

# 74AHC14-Q100; 74AHCT14-Q100

Hex inverting Schmitt trigger

Rev. 2 — 16 June 2020

Product data sheet

## 1. General description

The 74AHC14-Q100; 74AHCT14-Q100 is a hex inverter with Schmitt-trigger inputs. Inputs are overvoltage tolerant. This feature allows the use of these devices as translators in mixed voltage environments.

This product has been qualified to the Automotive Electronics Council (AEC) standard Q100 (Grade 1) and is suitable for use in automotive applications.

## 2. Features and benefits

- Automotive product qualification in accordance with AEC-Q100 (Grade 1)
  - Specified from -40 °C to +85 °C and from -40 °C to +125 °C
- Wide supply voltage range from 2.0 V to 5.5 V
- Overvoltage tolerant inputs to 5.5 V
- High noise immunity
- CMOS low power dissipation
- Balanced propagation delays
- Input levels:
  - For 74AHC14-Q100: CMOS level
  - For 74AHCT14-Q100: TTL level
- ESD protection:
  - MIL-STD-883, method 3015 exceeds 2000 V
  - HBM JESD22-A114F exceeds 2000 V
  - MM JESD22-A115-A exceeds 200 V (C = 200 pF, R = 0 Ω)
- Latch-up performance exceeds 100 mA per JESD 78 Class II Level A
- Multiple package options
- DHVQFN package with Side-Wettable Flanks enabling Automatic Optical Inspection (AOI) of solder joints

## 3. Ordering information

Table 1. Ordering information

| Type number     | Package           |          |  |          |
|-----------------|-------------------|----------|--|----------|
|                 | Temperature range | Name     | Description  | Version  |
| 74AHC14D-Q100   | -40 °C to +125 °C | SO14     | plastic small outline package; 14 leads; body width 3.9 mm   | SOT108-1 |
| 74AHCT14D-Q100  |                   |          |  |          |
| 74AHC14PW-Q100  | -40 °C to +125 °C | TSSOP14  | plastic thin shrink small outline package; 14 leads; body width 4.4 mm   | SOT402-1 |
| 74AHCT14PW-Q100 |                   |          |  |          |
| 74AHC14BQ-Q100  | -40 °C to +125 °C | DHVQFN14 | plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 14 terminals; body 2.5 × 3 × 0.85 mm | SOT762-1 |
| 74AHCT14BQ-Q100 |                   |          |  |          |

### 4. Functional diagram



### 5. Pinning information

#### 5.1. Pinning



## 5.2. Pin description

Table 2. Pin description

| Symbol                 | Pin                | Description    |
|------------------------|--------------------|----------------|
| 1A, 2A, 3A, 4A, 5A, 6A | 1, 3, 5, 9, 11, 13 | data input     |
| 1Y, 2Y, 3Y, 4Y, 5Y, 6Y | 2, 4, 6, 8, 10, 12 | data output    |
| GND                    | 7                  | ground (0 V)   |
| V <sub>CC</sub>        | 14                 | supply voltage |

## 6. Functional description

Table 3. Function table

H = HIGH voltage level; L = LOW voltage level.

| Input | Output |
|-------|--------|
| nA    | nY     |
| L     | H      |
| H     | L      |

## 7. Limiting values

Table 4. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND (ground = 0 V).

| Symbol           | Parameter               | Conditions  | Min  | Max  | Unit |
|------------------|-------------------------|---|------|------|------|
| V <sub>CC</sub>  | supply voltage          |   | -0.5 | +7.0 | V    |
| V <sub>I</sub>   | input voltage           |   | -0.5 | +7.0 | V    |
| I <sub>IK</sub>  | input clamping current  | V <sub>I</sub> < -0.5 V [1]   | -20  | -    | mA   |
| I <sub>OK</sub>  | output clamping current | V <sub>O</sub> < -0.5 V or V <sub>O</sub> > V <sub>CC</sub> + 0.5 V [1] | -20  | +20  | mA   |
| I <sub>O</sub>   | output current          | V <sub>O</sub> = -0.5 V to (V <sub>CC</sub> + 0.5 V)                    | -25  | +25  | mA   |
| I <sub>CC</sub>  | supply current          |   | -    | +75  | mA   |
| I <sub>GND</sub> | ground current          |   | -75  | -    | mA   |
| T <sub>stg</sub> | storage temperature     |   | -65  | +150 | °C   |
| P <sub>tot</sub> | total power dissipation | T <sub>amb</sub> = -40 °C to +125 °C [2]                                | -    | 500  | mW   |

[1] The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

[2] For SOT108-1 (SO14) package: P<sub>tot</sub> derates linearly with 10.1 mW/K above 100 °C.

For SOT402-1 (TSSOP14) package: P<sub>tot</sub> derates linearly with 7.3 mW/K above 81 °C.

For SOT762-1 (DHVQFN14) package: P<sub>tot</sub> derates linearly with 9.6 mW/K above 98 °C.

## 8. Recommended operating conditions

**Table 5. Recommended operating conditions**

Voltages are referenced to GND (ground = 0 V).

| Symbol           | Parameter           | Conditions | 74AHC14-Q100 |     |                 | 74AHCT14-Q100 |     |                 | Unit |
|------------------|---------------------|------------|--------------|-----|-----------------|---------------|-----|-----------------|------|
|                  |                     |            | Min          | Typ | Max             | Min           | Typ | Max             |      |
| V <sub>CC</sub>  | supply voltage      |            | 2.0          | 5.0 | 5.5             | 4.5           | 5.0 | 5.5             | V    |
| V <sub>I</sub>   | input voltage       |            | 0            | -   | 5.5             | 0             | -   | 5.5             | V    |
| V <sub>O</sub>   | output voltage      |            | 0            | -   | V <sub>CC</sub> | 0             | -   | V <sub>CC</sub> | V    |
| T <sub>amb</sub> | ambient temperature |            | -40          | +25 | +125            | -40           | +25 | +125            | °C   |

## 9. Static characteristics

**Table 6. Static characteristics**

At recommended operating conditions; voltages are referenced to GND (ground = 0 V).

| Symbol              | Parameter                 | Conditions  | 25 °C |     |      | -40 °C to +85 °C |      | -40 °C to +125 °C |      | Unit |
|---------------------|---------------------------|---|-------|-----|------|------------------|------|-------------------|------|------|
|                     |                           |   | Min   | Typ | Max  | Min              | Max  | Min               | Max  |      |
| <b>74AHC14-Q100</b> |                           |   |       |     |      |                  |      |                   |      |      |
| V <sub>OH</sub>     | HIGH-level output voltage | V <sub>I</sub> = V <sub>T+</sub> or V <sub>T-</sub>                                       |       |     |      |                  |      |                   |      |      |
|                     |                           | I <sub>O</sub> = -50 µA; V <sub>CC</sub> = 2.0 V  | 1.9   | 2.0 | -    | 1.9              | -    | 1.9               | -    | V    |
|                     |                           | I <sub>O</sub> = -50 µA; V <sub>CC</sub> = 3.0 V  | 2.9   | 3.0 | -    | 2.9              | -    | 2.9               | -    | V    |
|                     |                           | I <sub>O</sub> = -50 µA; V <sub>CC</sub> = 4.5 V  | 4.4   | 4.5 | -    | 4.4              | -    | 4.4               | -    | V    |
|                     |                           | I <sub>O</sub> = -4.0 mA; V <sub>CC</sub> = 3.0 V   | 2.58  | -   | -    | 2.48             | -    | 2.40              | -    | V    |
|                     |                           | I <sub>O</sub> = -8.0 mA; V <sub>CC</sub> = 4.5 V   | 3.94  | -   | -    | 3.80             | -    | 3.70              | -    | V    |
| V <sub>OL</sub>     | LOW-level output voltage  | V <sub>I</sub> = V <sub>T+</sub> or V <sub>T-</sub>                                       |       |     |      |                  |      |                   |      |      |
|                     |                           | I <sub>O</sub> = 50 µA; V <sub>CC</sub> = 2.0 V   | -     | 0   | 0.1  | -                | 0.1  | -                 | 0.1  | V    |
|                     |                           | I <sub>O</sub> = 50 µA; V <sub>CC</sub> = 3.0 V   | -     | 0   | 0.1  | -                | 0.1  | -                 | 0.1  | V    |
|                     |                           | I <sub>O</sub> = 50 µA; V <sub>CC</sub> = 4.5 V   | -     | 0   | 0.1  | -                | 0.1  | -                 | 0.1  | V    |
|                     |                           | I <sub>O</sub> = 4.0 mA; V <sub>CC</sub> = 3.0 V  | -     | -   | 0.36 | -                | 0.44 | -                 | 0.55 | V    |
|                     |                           | I <sub>O</sub> = 8.0 mA; V <sub>CC</sub> = 4.5 V  | -     | -   | 0.36 | -                | 0.44 | -                 | 0.55 | V    |
| I <sub>I</sub>      | input leakage current     | V <sub>I</sub> = 5.5 V or GND;<br>V <sub>CC</sub> = 0 V to 5.5 V                          | -     | -   | 0.1  | -                | 1.0  | -                 | 2.0  | µA   |
| I <sub>CC</sub>     | supply current            | V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A;<br>V <sub>CC</sub> = 5.5 V | -     | -   | 2.0  | -                | 20   | -                 | 40   | µA   |
| C <sub>I</sub>      | input capacitance         |   | -     | 3   | 10   | -                | 10   | -                 | 10   | pF   |
| C <sub>O</sub>      | output capacitance        |   | -     | 4   | -    | -                | -    | -                 | -    | pF   |

| Symbol               | Parameter                 | Conditions  | 25 °C |     |      | -40 °C to +85 °C |      | -40 °C to +125 °C |      | Unit |
|----------------------|---------------------------|---|-------|-----|------|------------------|------|-------------------|------|------|
|                      |                           |   | Min   | Typ | Max  | Min              | Max  | Min               | Max  |      |
| <b>74AHCT14-Q100</b> |                           |   |       |     |      |                  |      |                   |      |      |
| V <sub>OH</sub>      | HIGH-level output voltage | V <sub>I</sub> = V <sub>T+</sub> or V <sub>T-</sub>   |       |     |      |                  |      |                   |      |      |
|                      |                           | I <sub>O</sub> = -50 μA; V <sub>CC</sub> = 4.5 V  | 4.4   | 4.5 | -    | 4.4              | -    | 4.4               | -    | V    |
|                      |                           | I <sub>O</sub> = -8.0 mA; V <sub>CC</sub> = 4.5 V   | 3.94  | -   | -    | 3.80             | -    | 3.70              | -    | V    |
| V <sub>OL</sub>      | LOW-level output voltage  | V <sub>I</sub> = V <sub>T+</sub> or V <sub>T-</sub>   |       |     |      |                  |      |                   |      |      |
|                      |                           | I <sub>O</sub> = 50 μA; V <sub>CC</sub> = 4.5 V   | -     | 0   | 0.1  | -                | 0.1  | -                 | 0.1  | V    |
|                      |                           | I <sub>O</sub> = 8.0 mA; V <sub>CC</sub> = 4.5 V  | -     | -   | 0.36 | -                | 0.44 | -                 | 0.55 | V    |
| I <sub>I</sub>       | input leakage current     | V <sub>I</sub> = 5.5 V or GND;<br>V <sub>CC</sub> = 0 V to 5.5 V  | -     | -   | 0.1  | -                | 1.0  | -                 | 2.0  | μA   |
| I <sub>CC</sub>      | supply current            | V <sub>I</sub> = V <sub>CC</sub> or GND; I <sub>O</sub> = 0 A;<br>V <sub>CC</sub> = 5.5 V   | -     | -   | 2.0  | -                | 20   | -                 | 40   | μA   |
| ΔI <sub>CC</sub>     | additional supply current | per input pin; V <sub>I</sub> = V <sub>CC</sub> - 2.1 V;<br>other pins at V <sub>CC</sub> or GND;<br>I <sub>O</sub> = 0 A; V <sub>CC</sub> = 4.5 V to 5.5 V | -     | -   | 1.35 | -                | 1.5  | -                 | 1.5  | mA   |
| C <sub>I</sub>       | input capacitance         |   | -     | 3   | 10   | -                | 10   | -                 | 10   | pF   |
| C <sub>O</sub>       | output capacitance        |   | -     | 4   | -    | -                | -    | -                 | -    | pF   |

## 10. Dynamic characteristics

**Table 7. Dynamic characteristics**

Voltages are referenced to GND (ground = 0 V); for test circuit see Fig. 7.

| Symbol              | Parameter                     | Conditions  | 25 °C |        |      | -40 °C to +85 °C |      | -40 °C to +125 °C |      | Unit |
|---------------------|-------------------------------|---|-------|--------|------|------------------|------|-------------------|------|------|
|                     |                               |   | Min   | Typ[1] | Max  | Min              | Max  | Min               | Max  |      |
| <b>74AHC14-Q100</b> |                               |   |       |        |      |                  |      |                   |      |      |
| t <sub>pd</sub>     | propagation delay             | nA to nY; see Fig. 6 [2]  |       |        |      |                  |      |                   |      |      |
|                     |                               | V <sub>CC</sub> = 3.0 V to 3.6 V                                    |       |        |      |                  |      |                   |      |      |
|                     |                               | C <sub>L</sub> = 15 pF  | -     | 4.3    | 12.8 | 1.0              | 15.0 | 1.0               | 16.0 | ns   |
|                     |                               | C <sub>L</sub> = 50 pF  | -     | 5.8    | 16.3 | 1.0              | 18.0 | 1.0               | 20.5 | ns   |
|                     |                               | V <sub>CC</sub> = 4.5 V to 5.5 V                                    |       |        |      |                  |      |                   |      |      |
|                     |                               | C <sub>L</sub> = 15 pF  | -     | 3.2    | 8.6  | 1.0              | 10.0 | 1.0               | 11.0 | ns   |
|                     |                               | C <sub>L</sub> = 50 pF  | -     | 4.2    | 10.6 | 1.0              | 12.0 | 1.0               | 13.5 | ns   |
| C <sub>PD</sub>     | power dissipation capacitance | f <sub>i</sub> = 1 MHz; V <sub>I</sub> = GND to V <sub>CC</sub> [3] | -     | 10     | -    | -                | -    | -                 | -    | pF   |

| Symbol               | Parameter                     | Conditions  | 25 °C |        |     | -40 °C to +85 °C |     | -40 °C to +125 °C |      | Unit |
|----------------------|-------------------------------|---|-------|--------|-----|------------------|-----|-------------------|------|------|
|                      |                               |   | Min   | Typ[1] | Max | Min              | Max | Min               | Max  |      |
| <b>74AHCT14-Q100</b> |                               |   |       |        |     |                  |     |                   |      |      |
| t <sub>pd</sub>      | propagation delay             | nA to nY; see Fig. 6 [2]  |       |        |     |                  |     |                   |      |      |
|                      |                               | V <sub>CC</sub> = 4.5 V to 5.5 V                                    |       |        |     |                  |     |                   |      |      |
|                      |                               | C <sub>L</sub> = 15 pF  | -     | 4.0    | 7.0 | 1.0              | 8.0 | 1.0               | 9.0  | ns   |
|                      |                               | C <sub>L</sub> = 50 pF  | -     | 5.4    | 8.0 | 1.0              | 9.0 | 1.0               | 10.0 | ns   |
| C <sub>PD</sub>      | power dissipation capacitance | f <sub>i</sub> = 1 MHz; V <sub>I</sub> = GND to V <sub>CC</sub> [3] | -     | 12     | -   | -                | -   | -                 | -    | pF   |

[1] Typical values are measured at nominal supply voltage (V<sub>CC</sub> = 3.3 V and V<sub>CC</sub> = 5.0 V).

[2] t<sub>pd</sub> is the same as t<sub>PLH</sub> and t<sub>PHL</sub>.

[3] C<sub>PD</sub> is used to determine the dynamic power dissipation (P<sub>D</sub> in μW).

$$P_D = C_{PD} \times V_{CC}^2 \times f_i \times N + \sum(C_L \times V_{CC}^2 \times f_o) \text{ where:}$$

f<sub>i</sub> = input frequency in MHz;

f<sub>o</sub> = output frequency in MHz;

C<sub>L</sub> = output load capacitance in pF;

V<sub>CC</sub> = supply voltage in V;

N = number of inputs switching;

∑(C<sub>L</sub> × V<sub>CC</sub><sup>2</sup> × f<sub>o</sub>) = sum of the outputs.

### 10.1. Waveforms and test circuit



Fig. 6. Input to output propagation delays

Table 8. Measurement points

| Type          | Input                 | Output                |
|---------------|-----------------------|-----------------------|
|               | V <sub>M</sub>        | V <sub>M</sub>        |
| 74AHC14-Q100  | 0.5 × V <sub>CC</sub> | 0.5 × V <sub>CC</sub> |
| 74AHCT14-Q100 | 1.5 V                 | 0.5 × V <sub>CC</sub> |



Fig. 7. Test circuit for measuring switching times

Table 9. Test data

| Type          | Input    |               | Load         | Test               |
|---------------|----------|---------------|--------------|--------------------|
|               | $V_I$    | $t_r, t_f$    | $C_L$        |                    |
| 74AHC14-Q100  | $V_{CC}$ | $\leq 3.0$ ns | 50 pF, 15 pF | $t_{PLH}, t_{PHL}$ |
| 74AHCT14-Q100 | 3.0 V    | $\leq 3.0$ ns | 50 pF, 15 pF | $t_{PLH}, t_{PHL}$ |

## 10.2. Transfer characteristics

Table 10. Transfer characteristics

At recommended operating conditions; voltages are referenced to GND (ground = 0 V); see [Fig. 8](#) and [Fig. 9](#).

| Symbol              | Parameter                        | Conditions       | 25 °C |     |      | -40 °C to +85 °C |      | -40 °C to +125 °C |      | Unit |
|---------------------|----------------------------------|------------------|-------|-----|------|------------------|------|-------------------|------|------|
|                     |                                  |                  | Min   | Typ | Max  | Min              | Max  | Min               | Max  |      |
| <b>74AHC14-Q100</b> |                                  |                  |       |     |      |                  |      |                   |      |      |
| $V_{T+}$            | positive-going threshold voltage | $V_{CC} = 3.0$ V | -     | -   | 2.2  | -                | 2.2  | -                 | 2.2  | V    |
|                     |                                  | $V_{CC} = 4.5$ V | -     | -   | 3.15 | -                | 3.15 | -                 | 3.15 | V    |
|                     |                                  | $V_{CC} = 5.5$ V | -     | -   | 3.85 | -                | 3.85 | -                 | 3.85 | V    |
| $V_{T-}$            | negative-going threshold voltage | $V_{CC} = 3.0$ V | 0.9   | -   | -    | 0.9              | -    | 0.9               | -    | V    |
|                     |                                  | $V_{CC} = 4.5$ V | 1.35  | -   | -    | 1.35             | -    | 1.35              | -    | V    |
|                     |                                  | $V_{CC} = 5.5$ V | 1.65  | -   | -    | 1.65             | -    | 1.65              | -    | V    |
| $V_H$               | hysteresis voltage               | $V_{CC} = 3.0$ V | 0.3   | -   | 1.2  | 0.3              | 1.2  | 0.25              | 1.2  | V    |
|                     |                                  | $V_{CC} = 4.5$ V | 0.4   | -   | 1.4  | 0.4              | 1.4  | 0.35              | 1.4  | V    |
|                     |                                  | $V_{CC} = 5.5$ V | 0.5   | -   | 1.6  | 0.5              | 1.6  | 0.45              | 1.6  | V    |

| Symbol               | Parameter                        | Conditions              | 25 °C |     |     | -40 °C to +85 °C |     | -40 °C to +125 °C |     | Unit |
|----------------------|----------------------------------|-------------------------|-------|-----|-----|------------------|-----|-------------------|-----|------|
|                      |                                  |                         | Min   | Typ | Max | Min              | Max | Min               | Max |      |
| <b>74AHCT14-Q100</b> |                                  |                         |       |     |     |                  |     |                   |     |      |
| V <sub>T+</sub>      | positive-going threshold voltage | V <sub>CC</sub> = 4.5 V | -     | -   | 1.9 | -                | 1.9 | -                 | 1.9 | V    |
|                      |                                  | V <sub>CC</sub> = 5.5 V | -     | -   | 2.1 | -                | 2.1 | -                 | 2.1 | V    |
| V <sub>T-</sub>      | negative-going threshold voltage | V <sub>CC</sub> = 4.5 V | 0.5   | -   | -   | 0.5              | -   | 0.5               | -   | V    |
|                      |                                  | V <sub>CC</sub> = 5.5 V | 0.6   | -   | -   | 0.6              | -   | 0.6               | -   | V    |
| V <sub>H</sub>       | hysteresis voltage               | V <sub>CC</sub> = 4.5 V | 0.4   | -   | 1.4 | 0.4              | 1.4 | 0.35              | 1.4 | V    |
|                      |                                  | V <sub>CC</sub> = 5.5 V | 0.4   | -   | 1.5 | 0.4              | 1.5 | 0.35              | 1.5 | V    |

10.3. Transfer characteristics waveforms







## 11. Application information



$$\text{For 74AHC14-Q100: } f = \frac{1}{T} \approx \frac{1}{0.55 \times RC}$$

$$\text{For 74AHCT14-Q100: } f = \frac{1}{T} \approx \frac{1}{0.60 \times RC}$$

**Fig. 12. Relaxation oscillator**

## 12. Package outline

SO14: plastic small outline package; 14 leads; body width 3.9 mm

SOT108-1



Fig. 13. Package outline SOT108-1 (SO14)

TSSOP14: plastic thin shrink small outline package; 14 leads; body width 4.4 mm

SOT402-1



Fig. 14. Package outline SOT402-1 (TSSOP14)

DHVQFN14: plastic dual in-line compatible thermal enhanced very thin quad flat package; no leads; 14 terminals; body 2.5 x 3 x 0.85 mm

SOT762-1



Fig. 15. Package outline SOT762-1 (DHVQFN14)

## 13. Abbreviations

Table 11. Abbreviations

| Acronym | Description                             |
|---------|---|
| CMOS    | Complementary Metal-Oxide Semiconductor |
| DUT     | Device Under Test                       |
| ESD     | ElectroStatic Discharge                 |
| HBM     | Human Body Model                        |
| MIL     | Military                                |
| MM      | Machine Model                           |

## 14. Revision history

Table 12. Revision history

| Document ID           | Release date  | Data sheet status  | Change notice | Supersedes            |
|-----------------------|---|--------------------|---------------|-----------------------|
| 74AHC_AHCT14_Q100 v.2 | 20200616  | Product data sheet | -             | 74AHC_AHCT14_Q100 v.1 |
| Modifications:        | <ul style="list-style-type: none"> <li>The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia.</li> <li>Legal texts have been adapted to the new company name where appropriate.</li> <li><a href="#">Section 1</a> and <a href="#">Section 2</a> updated.</li> <li><a href="#">Table 4</a>: Derating values for <math>P_{tot}</math> total power dissipation have been updated.</li> <li>Package outline drawing of SOT762-1 (<a href="#">Fig. 15</a>) updated.</li> </ul> |                    |               |                       |
| 74AHC_AHCT14_Q100 v.1 | 20120709  | Product data sheet | -             | -                     |

## 15. Legal information

### Data sheet status

| Document status [1][2]         | Product status [3] | Definition  |
|--------------------------------|--------------------|---|
| Objective [short] data sheet   | Development        | This document contains data from the objective specification for product development. |
| Preliminary [short] data sheet | Qualification      | This document contains data from the preliminary specification.                       |
| Product [short] data sheet     | Production         | This document contains the product specification.                                     |

- [1] Please consult the most recently issued document before initiating or completing a design.
- [2] The term 'short data sheet' is explained in section "Definitions".
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