HEF4520B-Q100

Dual binary counter

Rev. 1 — 14 March 2017 Product data sheet

1 General description

The HEF4520B-Q100 is a dual 4-bit internally synchronous binary counter. The counter has an active HIGH clock input (nCP0) and an active LOW clock input (n$\overline{CP}$1), buffered outputs from all four bit positions (nQ0 to nQ3) and an active HIGH overriding asynchronous master reset input (nMR).

The counter advances on either the LOW-to-HIGH transition of the nCP0 input if n$\overline{CP}$1 is HIGH or the HIGH-to-LOW transition of the n$\overline{CP}$1 input if nCP0 is LOW. Either nCP0 or n$\overline{CP}$1 may be used as the clock input to the counter while the other clock input may be used as a clock enable input. Schmitt trigger action makes the clock input highly tolerant of slower clock rise and fall times. A HIGH on nMR resets the counter (nQ0 to nQ3 = LOW) independent of nCP0 and n$\overline{CP}$1.

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.

This product has been qualified to the Automotive Electronics Council (AEC) standard Q100 (Grade 3) and is suitable for use in automotive applications.

2 Features and benefits

- Automotive product qualification in accordance with AEC-Q100 (Grade 3)
  - Specified from -40 °C to +85 °C
- Tolerant of slow clock rise and fall times
- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- 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)
- Complies with JEDEC standard JESD 13-B

3 Ordering information

Table 1. Ordering information

All types operate from -40 °C to +85 °C.

Type number	Package		
	Name	Description	Version
HEF4520BT-Q100	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1

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4 Functional diagram

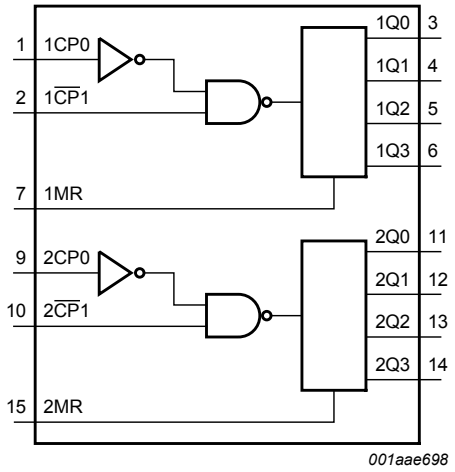


Figure 1. Functional diagram

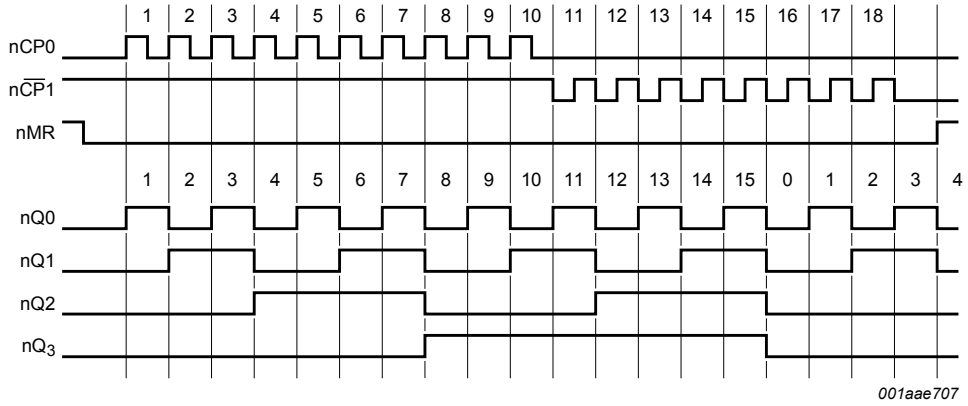


Figure 2. Timing diagram

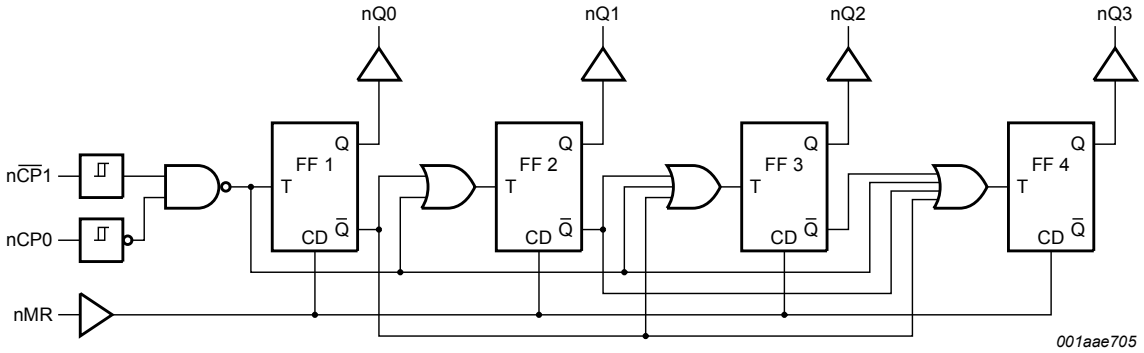


Figure 3. Logic diagram for one counter

5 Pinning information

5.1 Pinning

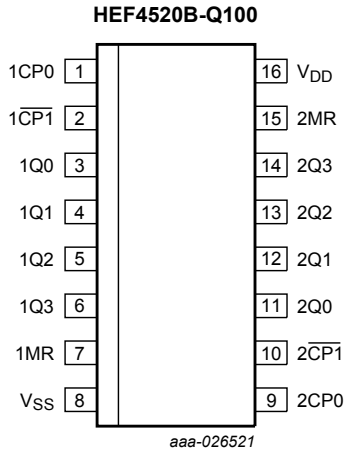


Figure 4. Pin configuration

5.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
1CP0, 2CP0	1, 9	clock input (LOW-to-HIGH triggered)
$1\overline{CP}1$, $2\overline{CP}1$	2, 10	clock input (HIGH-to-LOW triggered)
1Q0 to 1Q3	3, 4, 5, 6	output
1MR, 2MR	7, 15	master reset input
V_{SS}	8	ground supply voltage
2Q0 to 2Q3	11, 12, 13, 14	output
V_{DD}	16	supply voltage

6 Functional description

Table 3. Function table [1]

nCP0	$n\overline{CP}1$	nMR	Mode
↑	H	L	counter advances
L	↓	L	counter advances
↓	X	L	no change
X	↑	L	no change
↑	L	L	no change
H	↓	L	no change
X	X	H	nQ0 to nQ3 = LOW

[1] H = HIGH voltage level; L = LOW voltage level; X = don't care; ↑ = positive-going transition; ↓ = negative-going transition.

7 Limiting values

Table 4. Limiting values

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

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	per output	-65	+150	°C
T_{amb}	ambient temperature		-40	+85	°C
P_{tot}	total power dissipation	SO16 package [1]	-	500	mW
P	power dissipation		-	100	mW

[1] For SO16 package: P_{tot} derates linearly with 8 mW/K above 70 °C.

8 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

9 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; V_I = V_{SS} or V_{DD}	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; V_I = V_{SS} or V_{DD}	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	V_{DD} = 15 V	15 V	-	±0.3	-	±0.3	-	±1.0	µA
I_{DD}	supply current	I_O = 0 A; V_I = V_{SS} or V_{DD}	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

10 Dynamic characteristics

Table 7. Dynamic characteristics

V_{SS} = 0 V; T_{amb} = 25 °C; for test circuit see Figure 6; unless otherwise specified.

Symbol	Parameter	Conditions	V_{DD}	Extrapolation formula	Min	Typ	Max	Unit
t_{PHL}	HIGH to LOW propagation delay	nCP0, nCP1 to nQn; see Figure 5	5 V [1]	83 ns + (0.55 ns/pF)C_L	-	110	220	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
		nMR to nQn; see Figure 5	5 V	48 ns + (0.55 ns/pF)C_L	-	75	150	ns
			10 V	24 ns + (0.23 ns/pF)C_L	-	35	70	ns
			15 V	17 ns + (0.16 ns/pF)C_L	-	25	50	ns
t_{PLH}	LOW to HIGH propagation delay	nCP0, nCP1 to nQn; see Figure 5	5 V [1]	83 ns + (0.55 ns/pF)C_L	-	110	220	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	nQn; see Figure 5	5 V [1]	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	nCP0 input LOW; minimum width; see Figure 5	5 V		60	30	-	ns
			10 V		30	15	-	ns
			15 V		20	10	-	ns
		nCP1 input HIGH; minimum width; see Figure 5	5 V		60	30	-	ns
			10 V		30	15	-	ns
			15 V		20	10	-	ns
		nMR input HIGH; minimum width; see Figure 5	5 V		30	15	-	ns
			10 V		20	10	-	ns
			15 V		16	8	-	ns
t_{su}	set-up time	nCP0 to nCP1; see Figure 5	5 V		50	25	-	ns
			10 V		30	15	-	ns
			15 V		20	10	-	ns
		nCP1 to nCP0; see Figure 5	5 V		50	25	-	ns
			10 V		30	15	-	ns
			15 V		20	10	-	ns
t_{rec}	recovery time	see Figure 5	5 V		50	25	-	ns
			10 V		30	15	-	ns
			15 V		20	10	-	ns
f_{max}	maximum frequency	nCP0, nCP1; see Figure 5	5 V		8	16	-	MHz
			10 V		15	30	-	MHz
			15 V		20	40	-	MHz

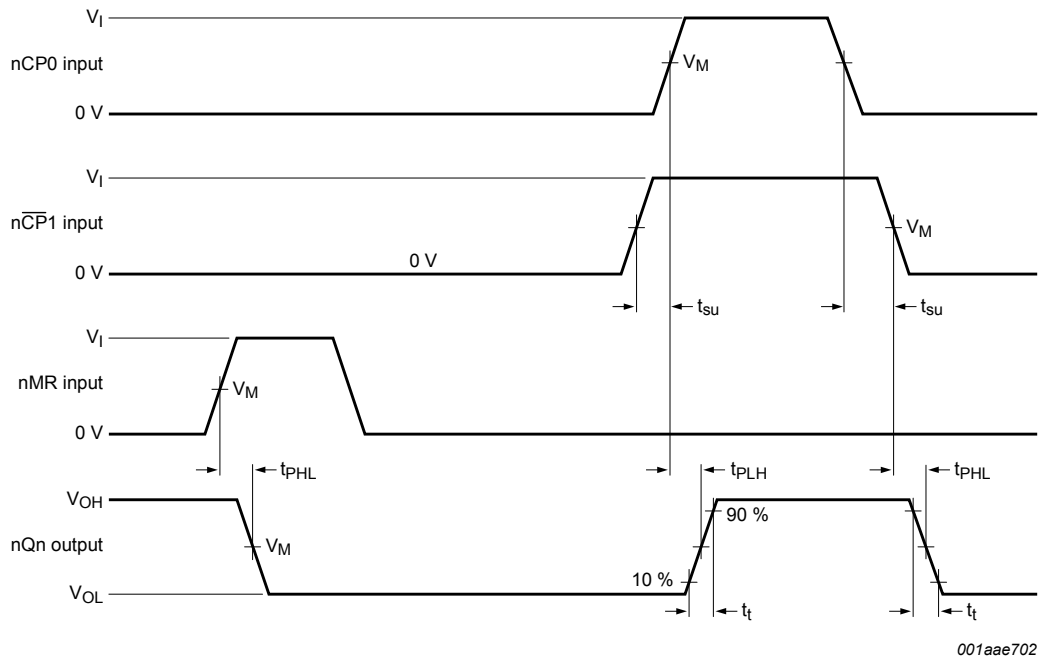
[1] The typical values of the propagation delay and transition times are calculated from the extrapolation formulas shown (C_L in pF).

Table 8. Dynamic power dissipation P_D

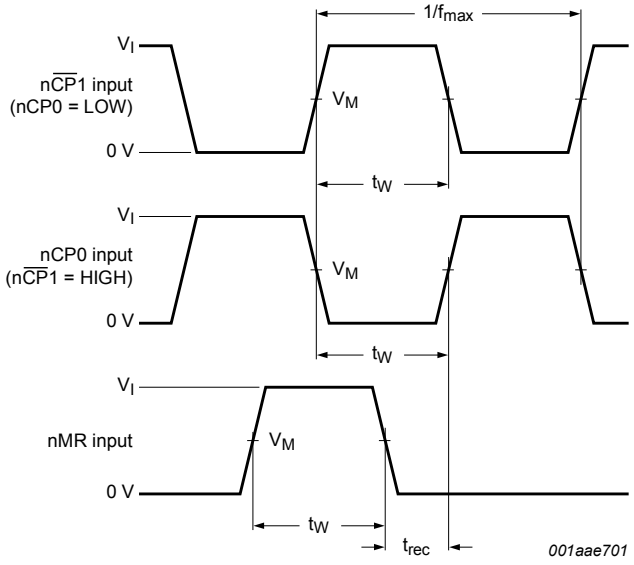
P_D can be calculated from the formulas shown. V_{SS} = 0 V; $t_r = t_f \leq 20$ ns; T_{amb} = 25 °C.

Symbol	Parameter	V_{DD}	Typical formula for P_D (µW)	Where:
P_D	dynamic power dissipation	5 V	$P_D = 850 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	f_i = input frequency in MHz, f_o = output frequency in MHz, C_L = output load capacitance in pF, V_{DD} = supply voltage in V, $\Sigma(f_o \times C_L)$ = sum of the outputs.
		10 V	$P_D = 3800 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	
		15 V	$P_D = 10200 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	

10.1 Waveforms and test circuit



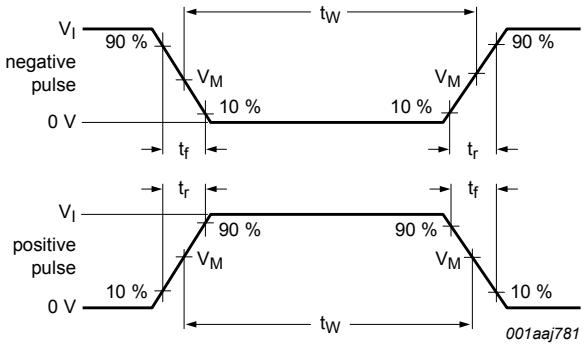
a. nCP0 and nCP1 set-up times, propagation delays and output transition times



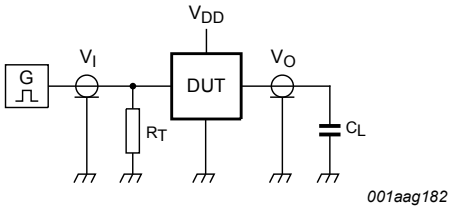
b. nMR recovery time, minimum nCP0, nCP1, and nMR pulse widths and maximum frequency

Measurement points are given in Table 9.
The logic levels V_{OH} and V_{OL} are typical output voltage levels that occur with the output load.

Figure 5. Waveforms showing measurements for switching times



a.Input waveforms



b.Test circuit

Test data is given in Table 9.

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.

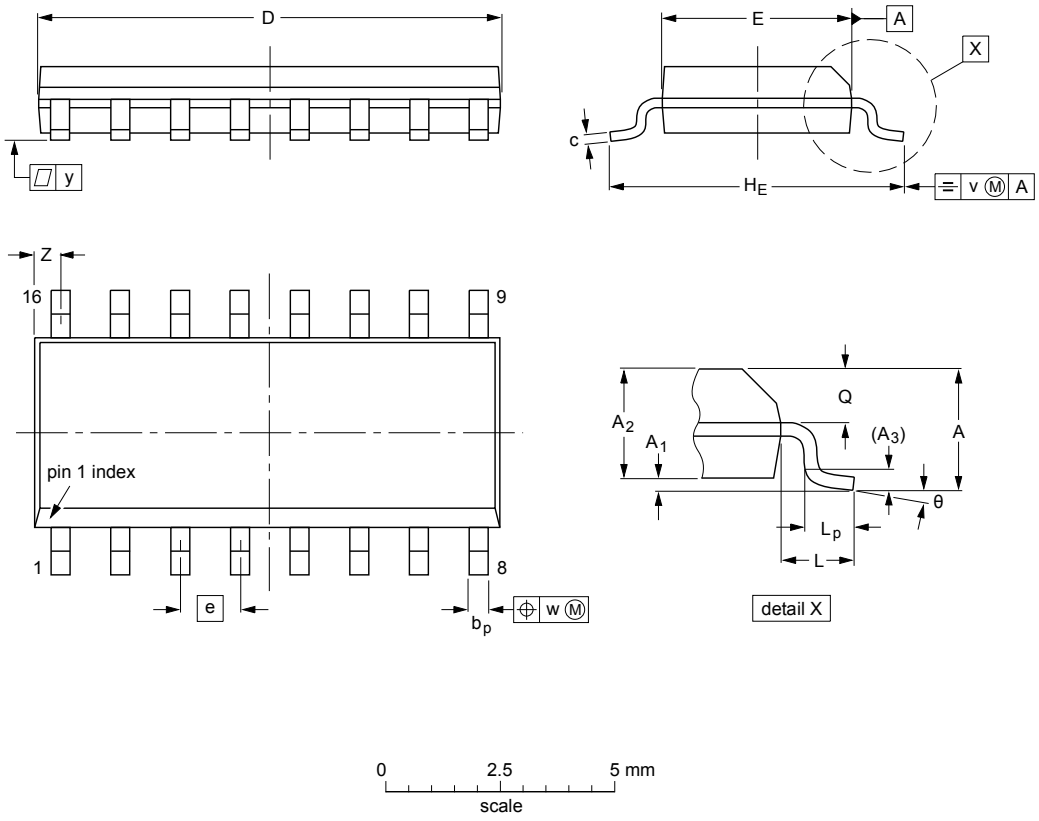
Figure 6. Test circuit for measuring switching times

Table 9. Measurement points and test data

Supply voltage	Input			Load
V_{DD}	V_I	V_M	t_r, t_f	C_L
5 V to 15 V	V_{DD}	$0.5V_I$	≤ 20 ns	50 pF

11 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 max.	A_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(1)}$	e	H_E	L	L_p	Q	v	w	y	$Z^{(1)}$	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	10.0 9.8	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8° 0°
inches	0.069	0.010 0.004	0.057 0.049	0.01	0.019 0.014	0.0100 0.0075	0.39 0.38	0.16 0.15	0.05	0.244 0.228	0.041	0.039 0.016	0.028 0.020	0.01	0.01	0.004	0.028 0.012	

Note

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

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT109-1	076E07	MS-012				~~99-12-27~~ 03-02-19

Figure 7. Package outline SOT109-1 (SO16)

12 Abbreviations

Table 10. Abbreviations

Acronym	Description
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body Model
MIL	Military
MM	Machine Model

13 Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF4520B_Q100 v.1	20170314	Product data sheet	-	-

14 Legal information

14.1 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.

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[2] The term 'short data sheet' is explained in section "Definitions".
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Date of release: 14 March 2017
Document identifier: HEF4520B_Q100