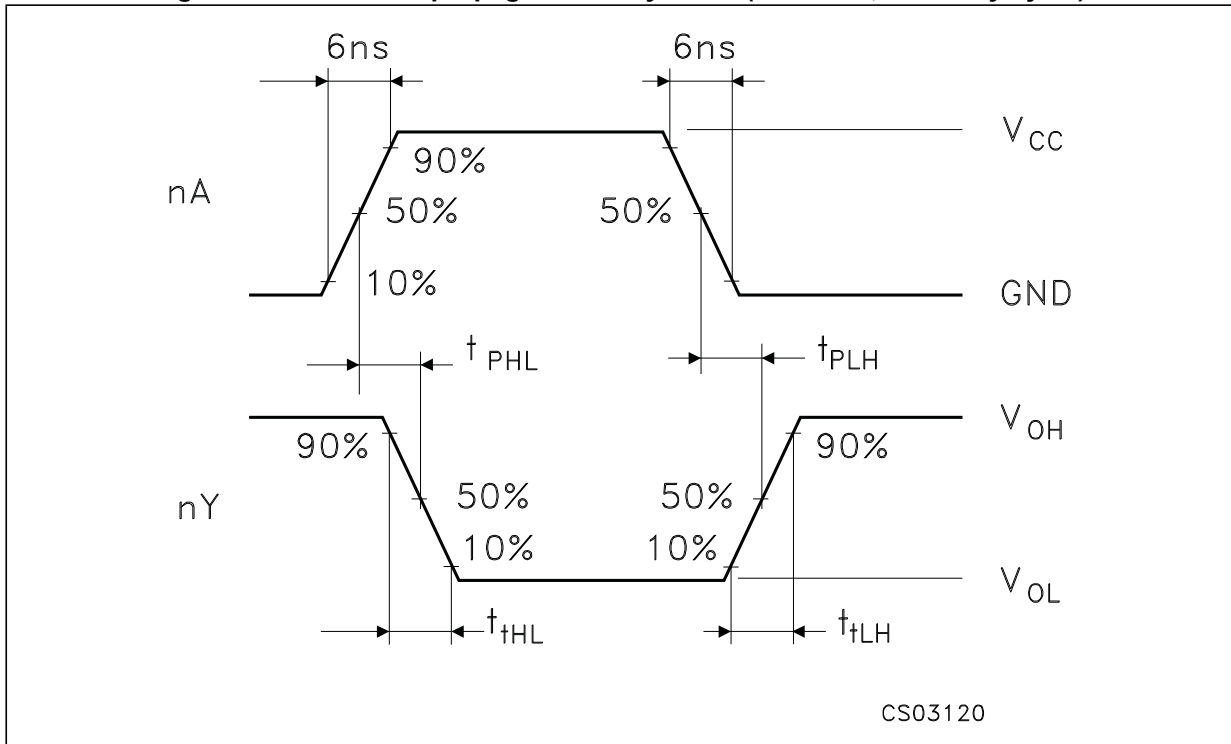


Figure 4. Waveforms: propagation delay times (f = 1 MHz; 50% duty cycle)





## 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

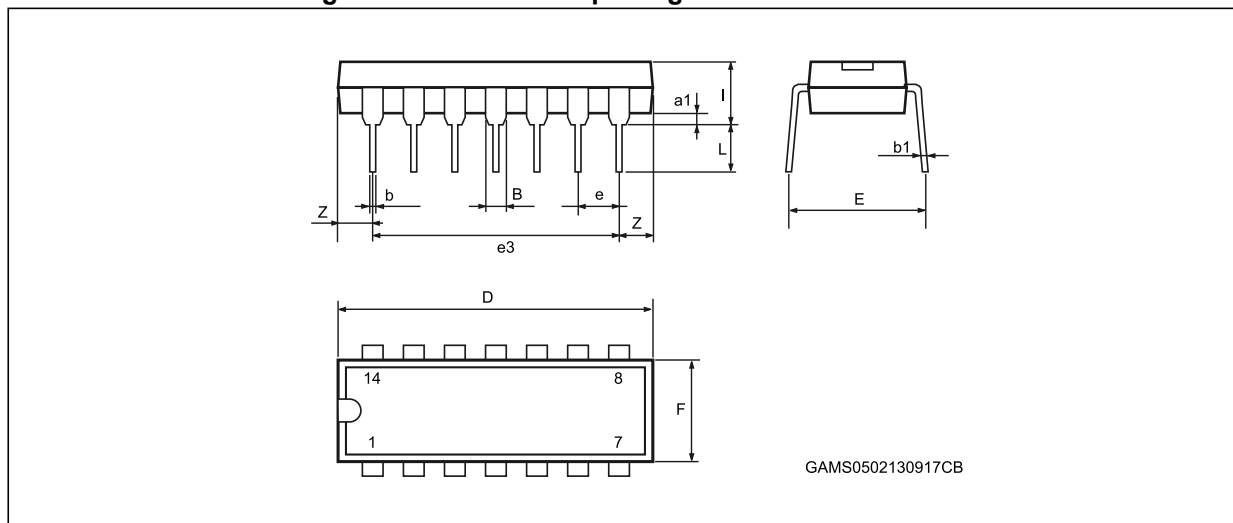


Table 9. Plastic DIP14 package mechanical data

| 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

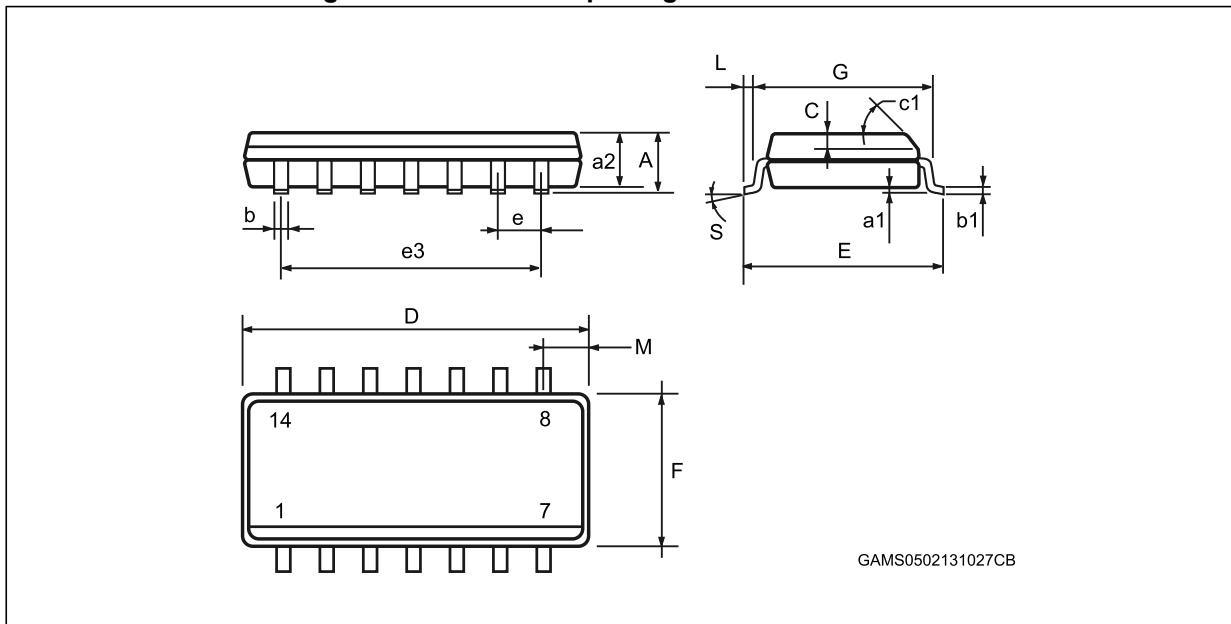


Table 10. SO14 package mechanical data

| 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

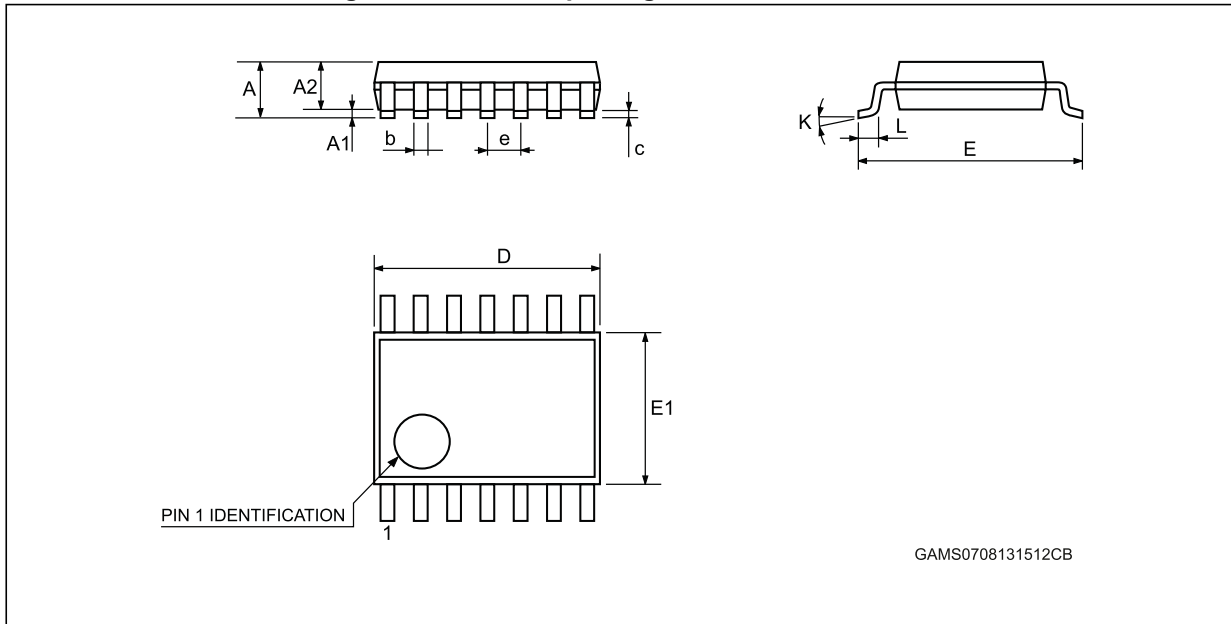


Table 11. TSSOP14 package mechanical data

| 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 |

**Please Read Carefully:**

Information in this document is provided solely in connection with ST products. STMicroelectronics NV and its subsidiaries ("ST") reserve the right to make changes, corrections, modifications or improvements, to this document, and the products and services described herein at any time, without notice.

All ST products are sold pursuant to ST's terms and conditions of sale.

Purchasers are solely responsible for the choice, selection and use of the ST products and services described herein, and ST assumes no liability whatsoever relating to the choice, selection or use of the ST products and services described herein.

No license, express or implied, by estoppel or otherwise, to any intellectual property rights is granted under this document. If any part of this document refers to any third party products or services it shall not be deemed a license grant by ST for the use of such third party products or services, or any intellectual property contained therein or considered as a warranty covering the use in any manner whatsoever of such third party products or services or any intellectual property contained therein.

**UNLESS OTHERWISE SET FORTH IN ST'S TERMS AND CONDITIONS OF SALE ST DISCLAIMS ANY EXPRESS OR IMPLIED WARRANTY WITH RESPECT TO THE USE AND/OR SALE OF ST PRODUCTS INCLUDING WITHOUT LIMITATION IMPLIED WARRANTIES OF MERCHANTABILITY, FITNESS FOR A PARTICULAR PURPOSE (AND THEIR EQUIVALENTS UNDER THE LAWS OF ANY JURISDICTION), OR INFRINGEMENT OF ANY PATENT, COPYRIGHT OR OTHER INTELLECTUAL PROPERTY RIGHT.**

**ST PRODUCTS ARE NOT AUTHORIZED FOR USE IN WEAPONS. NOR ARE ST PRODUCTS DESIGNED OR AUTHORIZED FOR USE IN: (A) SAFETY CRITICAL APPLICATIONS SUCH AS LIFE SUPPORTING, ACTIVE IMPLANTED DEVICES OR SYSTEMS WITH PRODUCT FUNCTIONAL SAFETY REQUIREMENTS; (B) AERONAUTIC APPLICATIONS; (C) AUTOMOTIVE APPLICATIONS OR ENVIRONMENTS, AND/OR (D) AEROSPACE APPLICATIONS OR ENVIRONMENTS. WHERE ST PRODUCTS ARE NOT DESIGNED FOR SUCH USE, THE PURCHASER SHALL USE PRODUCTS AT PURCHASER'S SOLE RISK, EVEN IF ST HAS BEEN INFORMED IN WRITING OF SUCH USAGE, UNLESS A PRODUCT IS EXPRESSLY DESIGNATED BY ST AS BEING INTENDED FOR "AUTOMOTIVE, AUTOMOTIVE SAFETY OR MEDICAL" INDUSTRY DOMAINS ACCORDING TO ST PRODUCT DESIGN SPECIFICATIONS. PRODUCTS FORMALLY ESCC, QML OR JAN QUALIFIED ARE DEEMED SUITABLE FOR USE IN AEROSPACE BY THE CORRESPONDING GOVERNMENTAL AGENCY.**

Resale of ST products with provisions different from the statements and/or technical features set forth in this document shall immediately void any warranty granted by ST for the ST product or service described herein and shall not create or extend in any manner whatsoever, any liability of ST.

ST and the ST logo are trademarks or registered trademarks of ST in various countries.

Information in this document supersedes and replaces all information previously supplied.

The ST logo is a registered trademark of STMicroelectronics. All other names are the property of their respective owners.

© 2013 STMicroelectronics - All rights reserved

STMicroelectronics group of companies

Australia - Belgium - Brazil - Canada - China - Czech Republic - Finland - France - Germany - Hong Kong - India - Israel - Italy - Japan - Malaysia - Malta - Morocco - Philippines - Singapore - Spain - Sweden - Switzerland - United Kingdom - United States of America

[www.st.com](http://www.st.com)

