# HEF4014B

## 8-bit static shift register

Rev. 12 — 8 August 2024 Product data sheet

## 1. General description

The HEF4014B is an 8-bit shift register with synchronous parallel enable. Inputs include clamp diodes. This enables the use of current limiting resistors to interface inputs to voltages in excess of $V_{DD}$.

## 2. Features and benefits

- Wide supply voltage range from 3.0 V to 15.0 V
- CMOS low power dissipation
- High noise immunity
- Tolerant of slow clock rise and fall times
- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Complies with JEDEC standard JESD 13-B
- ESD protection:
  - HBM: ANSI/ESDA/JEDEC JS-001 class 2 exceeds 2000 V
  - CDM: ANSI/ESDA/JEDEC JS-002 class C3 exceeds 1000 V
- Specified from -40 °C to +85 °C

## 3. Applications

- Parallel-to-serial converter
- Serial data queueing
- General purpose register

## 4. Ordering information

**Table 1. Ordering information**

| Type number | Package | | | |
|---|---|---|---|---|
| | Temperature range | Name | Description | Version |
| HEF4014BT | -40 °C to +85 °C | SO16 | plastic small outline package; 16 leads; body width 3.9 mm | SOT109-1 |

## 5. Functional diagram

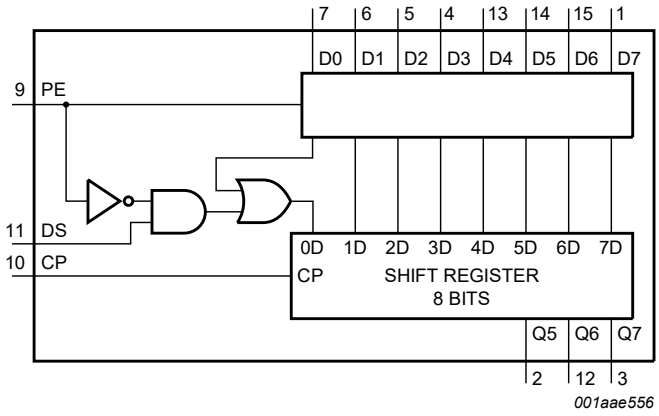



**Fig. 1. Functional diagram**

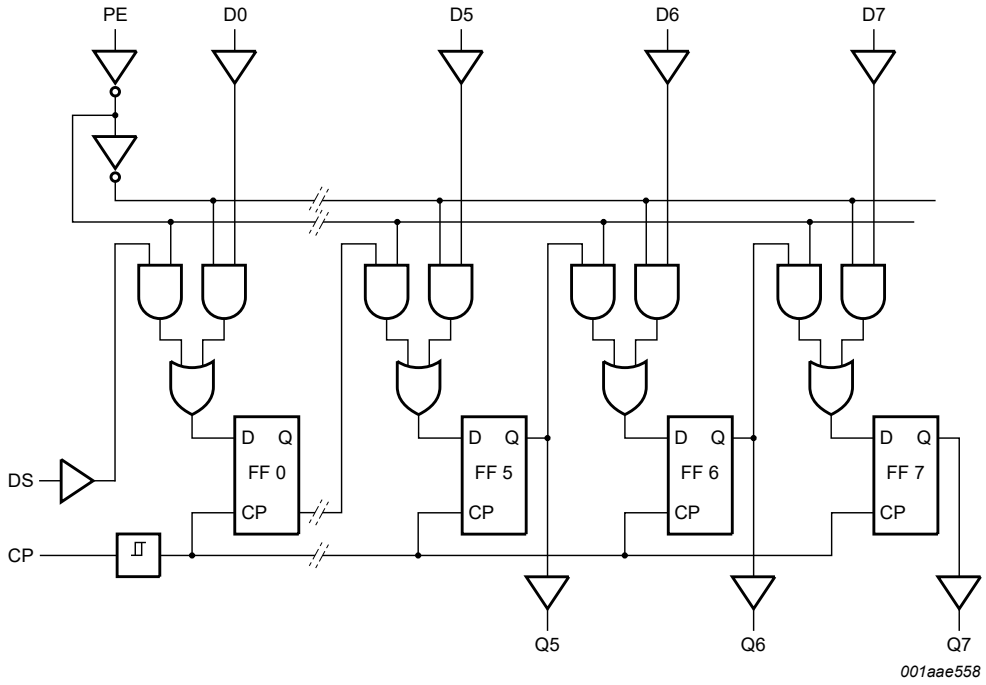
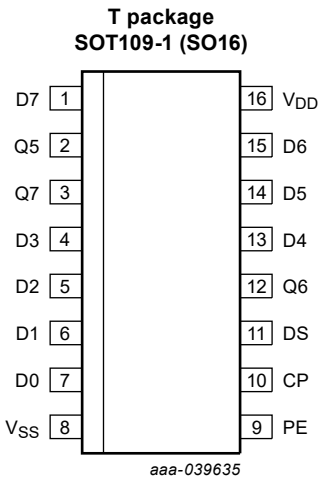



**Fig. 2. Logic diagram**

# 6. Pinning information

## 6.1. Pinning




## 6.2. Pin description

**Table 2. Pin description**

| Symbol | Pin | Description |
|---|---|---|
| Q5 to Q7 | 2, 12, 3 | output |
| D0 to D7 | 7, 6, 5, 4, 13, 14, 15, 1 | parallel data input |
| $V_{SS}$ | 8 | ground supply voltage |
| PE | 9 | parallel enable input |
| CP | 10 | clock input (LOW-to-HIGH edge-triggered) |
| DS | 11 | serial data input |
| $V_{DD}$ | 16 | supply voltage |

# 7. Functional description

**Table 3. Function table**

*H = HIGH voltage level; L = LOW voltage level; X = don't care; nD = HIGH or LOW;*
*↑ = LOW-to-HIGH clock transition; ↓ = HIGH-to-LOW clock transition.*

| Number of clock transitions | Inputs | | | Outputs | | |
|---|---|---|---|---|---|---|
| | CP | DS | PE | Q5 | Q6 | Q7 |
| **Serial operation** | | | | | | |
| 1 | ↑ | 1D | L | X | X | X |
| 2 | ↑ | 2D | L | X | X | X |
| 3 | ↑ | 3D | L | X | X | X |
| 6 | ↑ | X | L | 1D | X | X |
| 7 | ↑ | X | L | 2D | 1D | X |
| 8 | ↑ | X | L | 3D | 2D | 1D |
| | ↓ | X | X | no change | no change | no change |
| **Parallel operation** | | | | | | |
| 1 | ↑ | X | H | D5 | D6 | D7 |
| | ↓ | X | X | no change | no change | no change |

# 8. Limiting values

**Table 4. Limiting values**

*In accordance with the Absolute Maximum Rating System (IEC 60134).*

| Symbol | Parameter | Conditions | Min | Max | Unit |
|---|---|---|---|---|---|
| $V_{DD}$ | supply voltage | | -0.5 | +18 | V |
| $I_{IK}$ | input clamping current | $V_I$ < -0.5 V or $V_I$ > $V_{DD}$ + 0.5 V | - | ±10 | mA |
| $V_I$ | input voltage | | -0.5 | $V_{DD}$ + 0.5 | V |
| $I_{OK}$ | output clamping current | $V_O$ < -0.5 V or $V_O$ > $V_{DD}$ + 0.5 V | - | ±10 | mA |
| $I_{I/O}$ | input/output current | | - | ±10 | mA |
| $I_{DD}$ | supply current | | - | 50 | mA |
| $T_{stg}$ | storage temperature | | -65 | +150 | °C |
| $T_{amb}$ | ambient temperature | | -40 | +85 | °C |
| $P_{tot}$ | total power dissipation | $T_{amb}$ = -40 °C to +85 °C | - | 500 | mW |
| P | power dissipation | per output | - | 100 | mW |

# 9. Recommended operating conditions

**Table 5. Recommended operating conditions**

| Symbol | Parameter | Conditions | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{DD}$ | supply voltage | | 3 | - | 15 | V |
| $V_I$ | input voltage | | 0 | - | $V_{DD}$ | V |
| $T_{amb}$ | ambient temperature | in free air | -40 | - | +85 | °C |
| Δt/ΔV | input transition rise and fall rate | $V_{DD}$ = 5 V | - | - | 3.75 | µs/V |
| | | $V_{DD}$ = 10 V | - | - | 0.5 | µs/V |
| | | $V_{DD}$ = 15 V | - | - | 0.08 | µs/V |

## 10. Static characteristics

**Table 6. Static characteristics**

*$V_{SS}$ = 0 V; $V_I$ = $V_{SS}$ or $V_{DD}$ unless otherwise specified.*

| Symbol | Parameter | Conditions | $V_{DD}$ | $T_{amb}$ = -40 °C | | $T_{amb}$ = +25 °C | | $T_{amb}$ = +85 °C | | Unit |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Min | Max | Min | Max | Min | Max | |
| $V_{IH}$ | HIGH-level input voltage | $\|I_O\|$ < 1 µA | 5 V | 3.5 | - | 3.5 | - | 3.5 | - | V |
| | | | 10 V | 7.0 | - | 7.0 | - | 7.0 | - | V |
| | | | 15 V | 11.0 | - | 11.0 | - | 11.0 | - | V |
| $V_{IL}$ | LOW-level input voltage | $\|I_O\|$ < 1 µA | 5 V | - | 1.5 | - | 1.5 | - | 1.5 | V |
| | | | 10 V | - | 3.0 | - | 3.0 | - | 3.0 | V |
| | | | 15 V | - | 4.0 | - | 4.0 | - | 4.0 | V |
| $V_{OH}$ | HIGH-level output voltage | $\|I_O\|$ < 1 µA | 5 V | 4.95 | - | 4.95 | - | 4.95 | - | V |
| | | | 10 V | 9.95 | - | 9.95 | - | 9.95 | - | V |
| | | | 15 V | 14.95 | - | 14.95 | - | 14.95 | - | V |
| $V_{OL}$ | LOW-level output voltage | $\|I_O\|$ < 1 µA | 5 V | - | 0.05 | - | 0.05 | - | 0.05 | V |
| | | | 10 V | - | 0.05 | - | 0.05 | - | 0.05 | V |
| | | | 15 V | - | 0.05 | - | 0.05 | - | 0.05 | V |
| $I_{OH}$ | HIGH-level output current | $V_O$ = 2.5 V | 5 V | - | -1.7 | - | -1.4 | - | -1.1 | mA |
| | | $V_O$ = 4.6 V | 5 V | - | -0.52 | - | -0.44 | - | -0.36 | mA |
| | | $V_O$ = 9.5 V | 10 V | - | -1.3 | - | -1.1 | - | -0.9 | mA |
| | | $V_O$ = 13.5 V | 15 V | - | -3.6 | - | -3.0 | - | -2.4 | mA |
| $I_{OL}$ | LOW-level output current | $V_O$ = 0.4 V | 5 V | 0.52 | - | 0.44 | - | 0.36 | - | mA |
| | | $V_O$ = 0.5 V | 10 V | 1.3 | - | 1.1 | - | 0.9 | - | mA |
| | | $V_O$ = 1.5 V | 15 V | 3.6 | - | 3.0 | - | 2.4 | - | mA |
| $I_I$ | input leakage current | | 15 V | - | ±0.3 | - | ±0.3 | - | ±1.0 | µA |
| $I_{DD}$ | supply current | $I_O$ = 0 A | 5 V | - | 20 | - | 20 | - | 150 | µA |
| | | | 10 V | - | 40 | - | 40 | - | 300 | µA |
| | | | 15 V | - | 80 | - | 80 | - | 600 | µA |
| $C_I$ | input capacitance | | - | - | - | - | 7.5 | - | - | pF |

# 11. Dynamic characteristics

**Table 7. Dynamic characteristics**

*$T_{amb}$ = 25 °C; $V_{SS}$ = 0 V.*

| Symbol | Parameter | Conditions | $V_{DD}$ | Extrapolation formula [1] | Min | Typ | Max | Unit |
|---|---|---|---|---|---|---|---|---|
| $t_{PHL}$ | HIGH to LOW propagation delay | CP to Qn; see Fig. 3 | 5 V | 103 ns + (0.55 ns/pF)$C_L$ | - | 130 | 260 | ns |
| | | | 10 V | 44 ns + (0.23 ns/pF)$C_L$ | - | 55 | 110 | ns |
| | | | 15 V | 32 ns + (0.16 ns/pF)$C_L$ | - | 40 | 80 | ns |
| $t_{PLH}$ | LOW to HIGH propagation delay | CP to Qn; see Fig. 3 | 5 V | 88 ns + (0.55 ns/pF)$C_L$ | - | 115 | 230 | ns |
| | | | 10 V | 39 ns + (0.23 ns/pF)$C_L$ | - | 50 | 100 | ns |
| | | | 15 V | 32 ns + (0.16 ns/pF)$C_L$ | - | 40 | 80 | ns |
| $t_t$ | transition time | Qn output; see Fig. 3 | 5 V [2] | 10 ns + (1.00 ns/pF)$C_L$ | - | 60 | 120 | ns |
| | | | 10 V | 9 ns + (0.42 ns/pF)$C_L$ | - | 30 | 60 | ns |
| | | | 15 V | 6 ns + (0.28 ns/pF)$C_L$ | - | 20 | 40 | ns |
| $t_W$ | pulse width | CP input; minimum width; see Fig. 4 | 5 V | | 70 | 35 | - | ns |
| | | | 10 V | | 30 | 15 | - | ns |
| | | | 15 V | | 24 | 12 | - | ns |
| $t_{su}$ | set-up time | PE to CP; see Fig. 4 | 5 V | | 40 | 10 | - | ns |
| | | | 10 V | | 25 | 5 | - | ns |
| | | | 15 V | | 15 | 0 | - | ns |
| | | DS to CP; see Fig. 4 | 5 V | | +35 | -5 | - | ns |
| | | | 10 V | | +25 | -5 | - | ns |
| | | | 15 V | | 25 | 0 | - | ns |
| | | Dn to CP; see Fig. 4 | 5 V | | +35 | -5 | - | ns |
| | | | 10 V | | +25 | -5 | - | ns |
| | | | 15 V | | 25 | 0 | - | ns |
| $t_h$ | hold time | PE to CP; see Fig. 4 | 5 V | | +25 | -5 | - | ns |
| | | | 10 V | | 20 | 0 | - | ns |
| | | | 15 V | | 15 | 0 | - | ns |
| | | DS to CP; see Fig. 4 | 5 V | | 30 | 15 | - | ns |
| | | | 10 V | | 20 | 10 | - | ns |
| | | | 15 V | | 15 | 7 | - | ns |
| | | Dn to CP; see Fig. 4 | 5 V | | 30 | 15 | - | ns |
| | | | 10 V | | 20 | 10 | - | ns |
| | | | 15 V | | 15 | 7 | - | ns |
| $f_{clk(max)}$ | maximum clock frequency | see Fig. 4 | 5 V | | 6 | 13 | - | MHz |
| | | | 10 V | | 15 | 30 | - | MHz |
| | | | 15 V | | 20 | 40 | - | MHz |

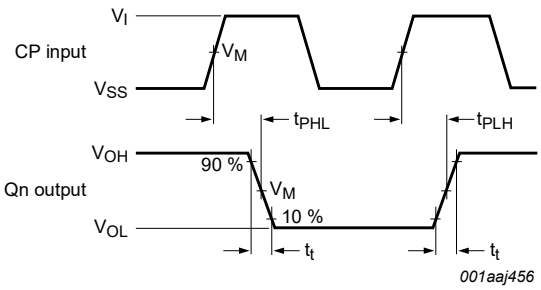
[1] The typical values of the propagation delay and transition times are calculated from the extrapolation formulas shown ($C_L$ in pF).
[2] $t_t$ is the same as $t_{THL}$ and $t_{TLH}$.

**Table 8. Dynamic power dissipation $P_D$**

*$P_D$ can be calculated from the formulas shown. $V_{SS}$ = 0 V; $t_r = t_f \leq 20$ ns; $T_{amb}$ = 25 °C.*

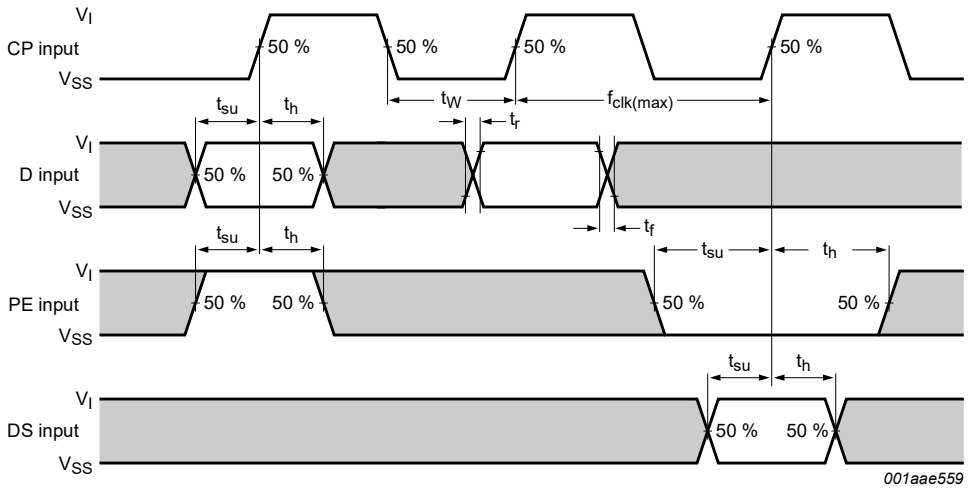
| Symbol | Parameter | $V_{DD}$ | Typical formula for $P_D$ (µW) | Where: |
|---|---|---|---|---|
| $P_D$ | dynamic power dissipation | 5 V | $P_D = 900 \times f_i + \sum(f_o \times C_L) \times V_{DD}^2$ | $f_i$ = input frequency in MHz;<br>$f_o$ = output frequency in MHz;<br>$C_L$ = output load capacitance in pF;<br>$V_{DD}$ = supply voltage in V;<br>$\sum(C_L \times f_o)$ = sum of the outputs. |
| | | 10 V | $P_D = 4300 \times f_i + \sum(f_o \times C_L) \times V_{DD}^2$ | |
| | | 15 V | $P_D = 12000 \times f_i + \sum(f_o \times C_L) \times V_{DD}^2$ | |

## 11.1. Waveforms and test circuit




Measurement points are given in Table 9.

**Fig. 3. CP to Qn propagation delays and output transition times**

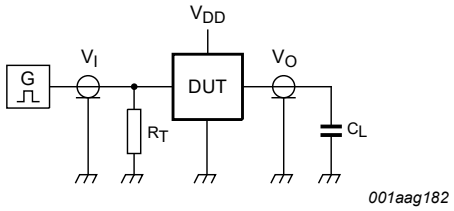



The shaded areas indicate where change is permitted for predictable output performance.
Set-up and hold times are shown as positive values but may be specified as negative values.
Measurement points are given in Table 9.

**Fig. 4. Minimum clock pulse width, and set-up and hold times for PE to CP, DS to CP, and D to CP**

**Table 9. Measurement points**

| Supply voltage | Input | Output |
|---|---|---|
| $V_{DD}$ | $V_M$ | $V_M$ |
| 5 V to 15 V | $0.5V_{DD}$ | $0.5V_{DD}$ |




Test data is given in Table 10.

Definitions test circuit:

$C_L$ = load capacitance including jig and probe capacitance;

$R_T$ = termination resistance should be equal to the output impedance $Z_o$ of the pulse generator.

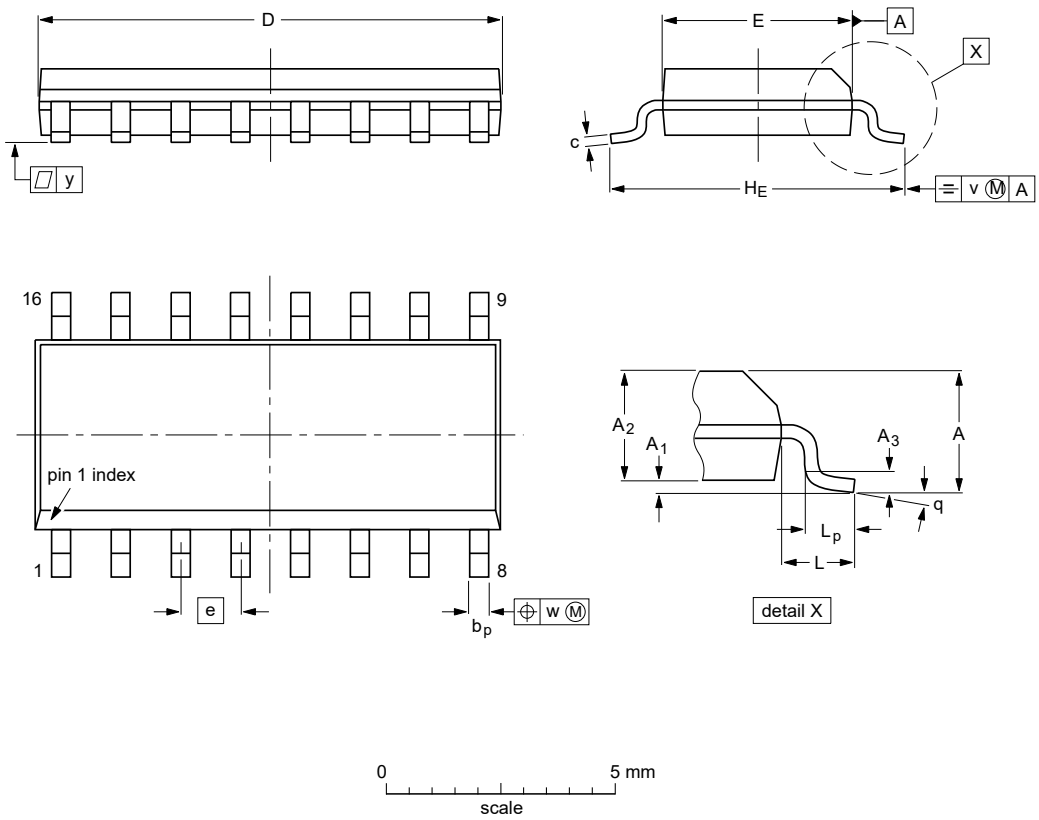
**Fig. 5. Test circuit for measuring switching times**

**Table 10. Test data**

| Supply voltage | Input | | Load |
|---|---|---|---|
| $V_{DD}$ | $V_I$ | $t_r$, $t_f$ | $C_L$ |
| 5 V to 15 V | $V_{SS}$ or $V_{DD}$ | ≤ 20 ns | 50 pF |

## 12. Package outline

**SO16: plastic small outline package; 16 leads; body width 3.9 mm** **SOT109-1**




Dimensions (inch dimensions are derived from the original mm dimensions)

| Unit | | A | $A_1$ | $A_2$ | $A_3$ | $b_p$ | c | $D^{(1)}$ | $E^{(1)}$ | e | $H_E$ | L | $L_p$ | v | w | y | θ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | max | 1.75 | 0.25 | | | 0.51 | 0.25 | 10.0 | 4.0 | | 6.2 | | 1.27 | | | | 8° |
| | nom | | | | 0.25 | | | | | 1.27 | | 1.05 | | 0.2 | 0.25 | 0.1 | |
| | min | | 0.10 | 1.25 | | 0.31 | 0.10 | 9.8 | 3.8 | | 5.8 | | 0.4 | | | | 0° |
| inches | max | 0.069 | 0.010 | | | 0.020 | 0.010 | 0.394 | 0.16 | | 0.244 | | 0.05 | | | | 8° |
| | nom | | | | 0.01 | | | | | 0.05 | | 0.041 | | 0.008 | 0.01 | 0.004 | |
| | min | | 0.004 | 0.049 | | 0.012 | 0.004 | 0.386 | 0.15 | | 0.228 | | 0.016 | | | | 0° |

Note
1. Plastic or metal protrusions of 0.15 mm (0.006 inch) maximum per side are not included.

*sot109-1_po*

| Outline version | References | | | | European projection | Issue date |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT109-1 | | MS-012 | | | | ~~03-02-19~~ 23-10-27 |

**Fig. 6. Package outline SOT109-1 (SO16)**

# 13. Abbreviations

**Table 11. Abbreviations**

| Acronym | Description |
|---|---|
| ANSI | American National Standards Institute |
| CDM | Charged Device Model |
| CMOS | Complementary Metal-Oxide Semiconductor |
| DUT | Device Under Test |
| ESD | ElectroStatic Discharge |
| ESDA | ElectroStatic Discharge Association |
| HBM | Human Body Model |
| JEDEC | Joint Electron Device Engineering Council |

# 14. Revision history

**Table 12. Revision history**

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|---|---|---|---|---|
| HEF4014B v.12 | 20240808 | Product data sheet | - | HEF4014B v.11 |
| Modifications: | • Section 2: ESD specification updated according to the latest JEDEC standard.<br>• Fig. 6: Aligned SO package outline drawing to JEDEC MS-012 | | | |
| HEF4014B v.11 | 20211124 | Product data sheet | - | HEF4014B v.10 |
| Modifications: | • Section 1 and Section 2 updated. | | | |
| HEF4014B v.10 | 20181017 | Product data sheet | - | HEF4014B v.9 |
| Modifications: | • The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia.<br>• Legal texts have been adapted to the new company name where appropriate. | | | |
| HEF4014B v.9 | 20160321 | Product data sheet | - | HEF4014B v.8 |
| Modifications: | • Type number HEF4014BP (SOT38-4) removed. | | | |
| HEF4014B v.8 | 20111121 | Product data sheet | - | HEF4014B v.7 |
| Modifications: | • Legal pages updated.<br>• Changes in "General description" and "Features and benefits". | | | |
| HEF4014B v.7 | 20110914 | Product data sheet | - | HEF4014B v.6 |
| HEF4014B v.6 | 20091102 | Product data sheet | - | HEF4014B v.5 |
| HEF4014B v.5 | 20090624 | Product data sheet | - | HEF4014B v.4 |
| HEF4014B v.4 | 20090122 | Product data sheet | - | HEF4014B_CNV v.3 |
| HEF4014B_CNV v.3 | 19950101 | Product specification | - | HEF4014B_CNV v.2 |
| HEF4014B_CNV v.2 | 19950101 | Product specification | - | - |

# 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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