

# HEF40106B

Hex inverting Schmitt trigger

Rev. 8 — 10 December 2015

Product data sheet

## 1. General description

The HEF40106B provides six inverting buffers. Each input has a Schmitt trigger circuit. The inverting buffer switches at different points for positive-going and negative-going signals. The difference between the positive voltage ( $V_{T+}$ ) and the negative voltage ( $V_{T-}$ ) is defined as hysteresis voltage ( $V_H$ ).

The HEF40106B may be used for enhanced noise immunity or to “square up” slowly changing waveforms.

It operates over a recommended  $V_{DD}$  power supply range of 3 V to 15 V referenced to  $V_{SS}$  (usually ground). Unused inputs must be connected to  $V_{DD}$ ,  $V_{SS}$ , or another input.

## 2. Features and benefits

- Schmitt trigger input discrimination
- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Specified from  $-40\text{ °C}$  to  $+125\text{ °C}$
- Complies with JEDEC standard JESD 13-B

## 3. Applications

- Wave and pulse shapers
- Astable multivibrators
- Monostable multivibrators

## 4. Ordering information

**Table 1. Ordering information**

All types operate from  $-40\text{ °C}$  to  $+125\text{ °C}$

Type number	Package		
	Name	Description	Version
HEF40106BT	SO14	plastic small outline package; 14 leads; body width 3.9 mm	SOT108-1
HEF40106BTT	TSSOP14	plastic thin shrink small outline package; 14 leads; body width 4.4 mm	SOT402-1

## 5. Functional diagram

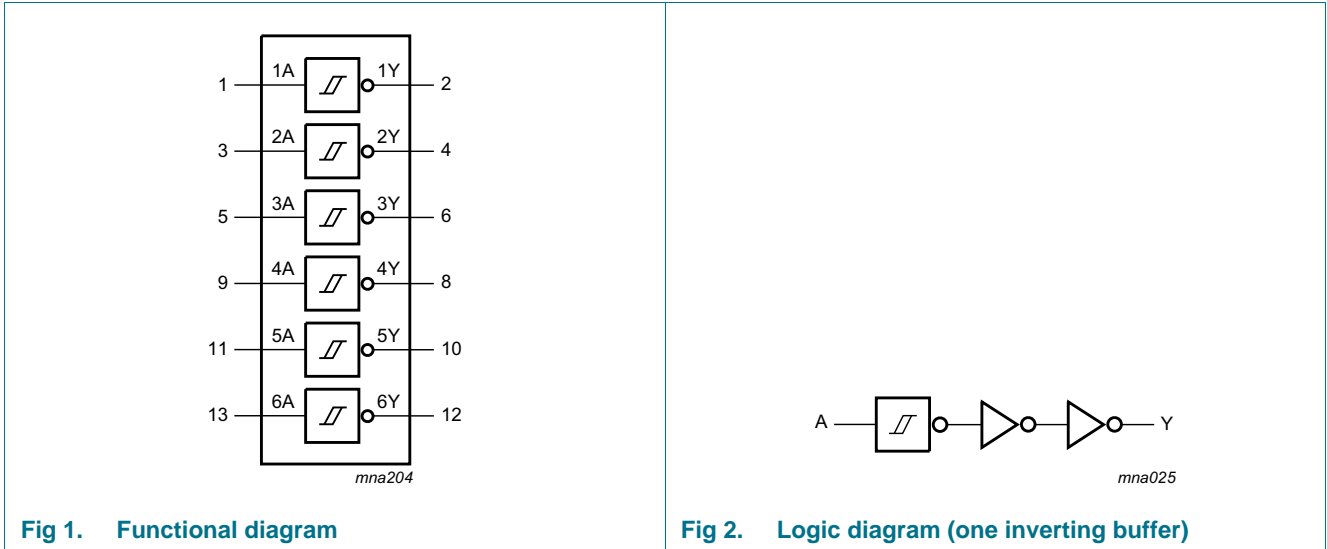


Fig 1. Functional diagram

Fig 2. Logic diagram (one inverting buffer)

## 6. Pinning information

### 6.1 Pinning

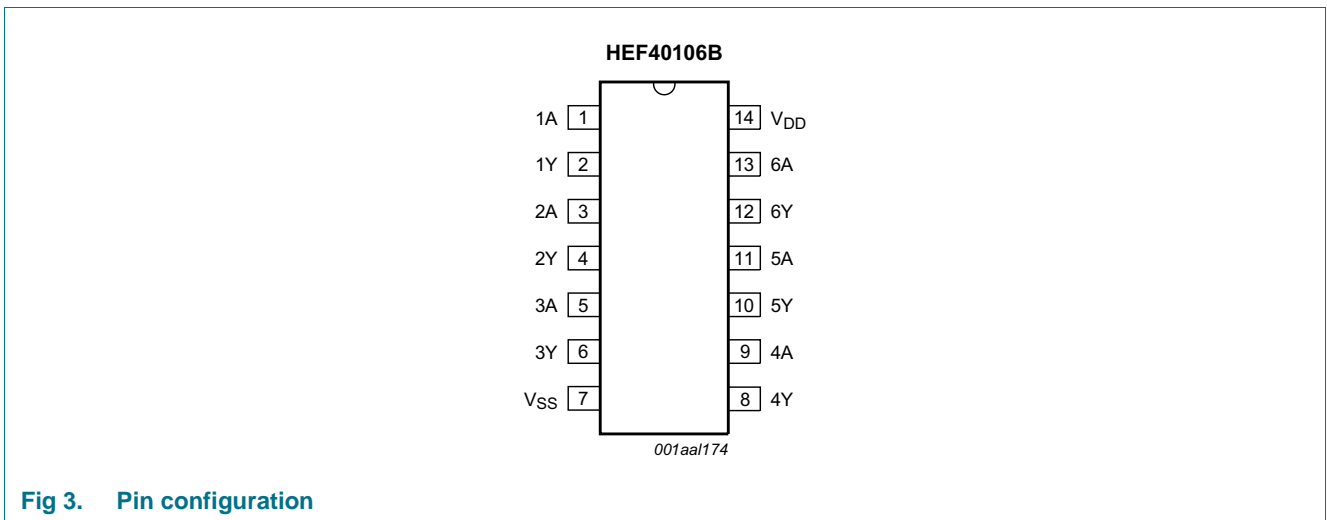


Fig 3. Pin configuration

## 6.2 Pin description

Table 2. Pin description

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

## 7. Functional description

Table 3. Function table<sup>[1]</sup>

Input	Output
nA	nY
L	H
H	L

[1] H = HIGH voltage level; L = LOW voltage level.

## 8. Limiting values

Table 4. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to V<sub>SS</sub> = 0 V (ground).

Symbol	Parameter	Conditions	Min	Max	Unit
V <sub>DD</sub>	supply voltage		-0.5	+18	V
I <sub>IK</sub>	input clamping current	V <sub>I</sub> < -0.5 V or V <sub>I</sub> > V <sub>DD</sub> + 0.5 V	-	±10	mA
V <sub>I</sub>	input voltage		-0.5	V <sub>DD</sub> + 0.5	V
I <sub>OK</sub>	output clamping current	V <sub>O</sub> < -0.5 V or V <sub>O</sub> > V <sub>DD</sub> + 0.5 V	-	±10	mA
I <sub>I/O</sub>	input/output current		-	±10	mA
I <sub>DD</sub>	supply current		-	50	mA
T <sub>stg</sub>	storage temperature		-65	+150	°C
T <sub>amb</sub>	ambient temperature		-40	+125	°C
P <sub>tot</sub>	total power dissipation	T <sub>amb</sub> = -40 °C to +125 °C			
		SO14 <sup>[1]</sup>	-	500	mW
		TSSOP14 <sup>[2]</sup>	-	500	mW
P	power dissipation	per output	-	100	mW

[1] For SO14 packages: above T<sub>amb</sub> = 70 °C, P<sub>tot</sub> derates linearly with 8 mW/K.

[2] For TSSOP14 packages: above T<sub>amb</sub> = 60 °C, P<sub>tot</sub> derates linearly with 5.5 mW/K.

## 9. Recommended operating conditions

Table 5. Recommended operating conditions

Symbol	Parameter	Conditions	Min	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	+125	°C

## 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		$T_{amb} = +125$ °C		Unit
				Min	Max	Min	Max	Min	Max	Min	Max	
$V_{OH}$	HIGH-level output voltage	$ I_O  < 1$ $\mu$ A	5 V	4.95	-	4.95	-	4.95	-	4.95	-	V
			10 V	9.95	-	9.95	-	9.95	-	9.95	-	V
			15 V	14.95	-	14.95	-	14.95	-	14.95	-	V
$V_{OL}$	LOW-level output voltage	$ I_O  < 1$ $\mu$ A	5 V	-	0.05	-	0.05	-	0.05	-	0.05	V
			10 V	-	0.05	-	0.05	-	0.05	-	0.05	V
			15 V	-	0.05	-	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	-	-1.1	mA
		$V_O = 4.6$ V	5 V	-	-0.64	-	-0.5	-	-0.36	-	-0.36	mA
		$V_O = 9.5$ V	10 V	-	-1.6	-	-1.3	-	-0.9	-	-0.9	mA
		$V_O = 13.5$ V	15 V	-	-4.2	-	-3.4	-	-2.4	-	-2.4	mA
$I_{OL}$	LOW-level output current	$V_O = 0.4$ V	5 V	0.64	-	0.5	-	0.36	-	0.36	-	mA
		$V_O = 0.5$ V	10 V	1.6	-	1.3	-	0.9	-	0.9	-	mA
		$V_O = 1.5$ V	15 V	4.2	-	3.4	-	2.4	-	2.4	-	mA
$I_I$	input leakage current		15 V	-	$\pm 0.1$	-	$\pm 0.1$	-	$\pm 1.0$	-	$\pm 1.0$	$\mu$ A
$I_{DD}$	supply current	all valid input combinations; $I_O = 0$ A	5 V	-	0.25	-	0.25	-	7.5	-	7.5	$\mu$ A
			10 V	-	0.5	-	0.5	-	15.0	-	15.0	$\mu$ A
			15 V	-	1.0	-	1.0	-	30.0	-	30.0	$\mu$ A
$C_I$	input capacitance			-	-	-	7.5	-	-	-	pF	

## 11. Dynamic characteristics

**Table 7. Dynamic characteristics**

$T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $C_L = 50\text{ pF}$ ;  $t_r = t_f \leq 20\text{ ns}$ ; wave forms see [Figure 4](#); test circuit see [Figure 5](#); unless otherwise specified.

Symbol	Parameter	Conditions	V <sub>DD</sub>	Extrapolation formula <sup>[1]</sup>	Min	Typ	Max	Unit
t <sub>PHL</sub>	HIGH to LOW propagation delay	nA or nB to nY	5 V	$63\text{ ns} + (0.55\text{ ns/pF})C_L$	-	90	180	ns
			10 V	$29\text{ ns} + (0.23\text{ ns/pF})C_L$	-	35	70	ns
			15 V	$22\text{ ns} + (0.16\text{ ns/pF})C_L$	-	30	60	ns
t <sub>PLH</sub>	LOW to HIGH propagation delay	nA or nB to nY	5 V	$58\text{ ns} + (0.55\text{ ns/pF})C_L$	-	75	150	ns
			10 V	$29\text{ ns} + (0.23\text{ ns/pF})C_L$	-	35	70	ns
			15 V	$22\text{ ns} + (0.16\text{ ns/pF})C_L$	-	30	60	ns
t <sub>THL</sub>	HIGH to LOW output transition time	nY to LOW	5 V	$10\text{ ns} + (1.00\text{ ns/pF})C_L$	-	60	120	ns
			10 V	$9\text{ ns} + (0.42\text{ ns/pF})C_L$	-	30	60	ns
			15 V	$6\text{ ns} + (0.28\text{ ns/pF})C_L$	-	20	40	ns
t <sub>TLH</sub>	LOW to HIGH output transition time	nA or nB to HIGH	5 V	$10\text{ ns} + (1.00\text{ ns/pF})C_L$	-	60	120	ns
			10 V	$9\text{ ns} + (0.42\text{ ns/pF})C_L$	-	30	60	ns
			15 V	$6\text{ ns} + (0.28\text{ ns/pF})C_L$	-	20	40	ns

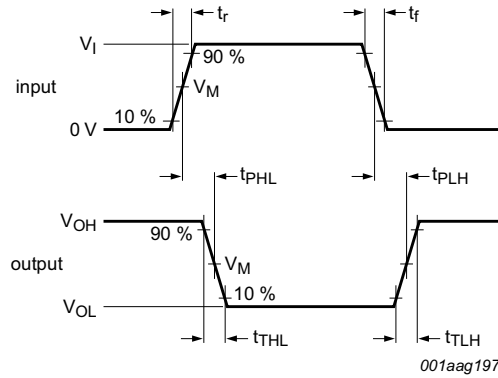
[1] Typical value of the propagation delay and output transition time can be calculated with the extrapolation formula ( $C_L$  in pF).

**Table 8. Dynamic power dissipation**

$V_{SS} = 0\text{ V}$ ;  $t_r = t_f \leq 20\text{ ns}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

Symbol	Parameter	V <sub>DD</sub>	Typical formula	where:
P <sub>D</sub>	dynamic power dissipation	5 V	$P_D = 2300 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2\text{ (}\mu\text{W)}$	$f_i$ = input frequency in MHz; $f_o$ = output frequency in MHz; $C_L$ = output load capacitance in pF; $\Sigma(f_o \times C_L)$ = sum of the outputs; $V_{DD}$ = supply voltage in V.
		10 V	$P_D = 9000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2\text{ (}\mu\text{W)}$	
		15 V	$P_D = 20000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2\text{ (}\mu\text{W)}$	

12. Waveforms

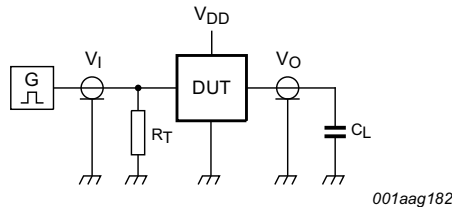


Measurement points are given in [Table 9](#).  
 Logic levels:  $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.  
 $t_r$ ,  $t_f$  = input rise and fall times.

Fig 4. Propagation delay and output transition time

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 given in [Table 10](#).  
 Definitions for test circuit:  
 DUT = Device Under Test.  
 $C_L$  = 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 $V_{DD}$	$\leq 20$ ns	50 pF

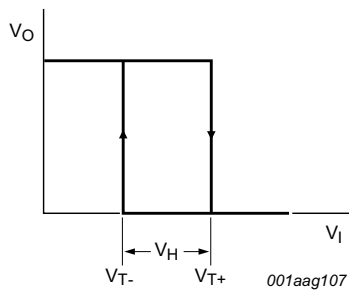
### 13. Transfer characteristics

**Table 11. Transfer characteristics**

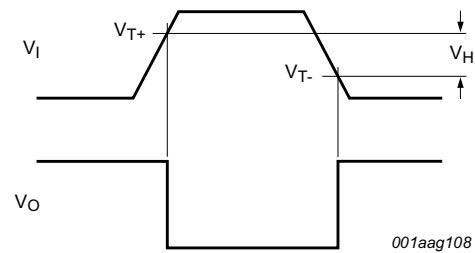
$V_{SS} = 0$  V; see [Figure 6](#) and [Figure 7](#).

Symbol	Parameter	Conditions	$V_{DD}$	$T_{amb} = -40\text{ °C to }+85\text{ °C}$			$T_{amb} = -40\text{ °C to }+125\text{ °C}$		Unit
				Min	Typ <sup>[1]</sup>	Max	Min	Max	
$V_{T+}$	positive-going threshold voltage		5 V	2.0	3.0	3.5	2.0	3.5	V
			10 V	3.7	5.8	7.0	3.7	7.0	V
			15 V	4.9	8.3	11.0	4.9	11.0	V
$V_{T-}$	negative-going threshold voltage		5 V	1.5	2.2	3.0	1.5	3.0	V
			10 V	3.0	4.5	6.3	3.0	6.3	V
			15 V	4.0	6.5	10.1	4.0	10.1	V
$V_H$	hysteresis voltage		5 V	0.5	0.8	-	0.5	-	V
			10 V	0.7	1.3	-	0.7	-	V
			15 V	0.9	1.8	-	0.9	-	V

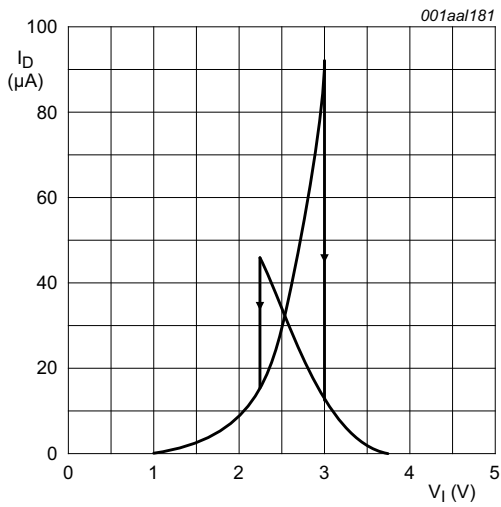
[1] All typical values are at  $T_{amb} = 25\text{ °C}$ .



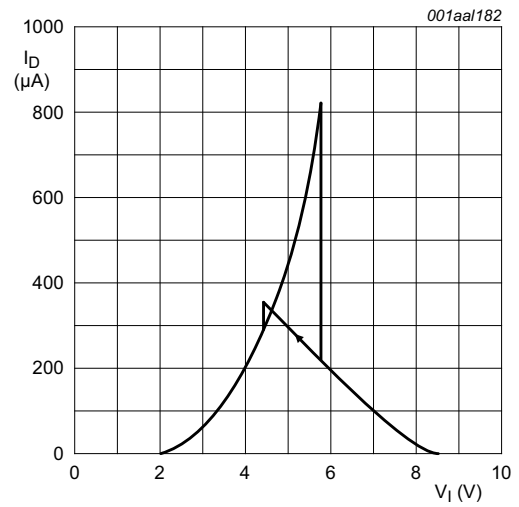
**Fig 6. Transfer characteristic**



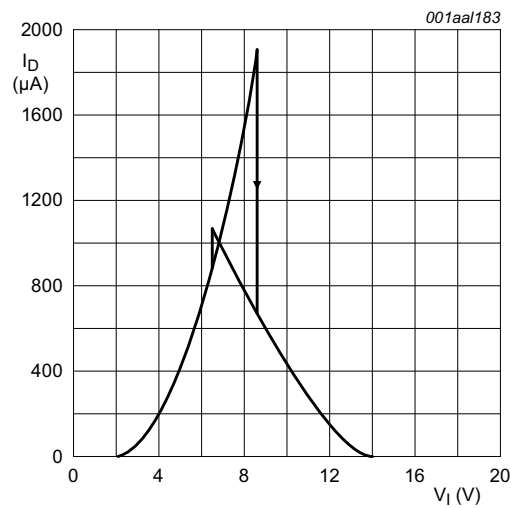
**Fig 7. Waveforms showing definition of  $V_{T+}$  and  $V_{T-}$  (between limits at 30 % and 70 %) and  $V_H$**



a.  $V_{DD} = 5\text{ V}$ ;  $T_{amb} = 25\text{ }^\circ\text{C}$



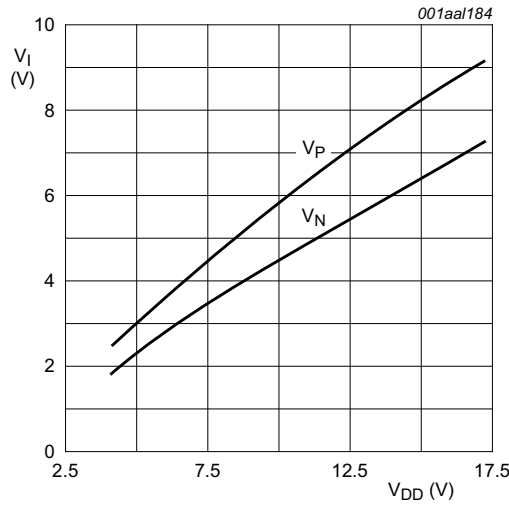
b.  $V_{DD} = 10\text{ V}$ ;  $T_{amb} = 25\text{ }^\circ\text{C}$



c.  $V_{DD} = 15\text{ V}$ ;  $T_{amb} = 25\text{ }^\circ\text{C}$

Fig 8. Typical drain current as a function of input





T<sub>amb</sub> = 25 °C.

Fig 9. Typical switching levels as a function of supply voltage

## 14. Application information

Some examples of applications for the HEF40106B are:

- Wave and pulse shapers
- Astable multivibrators
- Monostable multivibrators

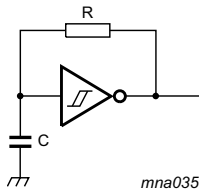


Fig 10. Astable multivibrator

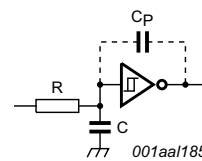


Fig 11. Schmitt trigger driven via a high-impedance input

If a Schmitt trigger is driven via a high-impedance ( $R > 1 \text{ k}\Omega$ ), then it is necessary to incorporate a capacitor C with a value of  $\frac{C}{C_p} > \frac{V_{DD} - V_{SS}}{V_H}$ ; otherwise oscillation can occur on the edges of a pulse.

C<sub>p</sub> is the external parasitic capacitance between inputs and output; the value depends on the circuit board layout.

15. Package outline

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

SOT108-1



Fig 12. Package outline SOT108-1 (SO14)

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

SOT402-1



Fig 13. Package outline SOT402-1 (TSSOP14)

## 16. Abbreviations

Table 12. Abbreviations

Acronym	Description
DUT	Device Under Test

## 17. Revision history

Table 13. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF40106B v.8	20151210	Product data sheet	-	HEF40106B v.7
Modifications:	<ul style="list-style-type: none"> <li>Type number HEF40106BP (SOT27-1) removed.</li> </ul>			
HEF40106B v.7	20111121	Product data sheet	-	HEF40106B v.6
Modifications:	<ul style="list-style-type: none"> <li>Legal pages updated.</li> <li>Changes in "General description" and "Features and benefits".</li> </ul>			
HEF40106B v.6	20110823	Product data sheet	-	HEF40106B v.5
HEF40106B v.5	20110511	Product data sheet	-	HEF40106B v.4
HEF40106B v.4	20101115	Product data sheet	-	HEF40106B_CNV v.3
HEF40106B_CNV v.3	19950101	Product specification	-	HEF40106B_CNV v.2
HEF40106B_CNV v.2	19950101	Product specification	-	-

## 18. Legal information

### 18.1 Data sheet status

Document status <sup>[1][2]</sup>	Product status <sup>[3]</sup>	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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