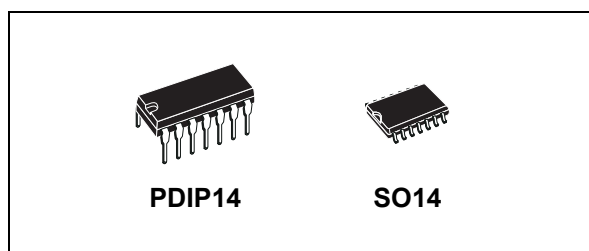


## Dual D-type flip-flop

Datasheet - production data



### Features

- Set-reset capability
- Static flip-flop operation - retains state indefinitely with clock level either "high" or "low"
- Medium speed operation 16 MHz (typ.), clock toggle rate at 10 V
- Standardized symmetrical output characteristics
- Quiescent current specified up to 20 V
- 5 V, 10 V, and 15 V parametric ratings
- Input leakage current  $I_l = 100$  nA (max.) at  $V_{DD} = 18$  V,  $T_A = 25$  °C
- 100 % tested for quiescent current
- ESD performance
  - HBM: 2 kV
  - MM: 200 V
  - CDM: 1 kV

### Applications

- Automotive
- Industrial
- Computer
- Consumer

### Description

The HCF4013 is a monolithic integrated circuit fabricated in metal oxide semiconductor technology available in PDIP14 and SO14 packages.

The HCF4013 consists of two identical, independent data type flip-flops. Each flip-flop has independent data, set, reset, and clock inputs, and Q and  $\bar{Q}$  outputs. This device can be used for shift register applications. It can also be used for counter and toggle applications by connecting  $\bar{Q}$  output to the data input.

The logic level present at the D input is transferred to the  $\bar{Q}$  output during the positive-going transition of the clock pulse. Setting or resetting is independent of the clock and is accomplished by a high level on the set or reset line, respectively.

Table 1. Device summary table

| Order code         | Temperature range | Package                                | Packing       | Marking   |
|--------------------|-------------------|----------------------------------------|---------------|-----------|
| HCF4013M013TR      | -55 °C to +125 °C | SO14                                   | Tape and reel | HCF4013   |
| HCF4013YM013TR (1) | -40 °C to +125 °C | SO14 (automotive grade) <sup>(1)</sup> |               | HCF4013Y  |
| HCF4013BEY         | -55 °C to +125 °C | PDIP14                                 | Tube          | HCF4013BE |

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

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# 1 Pin information

Figure 1. Pin connections (top view)

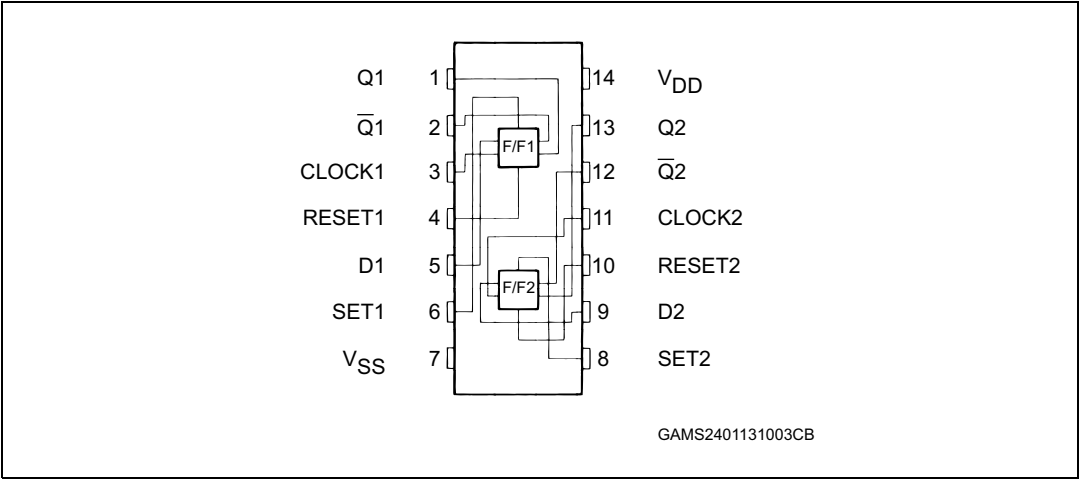
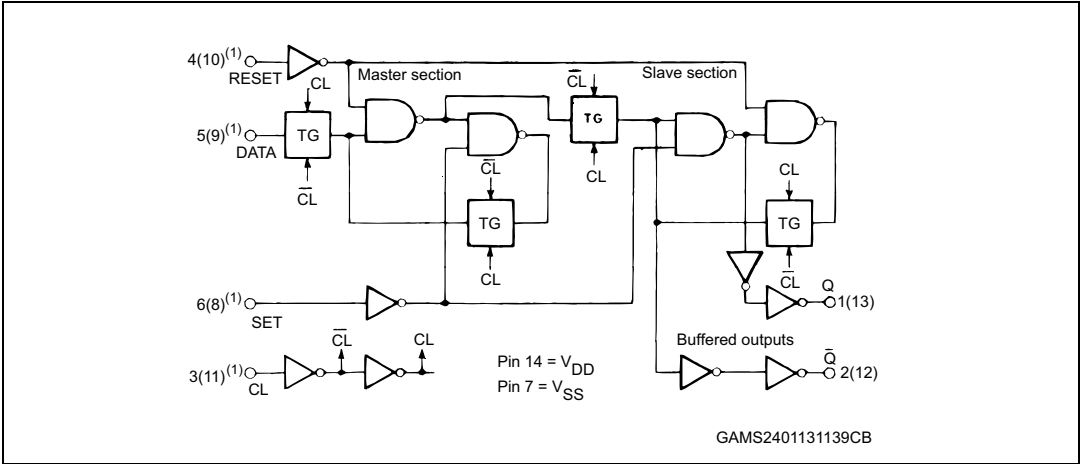


Table 2. Pin description

| Pin no | Symbol           | Name and function       |
|--------|------------------|-------------------------|
| 3, 11  | CLOCK1<br>CLOCK2 | Clock inputs            |
| 4, 10  | RESET1<br>RESET2 | Reset inputs            |
| 6, 8   | SET1, SET2       | Set inputs              |
| 5, 9   | D1, D2           | Data inputs             |
| 1, 13  | Q1, Q2           | Data outputs            |
| 2, 12  | Q1-bar, Q2-bar   | Data outputs            |
| 7      | VSS              | Negative supply voltage |
| 14     | VDD              | Positive supply voltage |

2      Functional description

Figure 2. Logic diagram



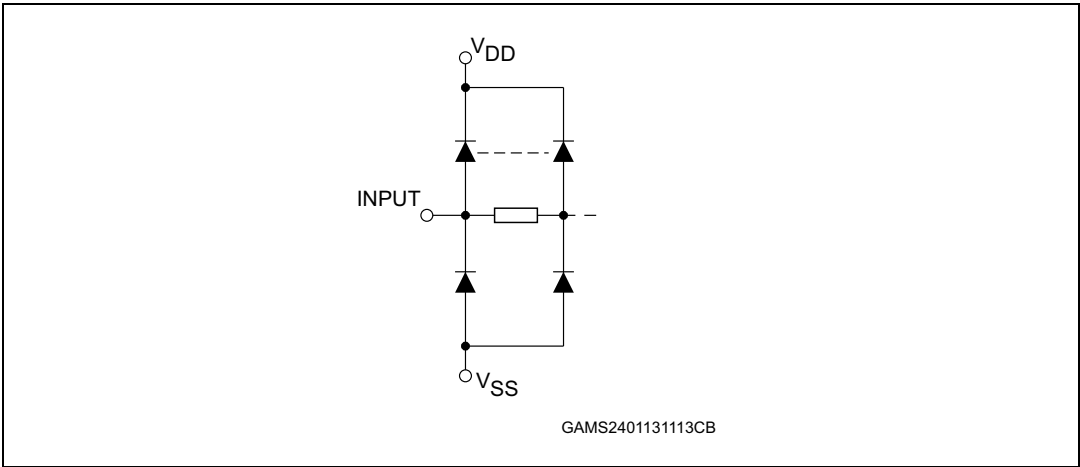
1. All inputs are protected by a COS/MOS protection network.

Table 3. Truth table

| CLOCK <sup>(1)</sup> | D                | RESET | SET | Q | $\overline{Q}$ |
|----------------------|------------------|-------|-----|---|----------------|
|                      | L                | L     | L   | L | H              |
|                      | H                | L     | L   | H | L              |
|                      | X <sup>(2)</sup> | L     | L   | Q | $\overline{Q}$ |
| X <sup>(2)</sup>     | X <sup>(2)</sup> | H     | L   | L | H              |
| X <sup>(2)</sup>     | X <sup>(2)</sup> | L     | H   | H | L              |
| X <sup>(2)</sup>     | X <sup>(2)</sup> | H     | H   | H | H              |

1. Low level  
2. Don't care

Figure 3. Input equivalent circuit



### 3 Electrical characteristics

Absolute maximum ratings are those values beyond which damage to the device may occur. Functional operation under these conditions is not implied. All voltage values are referred to  $V_{SS}$  pin voltage.

**Table 4. Absolute maximum ratings (AMR)**

| Symbol    | Parameter                               | Value                  | Unit |
|-----------|-----------------------------------------|------------------------|------|
| $V_{DD}$  | Supply voltage                          | -0.5 to +22            | V    |
| $V_I$     | DC input voltage                        | -0.5 to $V_{DD} + 0.5$ |      |
| $I_I$     | DC input current                        | $\pm 10$               | mA   |
| $P_D$     | Power dissipation per package           | 200                    | mW   |
|           | Power dissipation per output transistor | 100                    |      |
| $T_{op}$  | Operating temperature                   | -55 to +125            | °C   |
| $T_{stg}$ | Storage temperature                     | -65 to +150            |      |

**Table 5. Recommended operating conditions**

| Symbol   | Parameter             | Value         | Unit |
|----------|-----------------------|---------------|------|
| $V_{DD}$ | Supply voltage        | 3 to 20       | V    |
| $V_I$    | Input voltage         | 0 to $V_{DD}$ |      |
| $T_{op}$ | Operating temperature | -55 to 125    | °C   |

Table 6. DC specifications<sup>(1)</sup>

| Sym.            | Parameter                 | Test condition     |                    |                       |                     | Value                  |                   |      |              |      |              |      |    | Unit |
|-----------------|---------------------------|--------------------|--------------------|-----------------------|---------------------|------------------------|-------------------|------|--------------|------|--------------|------|----|------|
|                 |                           | V <sub>I</sub> (V) | V <sub>O</sub> (V) | I <sub>O</sub>   (μA) | V <sub>DD</sub> (V) | T <sub>A</sub> = 25 °C |                   |      | -40 to 85 °C |      | -55 to 125°C |      |    |      |
|                 |                           |                    |                    |                       |                     | Min.                   | Typ.              | Max. | Min.         | Max. | Min.         | Max. |    |      |
| I <sub>L</sub>  | Quiescent current         | 0/5                |                    |                       | 5                   |                        | 0.02              | 1    |              | 30   |              | 30   | μA |      |
|                 |                           | 0/10               |                    |                       | 10                  |                        | 0.02              | 2    |              | 60   |              | 60   |    |      |
|                 |                           | 0/15               |                    |                       | 15                  |                        | 0.02              | 4    |              | 120  |              | 120  |    |      |
|                 |                           | 0/20               |                    |                       | 20                  |                        | 0.04              | 20   |              | 600  |              | 600  |    |      |
| V <sub>OH</sub> | High level output voltage | 0/5                |                    | <1                    | 5                   | 4.95                   |                   |      | 4.95         |      | 4.95         |      | V  |      |
|                 |                           | 0/10               |                    | <1                    | 10                  | 9.95                   |                   |      | 9.95         |      | 9.95         |      |    |      |
|                 |                           | 0/15               |                    | <1                    | 15                  | 14.95                  |                   |      | 14.95        |      | 14.95        |      |    |      |
| V <sub>OL</sub> | Low level output voltage  | 5/0                |                    | <1                    | 5                   |                        | 0.05              |      |              | 0.05 |              | 0.05 |    |      |
|                 |                           | 10/0               |                    | <1                    | 10                  |                        | 0.05              |      |              | 0.05 |              | 0.05 |    |      |
|                 |                           | 15/0               |                    | <1                    | 15                  |                        | 0.05              |      |              | 0.05 |              | 0.05 |    |      |
| V <sub>IH</sub> | High level input voltage  |                    | 0.5/4.5            | <1                    | 5                   | 3.5                    |                   |      | 3.5          |      | 3.5          |      |    |      |
|                 |                           |                    | 1/9                | <1                    | 10                  | 7                      |                   |      | 7            |      | 7            |      |    |      |
|                 |                           |                    | 1.5/13.5           | <1                    | 15                  | 11                     |                   |      | 11           |      | 11           |      |    |      |
| V <sub>IL</sub> | Low level input voltage   |                    | 4.5/0.5            | <1                    | 5                   |                        |                   | 1.5  |              | 1.5  |              | 1.5  |    |      |
|                 |                           |                    | 9/1                | <1                    | 10                  |                        |                   | 3    |              | 3    |              | 3    |    |      |
|                 |                           |                    | 13.5/1.5           | <1                    | 15                  |                        |                   | 4    |              | 4    |              | 4    |    |      |
| I <sub>OH</sub> | Output drive current      | 0/5                | 2.5                | <1                    | 5                   | -1.36                  | -3.2              |      | -1.15        |      | -1.1         |      | mA |      |
|                 |                           | 0/5                | 4.6                | <1                    | 5                   | -0.44                  | -1                |      | -0.36        |      | -0.36        |      |    |      |
|                 |                           | 0/10               | 9.5                | <1                    | 10                  | -1.1                   | -2.6              |      | -0.9         |      | -0.9         |      |    |      |
|                 |                           | 0/15               | 13.5               | <1                    | 15                  | -3.0                   | -6.8              |      | -2.4         |      | -2.4         |      |    |      |
| I <sub>OL</sub> | Output sink current       | 0/5                | 0.4                | <1                    | 5                   | 0.44                   | 1                 |      | 0.36         |      | 0.36         |      |    |      |
|                 |                           | 0/10               | 0.5                | <1                    | 10                  | 1.1                    | 2.6               |      | 0.9          |      | 0.9          |      |    |      |
|                 |                           | 0/15               | 1.5                | <1                    | 15                  | 3.0                    | 6.8               |      | 2.4          |      | 2.4          |      |    |      |
| I <sub>I</sub>  | Input leakage current     | 0/18               | Any input          |                       | 18                  |                        | ±10 <sup>-5</sup> | ±0.1 |              | ±1   |              | ±1   | μA |      |
| C <sub>I</sub>  | Input capacitance         |                    | Any input          |                       |                     |                        | 5                 | 7.5  |              |      |              |      | pF |      |

1. The noise margin for both level "1" and "0" is: 1 V min. with V<sub>DD</sub> = 5 V, 2 V min. with V<sub>DD</sub> = 10 V, and 2.5 V min. with V<sub>DD</sub> = 15 V.

**Table 7. Dynamic electrical characteristics**  
**( $T_{amb} = 25\text{ }^{\circ}\text{C}$ ,  $C_L = 50\text{ pF}$ ,  $R_L = 200\text{ k}\Omega$ ,  $t_r = t_f = 20\text{ ns}$ )**

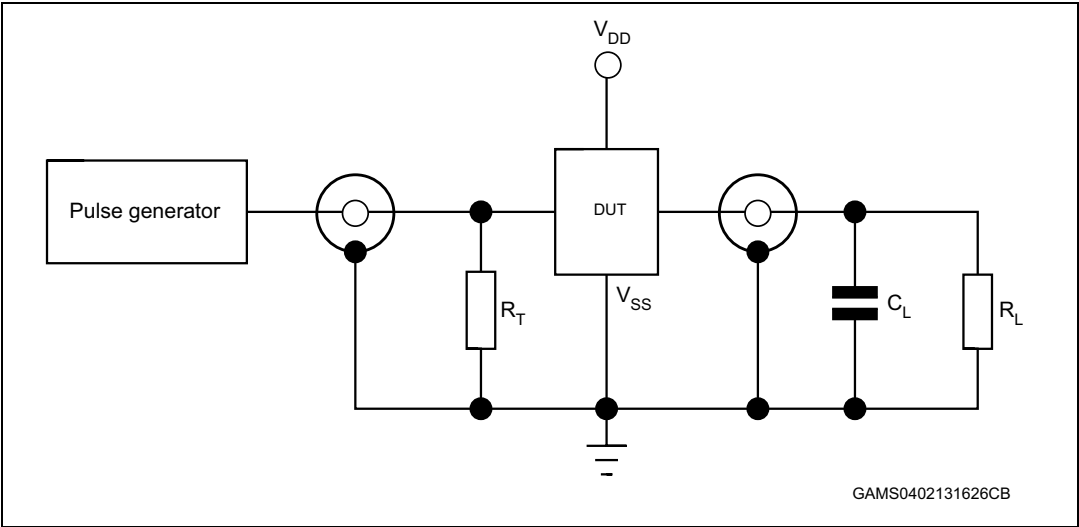
| Symbol             | Parameter                                           | Test condition | Value <sup>(1)</sup> |      |      | Unit          |
|--------------------|-----------------------------------------------------|----------------|----------------------|------|------|---------------|
|                    |                                                     | $V_{DD}$ (V)   | Min.                 | Typ. | Max. |               |
| $t_{TLH}, t_{THL}$ | Propagation delay time<br>(CLOCK to Q or Q outputs) | 5              |                      | 150  | 300  | ns            |
|                    |                                                     | 10             |                      | 65   | 130  |               |
|                    |                                                     | 15             |                      | 45   | 90   |               |
| $t_{PLH}$          | Propagation delay time<br>(SET to Q or RESET to Q)  | 5              |                      | 150  | 300  |               |
|                    |                                                     | 10             |                      | 65   | 130  |               |
|                    |                                                     | 15             |                      | 45   | 90   |               |
| $t_{PHL}$          | Propagation delay time<br>(SET to Q or RESET to Q)  | 5              |                      | 200  | 400  |               |
|                    |                                                     | 10             |                      | 85   | 170  |               |
|                    |                                                     | 15             |                      | 60   | 120  |               |
| $t_{THL}, t_{TLH}$ | Transition time                                     | 5              |                      | 100  | 200  |               |
|                    |                                                     | 10             |                      | 50   | 100  |               |
|                    |                                                     | 15             |                      | 40   | 80   |               |
| $f_{CL}^{(2)}$     | Maximum clock input frequency                       | 5              | 3.5                  | 7    |      | MHz           |
|                    |                                                     | 10             | 8                    | 16   |      |               |
|                    |                                                     | 15             | 12                   | 24   |      |               |
| $t_W$              | Clock pulse width                                   | 5              | 140                  | 70   |      | ns            |
|                    |                                                     | 10             | 60                   | 30   |      |               |
|                    |                                                     | 15             | 40                   | 20   |      |               |
|                    | Set or reset pulse width                            | 5              | 180                  | 90   |      |               |
|                    |                                                     | 10             | 80                   | 40   |      |               |
|                    |                                                     | 15             | 50                   | 25   |      |               |
| $t_r, t_f^{(3)}$   | Clock input rise or fall time                       | 5              |                      |      | 15   | $\mu\text{s}$ |
|                    |                                                     | 10             |                      |      | 4    |               |
|                    |                                                     | 15             |                      |      | 1    |               |
| $t_s$              | Data setup time                                     | 5              | 40                   | 20   |      | ns            |
|                    |                                                     | 10             | 20                   | 10   |      |               |
|                    |                                                     | 15             | 15                   | 7    |      |               |

1. The typical temperature coefficient for all  $V_{DD}$  values is 0.3 %/ $^{\circ}\text{C}$ .

2. Input  $t_r, t_f = 5\text{ ns}$

3. If more than one unit is cascaded in a parallel clocked application,  $t_r$  should be made less than or equal to the sum of the fixed propagation delay time at 15 pF and the transition time of the carry output driving stage for the estimated capacitive load.

Figure 4. Test circuit



1. Legend:  $C_L = 50$  pF or equivalent (includes jig and probe capacitance),  $R_L = 200$  K $\Omega$ ,  $R_T = Z_{OUT}$  of pulse generator (typically 50  $\Omega$ )

Figure 5. Dn to Qn timings (50 % clock duty cycle)

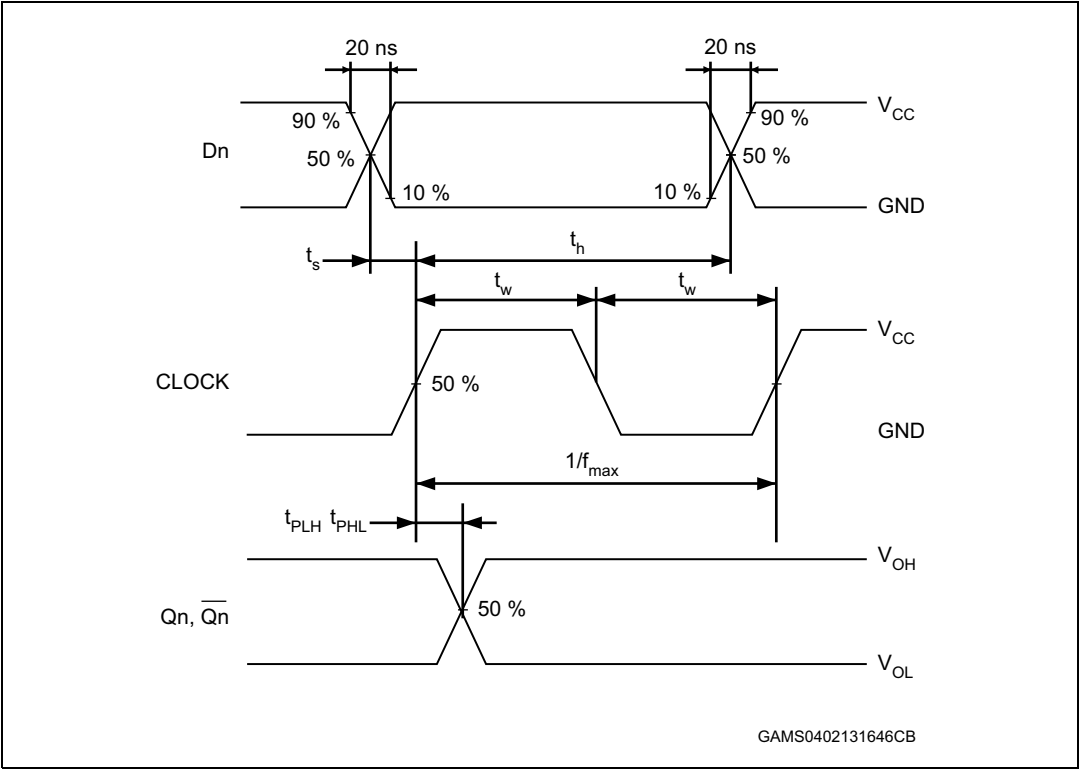
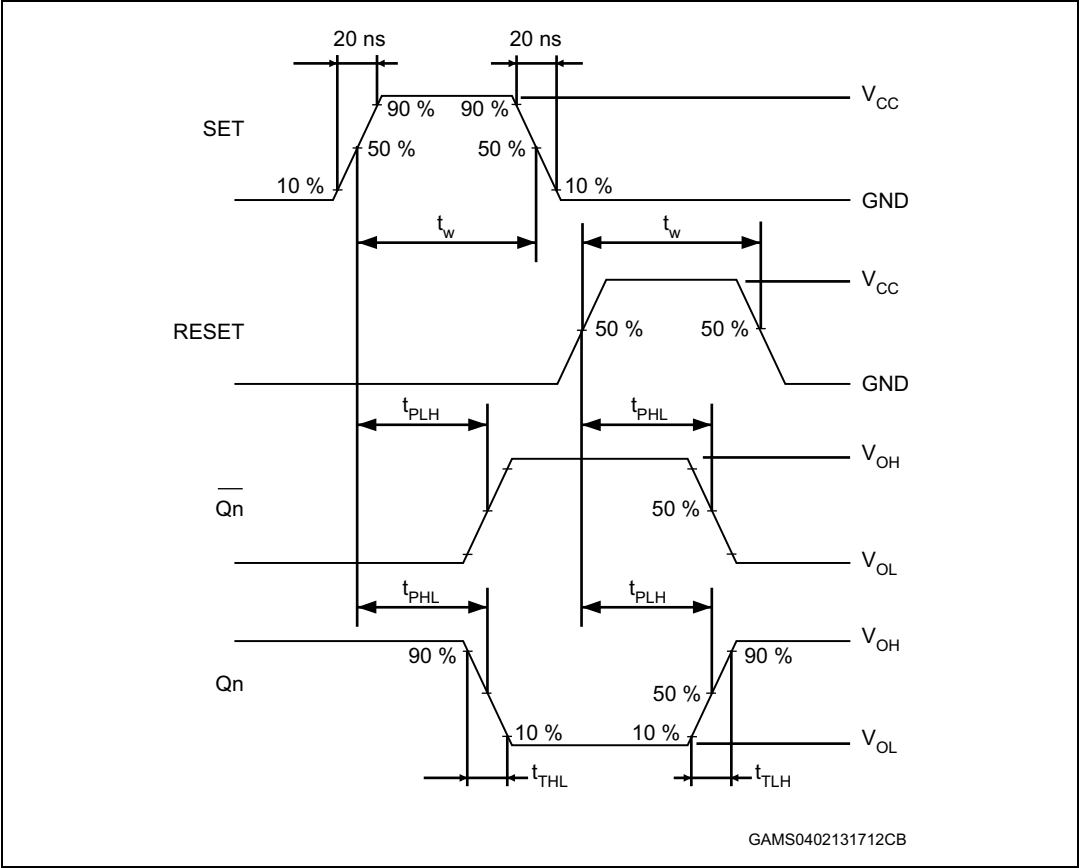


Figure 6. Set and reset timings



## 4 Package information

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

### 4.1 PDIP14 package information

Figure 7. PDIP14 package mechanical drawing

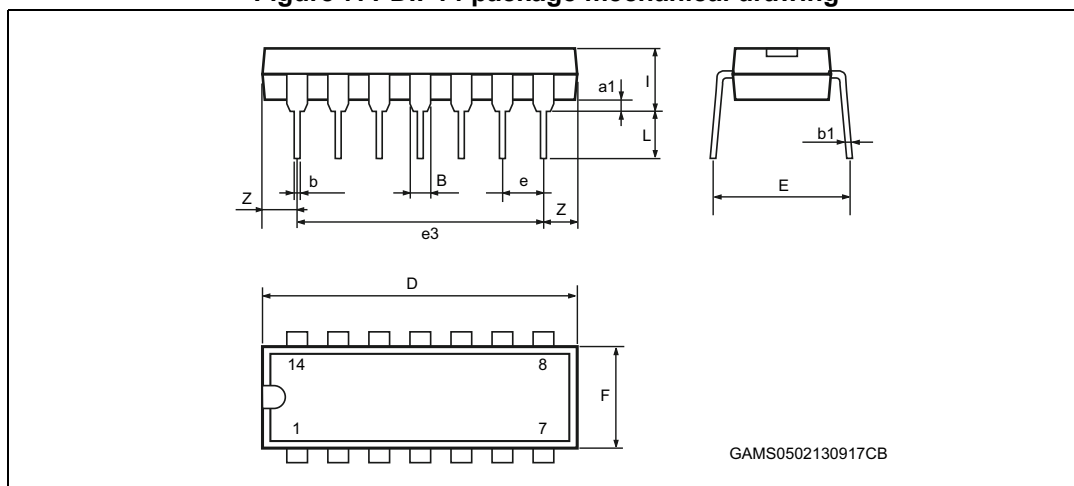


Table 8. PDIP14 package mechanical data

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

## 4.2 SO14 package information

Figure 8. SO14 package mechanical drawing

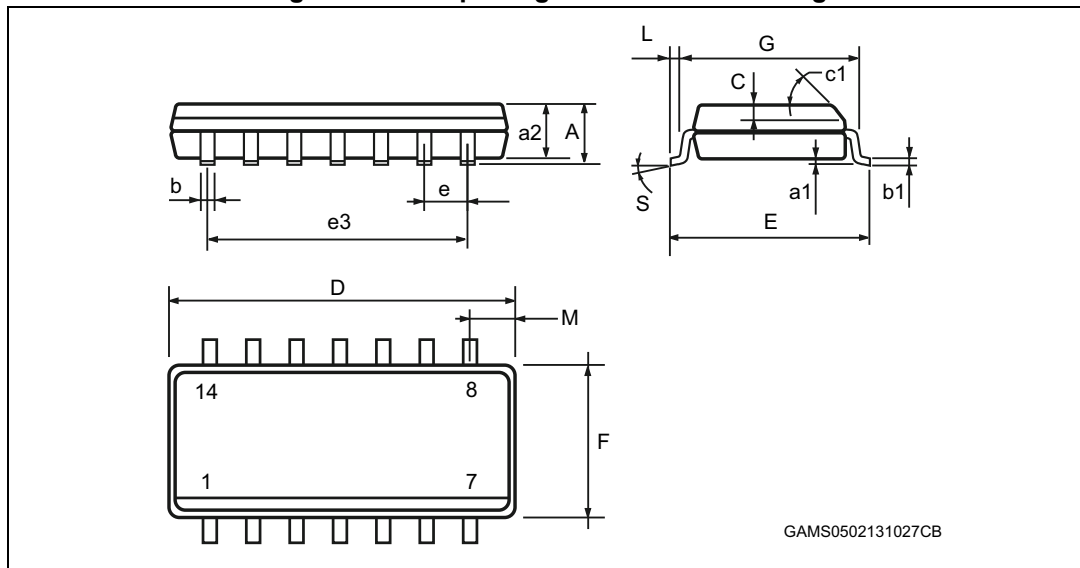


Table 9. SO14 package mechanical data

| 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 ° |      |        | 45 °  |       |
| 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 °  |        |       | 8 °   |

## 5 Ordering information

Table 10. Order codes

| Order code        | Temperature range   | Package                                   | Packing       | Marking   |
|-------------------|---------------------|-------------------------------------------|---------------|-----------|
| HCF4013M013TR     | -55 ° C to +125 ° C | SO14                                      | Tape and reel | HCF4013   |
| HCF4013YM013TR(1) | -40 ° C to +125 ° C | SO14<br>(automotive grade) <sup>(1)</sup> |               | HCF4013Y  |
| HCF4013BEY        | -55 ° C to +125 ° C | PDIP14                                    | Tube          | HCF4013BE |

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

## 6 Revision history

Table 11. Document revision history

| Date        | Revision | Changes                                                                                                                                                                                                                                                                                                                                                                                              |
|-------------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Sep-2001    | 1        | Initial release.                                                                                                                                                                                                                                                                                                                                                                                     |
| 18-Feb-2013 | 2        | Document template and layout updated<br>Removed "B" from part number<br>Added ESD information to <a href="#">Features</a><br>Updated package names (PDIP-14 and SO-14 instead of DIP-14 and SOP-14).<br>Added <a href="#">Applications</a><br>Added <a href="#">Device summary table</a><br>Updated symbol names in <a href="#">Table 7</a><br>Added <a href="#">Section 5: Ordering information</a> |
| 30-Apr-2013 | 3        | <a href="#">Features</a> : updated ESD information                                                                                                                                                                                                                                                                                                                                                   |
| 30-May-2013 | 4        | <a href="#">Features</a> : updated ESD information<br>Updated footnote in <a href="#">Table 1</a> and <a href="#">Table 10</a>                                                                                                                                                                                                                                                                       |

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