# 74HC1G86; 74HCT1G86

## 2-input EXCLUSIVE-OR gate

Rev. 04 — 20 July 2007 Product data sheet

## 1. General description

74HC1G86 and 74HCT1G86 are high-speed Si-gate CMOS devices. They provide a 2-input EXCLUSIVE-OR function.

The HC device has CMOS input switching levels and supply voltage range 2 V to 6 V.

The HCT device has TTL input switching levels and supply voltage range 4.5 V to 5.5 V.

The standard output currents are half those of the 74HC/HCT86.

## 2. Features

- Symmetrical output impedance
- High noise immunity
- Low power dissipation
- Balanced propagation delays
- SOT353-1 and SOT753 package options
- Specified from –40 °C to +125 °C

## 3. Ordering information

**Table 1. Ordering information**

| Type number | Package | | | |
|---|---|---|---|---|
| | Temperature range | Name | Description | Version |
| 74HC1G86GW | –40 °C to +125 °C | TSSOP5 | plastic thin shrink small outline package; 5 leads; body width 1.25 mm | SOT353-1 |
| 74HCT1G86GW | | | | |
| 74HC1G86GV | –40 °C to +125 °C | SC-74A | plastic surface-mounted package; 5 leads | SOT753 |
| 74HCT1G86GV | | | | |

## 4. Marking

**Table 2. Marking codes**

| Type number | Marking |
|---|---|
| 74HC1G86GW | HH |
| 74HCT1G86GW | TH |
| 74HC1G86GV | H86 |
| 74HCT1G86GV | T86 |

## 5. Functional diagram

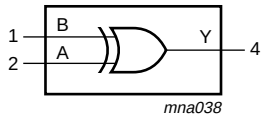



Fig 1. Logic symbol

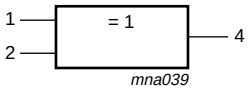



Fig 2. IEC logic symbol

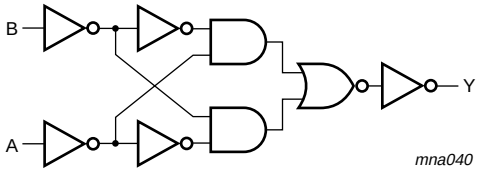



Fig 3. Logic diagram

## 6. Pinning information

### 6.1 Pinning

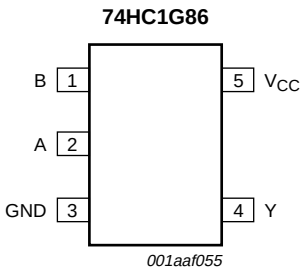



Fig 4. Pin configuration

### 6.2 Pin description

Table 3. Pin description

| Symbol | Pin | Description |
|---|---|---|
| B | 1 | data input |
| A | 2 | data input |
| GND | 3 | ground (0 V) |
| Y | 4 | data output |
| $V_{CC}$ | 5 | supply voltage |

# 7. Functional description

**Table 4. Function table**

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

| Inputs | | Output |
|---|---|---|
| **A** | **B** | **Y** |
| L | L | L |
| L | H | H |
| H | L | H |
| H | H | L |

# 8. Limiting values

**Table 5. Limiting values**

*In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND (ground = 0 V).* [1]

| Symbol | Parameter | Conditions | | Min | Max | Unit |
|---|---|---|---|---|---|---|
| $V_{CC}$ | supply voltage | | | –0.5 | +7.0 | V |
| $I_{IK}$ | input clamping current | $V_I < –0.5$ V or $V_I > V_{CC} + 0.5$ V | | - | ±20 | mA |
| $I_{OK}$ | output clamping current | $V_O < –0.5$ V or $V_O > V_{CC} + 0.5$ V | | - | ±20 | mA |
| $I_O$ | output current | $–0.5 \text{ V} < V_O < V_{CC} + 0.5$ V | | - | ±12.5 | mA |
| $I_{CC}$ | supply current | | | - | 25 | mA |
| $I_{GND}$ | ground current | | | –25 | - | mA |
| $T_{stg}$ | storage temperature | | | –65 | +150 | °C |
| $P_{tot}$ | total power dissipation | $T_{amb}$ = –40 °C to +125 °C | [2] | - | 200 | mW |

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

[2] Above 55 °C the value of $P_{tot}$ derates linearly with 2.5 mW/K.

# 9. Recommended operating conditions

**Table 6. Recommended operating conditions**

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

| Symbol | Parameter | Conditions | 74HC1G86 | | | 74HCT1G86 | | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | Min | Typ | Max | |
| $V_{CC}$ | supply voltage | | 2.0 | 5.0 | 6.0 | 4.5 | 5.0 | 5.5 | V |
| $V_I$ | input voltage | | 0 | - | $V_{CC}$ | 0 | - | $V_{CC}$ | V |
| $V_O$ | output voltage | | 0 | - | $V_{CC}$ | 0 | - | $V_{CC}$ | V |
| $T_{amb}$ | ambient temperature | | –40 | +25 | +125 | –40 | +25 | +125 | °C |
| $\Delta t/\Delta V$ | input transition rise and fall rate | $V_{CC}$ = 2.0 V | - | - | 625 | - | - | - | ns/V |
| | | $V_{CC}$ = 4.5 V | - | - | 139 | - | - | 139 | ns/V |
| | | $V_{CC}$ = 6.0 V | - | - | 83 | - | - | - | ns/V |

## 10. Static characteristics

**Table 7. Static characteristics**

*Voltages are referenced to GND (ground = 0 V). All typical values are measured at $T_{amb}$ = 25 °C.*

| Symbol | Parameter | Conditions | –40 °C to +85 °C | | | –40 °C to +125 °C | | Unit |
|---|---|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | Min | Max | |
| **For type 74HC1G86** | | | | | | | | |
| $V_{IH}$ | HIGH-level input voltage | $V_{CC}$ = 2.0 V | 1.5 | 1.2 | - | 1.5 | - | V |
| | | $V_{CC}$ = 4.5 V | 3.15 | 2.4 | - | 3.15 | - | V |
| | | $V_{CC}$ = 6.0 V | 4.2 | 3.2 | - | 4.2 | - | V |
| $V_{IL}$ | LOW-level input voltage | $V_{CC}$ = 2.0 V | - | 0.8 | 0.5 | - | 0.5 | V |
| | | $V_{CC}$ = 4.5 V | - | 2.1 | 1.35 | - | 1.35 | V |
| | | $V_{CC}$ = 6.0 V | - | 2.8 | 1.8 | - | 1.8 | V |
| $V_{OH}$ | HIGH-level output voltage | $V_I$ = $V_{IH}$ or $V_{IL}$ | | | | | | |
| | | $I_O$ = –20 µA; $V_{CC}$ = 2.0 V | 1.9 | 2.0 | - | 1.9 | - | V |
| | | $I_O$ = –20 µA; $V_{CC}$ = 4.5 V | 4.4 | 4.5 | - | 4.4 | - | V |
| | | $I_O$ = –20 µA; $V_{CC}$ = 6.0 V | 5.9 | 6.0 | - | 5.9 | - | V |
| | | $I_O$ = –2.0 mA; $V_{CC}$ = 4.5 V | 4.13 | 4.32 | - | 3.7 | - | V |
| | | $I_O$ = –2.6 mA; $V_{CC}$ = 6.0 V | 5.63 | 5.81 | - | 5.2 | - | V |
| $V_{OL}$ | LOW-level output voltage | $V_I$ = $V_{IH}$ or $V_{IL}$ | | | | | | |
| | | $I_O$ = 20 µA; $V_{CC}$ = 2.0 V | - | 0 | 0.1 | - | 0.1 | V |
| | | $I_O$ = 20 µA; $V_{CC}$ = 4.5 V | - | 0 | 0.1 | - | 0.1 | V |
| | | $I_O$ = 20 µA; $V_{CC}$ = 6.0 V | - | 0 | 0.1 | - | 0.1 | V |
| | | $I_O$ = 2.0 mA; $V_{CC}$ = 4.5 V | - | 0.15 | 0.33 | - | 0.4 | V |
| | | $I_O$ = 2.6 mA; $V_{CC}$ = 6.0 V | - | 0.16 | 0.33 | - | 0.4 | V |
| $I_I$ | input leakage current | $V_I$ = $V_{CC}$ or GND; $V_{CC}$ = 6.0 V | - | - | 1.0 | - | 1.0 | µA |
| $I_{CC}$ | supply current | $V_I$ = $V_{CC}$ or GND; $I_O$ = 0 A; $V_{CC}$ = 6.0 V | - | - | 10 | - | 20 | µA |
| $C_I$ | input capacitance | | - | 1.5 | - | - | - | pF |
| **For type 74HCT1G86** | | | | | | | | |
| $V_{IH}$ | HIGH-level input voltage | $V_{CC}$ = 4.5 V to 5.5 V | 2.0 | 1.6 | - | 2.0 | - | V |
| $V_{IL}$ | LOW-level input voltage | $V_{CC}$ = 4.5 V to 5.5 V | - | 1.2 | 0.8 | - | 0.8 | V |
| $V_{OH}$ | HIGH-level output voltage | $V_I$ = $V_{IH}$ or $V_{IL}$ | | | | | | |
| | | $I_O$ = –20 µA; $V_{CC}$ = 4.5 V | 4.4 | 4.5 | - | 4.4 | - | V |
| | | $I_O$ = –2.0 mA; $V_{CC}$ = 4.5 V | 4.13 | 4.32 | - | 3.7 | - | V |
| $V_{OL}$ | LOW-level output voltage | $V_I$ = $V_{IH}$ or $V_{IL}$ | | | | | | |
| | | $I_O$ = 20 µA; $V_{CC}$ = 4.5 V | - | 0 | 0.1 | - | 0.1 | V |
| | | $I_O$ = 2.0 mA; $V_{CC}$ = 4.5 V | - | 0.15 | 0.33 | - | 0.4 | V |
| $I_I$ | input leakage current | $V_I$ = $V_{CC}$ or GND; $V_{CC}$ = 5.5 V | - | - | 1.0 | - | 1.0 | µA |

**Table 7. Static characteristics** *…continued*

*Voltages are referenced to GND (ground = 0 V). All typical values are measured at $T_{amb}$ = 25 °C.*

| Symbol | Parameter | Conditions | –40 °C to +85 °C | | | –40 °C to +125 °C | | Unit |
|---|---|---|---|---|---|---|---|---|
| | | | Min | Typ | Max | Min | Max | |
| $I_{CC}$ | supply current | $V_I$ = $V_{CC}$ or GND; $I_O$ = 0 A; $V_{CC}$ = 5.5 V | - | - | 10 | - | 20 | µA |
| $\Delta I_{CC}$ | additional supply current | per input; $V_{CC}$ = 4.5 V to 5.5 V; $V_I$ = $V_{CC}$ – 2.1 V; $I_O$ = 0 A | - | - | 500 | - | 850 | µA |
| $C_I$ | input capacitance | | - | 1.5 | - | - | - | pF |

## 11. Dynamic characteristics

**Table 8. Dynamic characteristics**

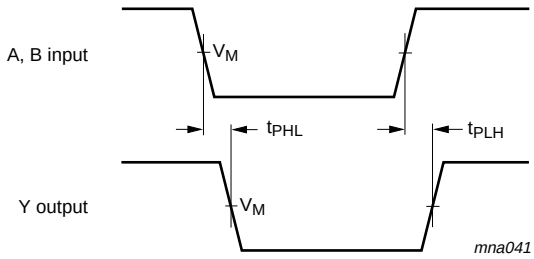
*GND = 0 V; $t_r$ = $t_f$ ≤ 6.0 ns; All typical values are measured at $T_{amb}$ = 25 °C. For test circuit see Figure 6*

| Symbol | Parameter | Conditions | | –40 °C to +85 °C | | | –40 °C to +125 °C | | Unit |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Min | Typ | Max | Min | Max | |
| **For type 74HC1G86** | | | | | | | | | |
| $t_{pd}$ | propagation delay | A and B to Y; see Figure 5 | [1] | | | | | | |
| | | $V_{CC}$ = 2.0 V; $C_L$ = 50 pF | | - | 22 | 115 | - | 135 | ns |
| | | $V_{CC}$ = 4.5 V; $C_L$ = 50 pF | | - | 11 | 23 | - | 27 | ns |
| | | $V_{CC}$ = 5.0 V; $C_L$ = 15 pF | | - | 9 | - | - | - | ns |
| | | $V_{CC}$ = 6.0 V; $C_L$ = 50 pF | | - | 9 | 20 | - | 23 | ns |
| $C_{PD}$ | power dissipation capacitance | $V_I$ = GND to $V_{CC}$ | [2] | - | 23 | - | - | - | pF |
| **For type 74HCT1G86** | | | | | | | | | |
| $t_{pd}$ | propagation delay | A and B to Y; see Figure 5 | [1] | | | | | | |
| | | $V_{CC}$ = 4.5 V; $C_L$ = 50 pF | | - | 13 | 23 | - | 27 | ns |
| | | $V_{CC}$ = 5.0 V; $C_L$ = 15 pF | | - | 10 | - | - | - | ns |
| $C_{PD}$ | power dissipation capacitance | $V_I$ = GND to $V_{CC}$ – 1.5 V | [2] | - | 23 | - | - | - | pF |

[1] $t_{pd}$ is the same as $t_{PLH}$ and $t_{PHL}$.

[2] $C_{PD}$ is used to determine the dynamic power dissipation $P_D$ (µW).
$P_D = C_{PD} \times V_{CC}^2 \times f_i + \sum (C_L \times V_{CC}^2 \times f_o)$ where:
$f_i$ = input frequency in MHz
$f_o$ = output frequency in MHz
$C_L$ = output load capacitance in pF
$V_{CC}$ = supply voltage in Volts
$\sum (C_L \times V_{CC}^2 \times f_o)$ = sum of outputs

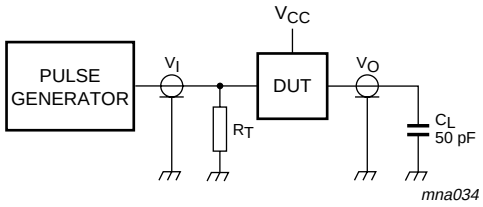
## 12. Waveforms




For 74HC1G86: $V_M = 0.5 \times V_{CC}$; $V_I$ = GND to $V_{CC}$.

For 74HCT1G86: $V_M$ = 1.3 V; $V_I$ = GND to 3.0 V.

**Fig 5. The input (A and B) to output (Y) propagation delays**




Test data is given in Table 8. Definitions for test circuit:

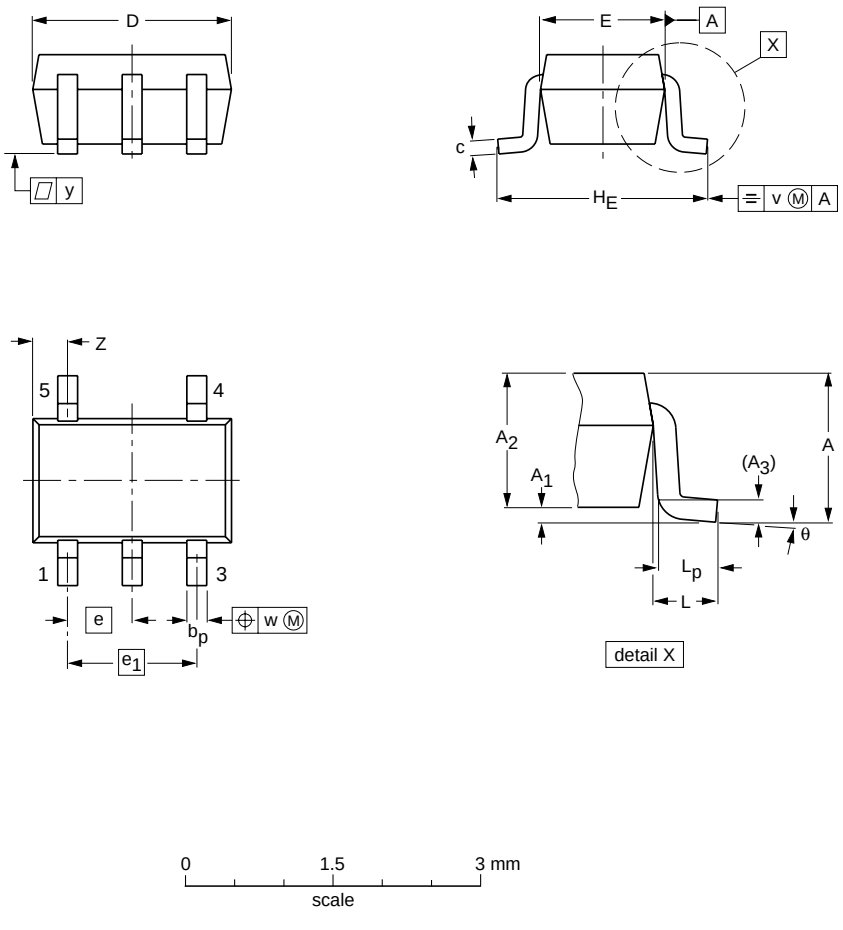
$C_L$ = Load capacitance including jig and probe capacitance.

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

**Fig 6. Load circuitry for switching times**

## 13. Package outline

**TSSOP5: plastic thin shrink small outline package; 5 leads; body width 1.25 mm** **SOT353-1**




**DIMENSIONS (mm are the original dimensions)**

| UNIT | A max. | $A_1$ | $A_2$ | $A_3$ | $b_p$ | c | $D^{(1)}$ | $E^{(1)}$ | e | $e_1$ | $H_E$ | L | $L_p$ | v | w | y | $Z^{(1)}$ | θ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 1.1 | 0.1<br>0 | 1.0<br>0.8 | 0.15 | 0.30<br>0.15 | 0.25<br>0.08 | 2.25<br>1.85 | 1.35<br>1.15 | 0.65 | 1.3 | 2.25<br>2.0 | 0.425 | 0.46<br>0.21 | 0.3 | 0.1 | 0.1 | 0.60<br>0.15 | 7°<br>0° |

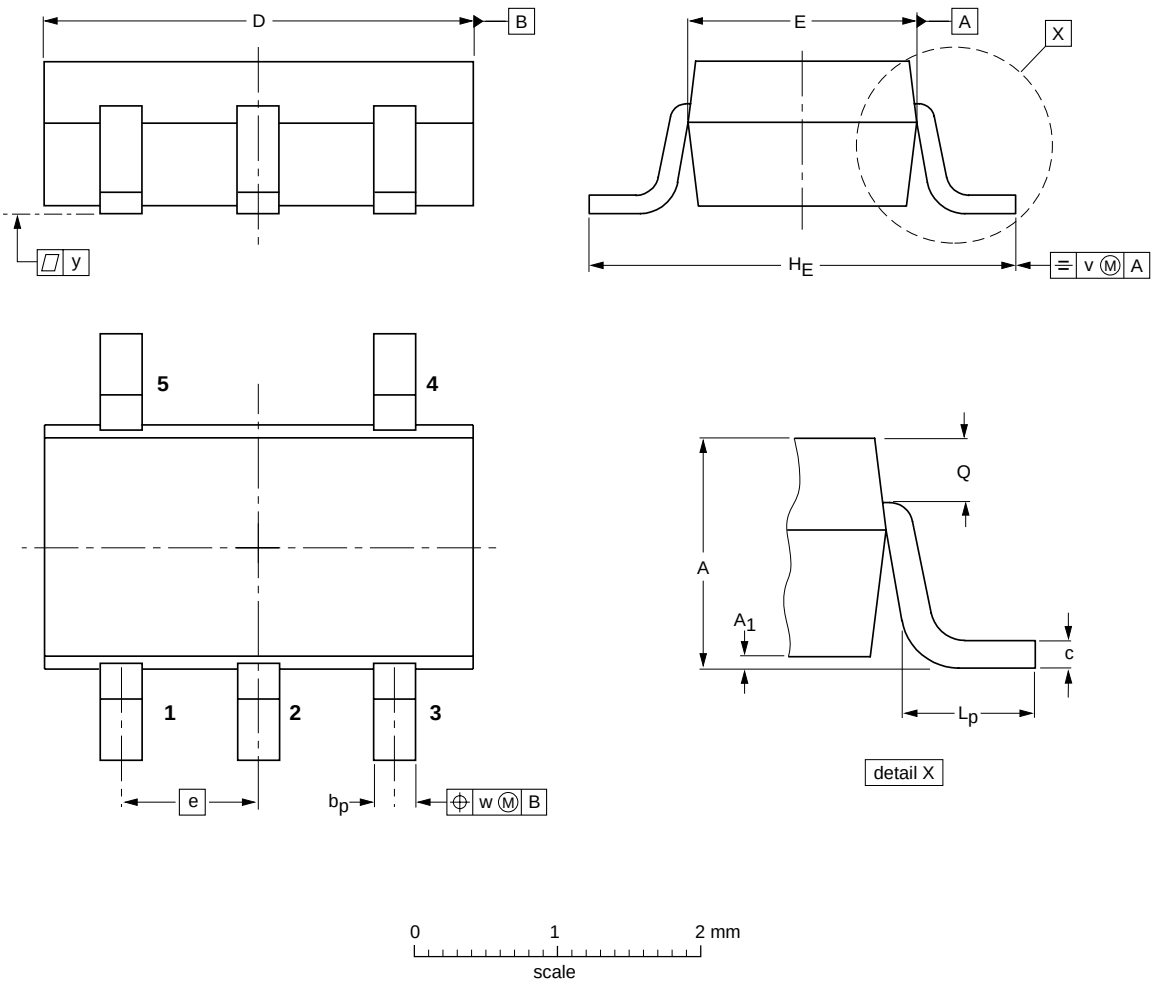
**Note**

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT353-1 | | MO-203 | SC-88A | | | ~~00-09-01~~<br>03-02-19 |

**Fig 7. Package outline SOT353-1 (TSSOP5)**

**Plastic surface-mounted package; 5 leads** **SOT753**




**DIMENSIONS (mm are the original dimensions)**

| UNIT | A | $A_1$ | $b_p$ | c | D | E | e | $H_E$ | $L_p$ | Q | v | w | y |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 1.1<br>0.9 | 0.100<br>0.013 | 0.40<br>0.25 | 0.26<br>0.10 | 3.1<br>2.7 | 1.7<br>1.3 | 0.95 | 3.0<br>2.5 | 0.6<br>0.2 | 0.33<br>0.23 | 0.2 | 0.2 | 0.1 |

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | JEITA | | | |
| SOT753 | | | SC-74A | | | ~~02-04-16~~<br>06-03-16 |

**Fig 8. Package outline SOT753 (SC-74A)**

## 14. Abbreviations

**Table 9. Abbreviations**

| Acronym | Description |
|---|---|
| DUT | Device Under Test |
| TTL | Transistor-Transistor Logic |

## 15. Revision history

**Table 10. Revision history**

| Document ID | Release date | Data sheet status | Change notice | Supersedes |
|---|---|---|---|---|
| 74HC_HCT1G86_4 | 20070720 | Product data sheet | - | 74HC_HCT1G86_3 |
| Modifications: | • The format of this data sheet has been redesigned to comply with the new identity guidelines of NXP Semiconductors.<br>• Legal texts have been adapted to the new company name where appropriate.<br>• Package SOT353 changed to SOT353-1 in Table 1 and Figure 7.<br>• Quick Reference Data and Soldering sections removed.<br>• Section 2 “Features” updated. | | | |
| 74HC_HCT1G86_3 | 20020515 | Product specification | - | 74HC_HCT1G86_2 |
| 74HC_HCT1G86_2 | 20010406 | Product specification | - | 74HC_HCT1G86_1 |
| 74HC_HCT1G86_1 | 19980805 | Product specification | - | - |

# 16. Legal information

## 16.1 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".

[3] The product status of device(s) described in this document may have changed since this document was published and may differ in case of multiple devices. The latest product status information is available on the Internet at URL http://www.nexperia.com.

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## 18. Contents





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**Date of release: 20 July 2007**