

HEF4541B-Q100

Programmable timer

Rev. 2 — 31 December 2013

Product data sheet

1. General description

The HEF4541B-Q100 is a programmable timer. It consists of a 16-stage binary counter, an integrated oscillator to be used with external timing components, an automatic power-on reset and output control logic. The external components R_{TC} and C_{TC} determines the frequency of the oscillator within the frequency range 1 Hz to 100 kHz. An external clock signal at input RS can replace the oscillator. The timer advances on the positive-going transition of RS. A LOW on the auto reset input (AR) and a LOW on the master reset input (MR) enables the internal power-on reset. A HIGH level at input MR resets the counter independent on all other inputs. Resetting, disables the oscillator to provide no active power dissipation.

A HIGH at input AR turns off the power-on reset to provide a low quiescent power dissipation of the timer. The 16-stage counter divides the oscillator frequency by 2^8 , 2^{10} , 2^{13} or 2^{16} depending on the state of the address inputs (A0, A1). The divided oscillator frequency is available at output O. The phase input (PH) features a complementary output signal. When the mode select input (MODE) is LOW the timer is a single transition timer and when HIGH the timer is a 2^n frequency divider.

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 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 $-40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$ and from $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$
- 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 ($C = 200\text{ pF}$, $R = 0\text{ }\Omega$)
- Complies with JEDEC standard JESD 13-B

3. Ordering information

Table 1. Ordering information

All types operate from $-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$.

Type number	Package		Version
	Name	Description	
HEF4541BT-Q100	SO14	plastic small outline package; 14 leads; body width 3.9 mm	SOT108-1

4. Functional diagram

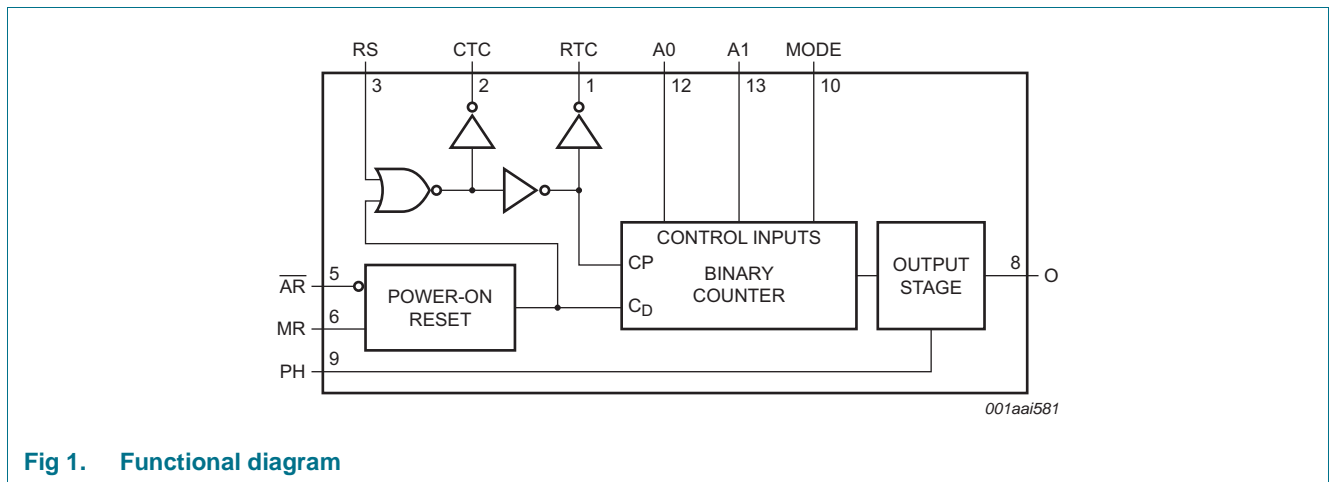


Fig 1. Functional diagram

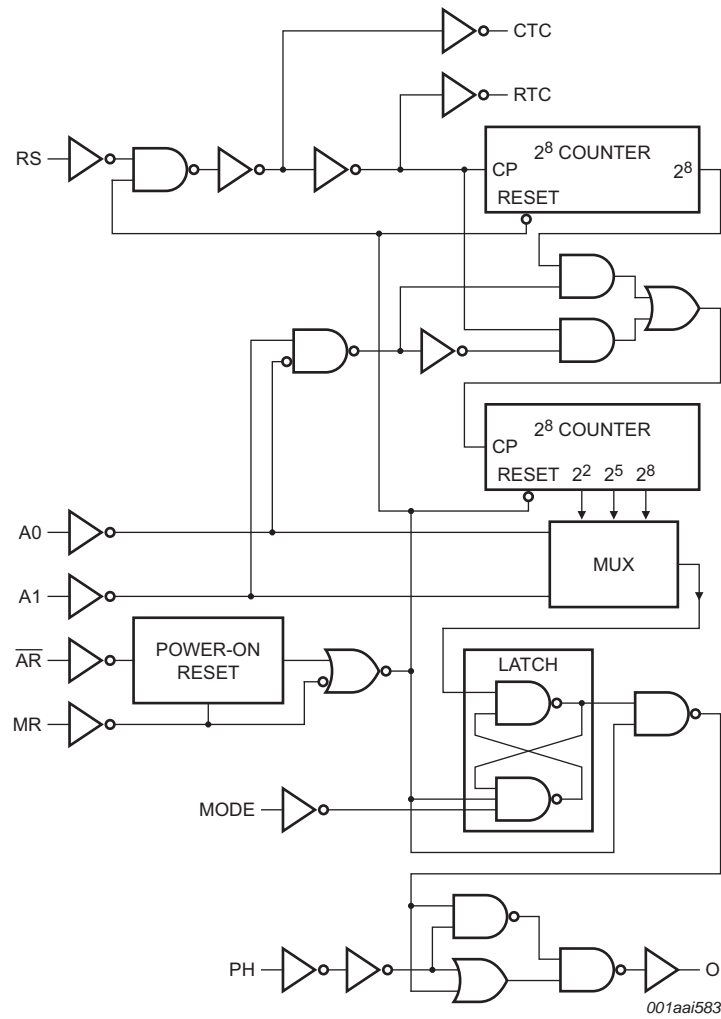


Fig 2. Logic diagram

5. Pinning information

5.1 Pinning

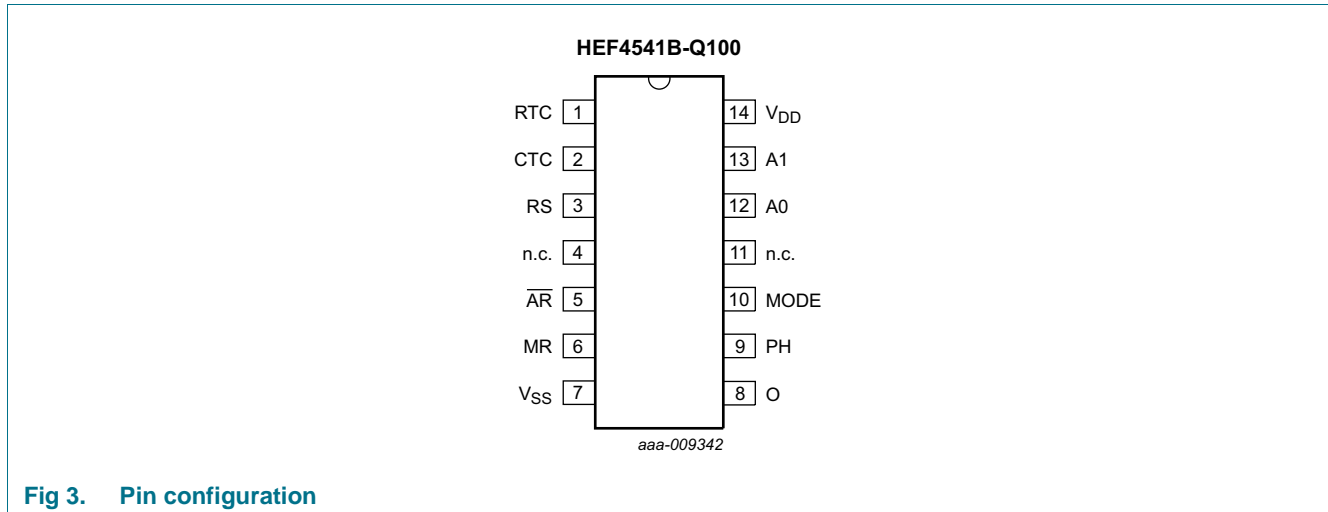


Fig 3. Pin configuration

5.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
RTC	1	external resistor connection
CTC	2	external capacitor connection
RS	3	external resistor connection (RS) or external clock input
nc	4, 11	not connected
$\overline{\text{AR}}$	5	auto reset input (active low)
MR	6	master reset input
V _{SS}	7	ground (0 V)
O	8	timer output
PH	9	phase input
MODE	10	mode select input
A0, A1	12, 13	address inputs
V _{DD}	14	supply voltage

6. Functional description

Table 3. Function table^[1]

Input				MODE
AR	MR	PH	MODE	
H	L	X	X	auto reset disabled
L	L	X	X	auto reset enabled ^[2]
X	H	X	X	master reset active
X	L	X	H	normal operation selected division to output
X	L	X	L	single-cycle mode ^[3]
X	L	L	X	output initially LOW after reset
X	L	H	X	output initially HIGH, after reset

[1] H = HIGH voltage level; L = LOW voltage level; X = don't care.

[2] For correct power-on reset, the supply voltage should be above 8.5 V. For $V_{DD} < 8.5$ V, disable the auto reset and connect \overline{AR} to V_{DD} .

[3] The timer is initialized on a reset pulse and the output changes state after 2^{n-1} counts and remains in that state (latched). A master reset or a LOW to HIGH transition on the MODE input, resets this latch.

Table 4. Frequency selection table

A0	A1	Number of counter stages n	$\frac{f_{osc}}{f_o} = 2^n$
L	L	13	8192
L	H	10	1024
H	L	8	256
H	H	16	65536

7. Limiting values

Table 5. 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	O output	-	± 10	mA
T_{stg}	storage temperature		-65	+150	°C
T_{amb}	ambient temperature		-40	+125	°C
P_{tot}	total power dissipation	$T_{amb} = -40$ °C to +125 °C	^[1] -	500	mW
P	power dissipation		-	100	mW

[1] For SO14 package: P_{tot} derates linearly with 8 mW/K above 70 °C.

8. Recommended operating conditions

Table 6. 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
$\Delta t/\Delta V$	input transition rise and fall rate	$V_{DD} = 5\text{ V}$	-	3.75	$\mu\text{s/V}$
		$V_{DD} = 10\text{ V}$	-	0.5	$\mu\text{s/V}$
		$V_{DD} = 15\text{ V}$	-	0.08	$\mu\text{s/V}$

9. Static characteristics

Table 7. Static characteristics

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

Symbol	Parameter	Conditions	V_{DD}	$T_{amb} = -40\text{ °C}$		$T_{amb} = 25\text{ °C}$		$T_{amb} = 85\text{ °C}$		$T_{amb} = 125\text{ °C}$		Unit	
				Min	Max	Min	Max	Min	Max	Min	Max		
V_{IH}	HIGH-level input voltage	$ I_O < 1\ \mu\text{A}$	5 V	3.5	-	3.5	-	3.5	-	3.5	-	V	
			10 V	7.0	-	7.0	-	7.0	-	7.0	-	V	
			15 V	11.0	-	11.0	-	11.0	-	11.0	-	V	
V_{IL}	LOW-level input voltage	$ I_O < 1\ \mu\text{A}$	5 V	-	1.5	-	1.5	-	1.5	-	1.5	V	
			10 V	-	3.0	-	3.0	-	3.0	-	3.0	V	
			15 V	-	4.0	-	4.0	-	4.0	-	4.0	V	
V_{OH}	HIGH-level output voltage	$ I_O < 1\ \mu\text{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\text{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	CTC, RTC;	$V_O = 2.5\text{ V}$	5 V	-	-1.4	-	-1.2	-	-0.95	-	-0.95	mA
			$V_O = 4.6\text{ V}$	5 V	-	-0.5	-	-0.4	-	-0.3	-	-0.3	mA
			$V_O = 9.5\text{ V}$	10 V	-	-1.4	-	-1.2	-	-0.95	-	-0.95	mA
			$V_O = 13.5\text{ V}$	15 V	-	-4.8	-	-4.0	-	-3.2	-	-3.2	mA
		O;	$V_O = 2.5\text{ V}$	5 V	-	-1.7	-	-1.4	-	-1.1	-	-1.1	mA
			$V_O = 4.6\text{ V}$	5 V	-	-0.64	-	-0.5	-	-0.36	-	-0.36	mA
			$V_O = 9.5\text{ V}$	10 V	-	-1.6	-	-1.3	-	-0.9	-	-0.9	mA
			$V_O = 13.5\text{ V}$	15 V	-	-4.2	-	-3.4	-	-2.4	-	-2.4	mA

Table 7. Static characteristics ...continued $V_{SS} = 0\text{ V}$; $V_I = V_{SS}$ or V_{DD} ; unless otherwise specified.

Symbol	Parameter	Conditions	V_{DD}	$T_{amb} = -40\text{ °C}$		$T_{amb} = 25\text{ °C}$		$T_{amb} = 85\text{ °C}$		$T_{amb} = 125\text{ °C}$		Unit
				Min	Max	Min	Max	Min	Max	Min	Max	
I_{OL}	LOW-level output current	CTC, RTC;										
		$V_O = 0.4\text{ V}$	5 V	0.33	-	0.27	-	0.20	-	0.20	-	mA
		$V_O = 0.5\text{ V}$	10 V	1.0	-	0.85	-	0.68	-	0.68	-	mA
		$V_O = 1.5\text{ V}$	15 V	3.2	-	2.7	-	2.3	-	2.3	-	mA
		O;										
		$V_O = 0.4\text{ V}$	5 V	0.64	-	0.5	-	0.36	-	0.36	-	mA
	$V_O = 0.5\text{ V}$	10 V	1.6	-	1.3	-	0.9	-	0.9	-	mA	
	$V_O = 1.5\text{ V}$	15 V	4.2	-	3.2	-	2.4	-	2.4	-	mA	
I_I	input leakage current		15 V	-	± 0.1	-	± 0.1	-	± 1.0	-	± 1.0	μA
I_{DD}	supply current	$I_O = 0\text{ A}$	5 V	-	5	-	5	-	150	-	150	μA
			10 V	-	10	-	10	-	300	-	300	μA
			15 V	-	20	-	20	-	600	-	600	μA
C_I	input capacitance		-	-	-	7.5	-	-	-	-	pF	

Table 8. Reset characteristics $V_{SS} = 0\text{ V}$; $V_I = V_{SS}$ or V_{DD} ; see [Table 12](#) for test conditions; unless otherwise specified.

Symbol	Parameter	Conditions	V_{DD}	$T_{amb} = -40\text{ °C}$		$T_{amb} = +25\text{ °C}$			$T_{amb} = +85\text{ °C}$		$T_{amb} = +125\text{ °C}$		Unit
				Min	Max	Min	Typ	Max	Min	Max	Min	Max	
I_{DD}	supply current	supply current for power-on reset enable; $\overline{AR} = \overline{MR} = 0\text{ V}$; Other inputs at 0 V or V_{DD}	5 V	-	80	-	20	80	-	230	-	230	μA
			10 V	-	750	-	250	600	-	700	-	700	μA
			15 V	-	1.6	-	0.5	1.3	-	1.5	-	1.5	mA
V_{DD}	supply voltage	supply voltage for automatic reset initialization; $\overline{AR} = \overline{MR} = 0\text{ V}$; Other inputs at 0 V or V_{DD}	-	-	-	8.5	5	-	-	-	-	V	

10. Dynamic characteristics

Table 9. Dynamic characteristics

$V_{SS} = 0\text{ V}$; $T_{amb} = 25\text{ °C}$ unless otherwise specified. For test circuit, see [Figure 5](#).

Symbol	Parameter	Conditions	V_{DD}	Extrapolation formula	Min	Typ ^[1]	Max	Unit
t_{pd}	propagation delay	RS to O; 2 ⁸ selected; see Figure 4	5 V ^[2]	$348\text{ ns} + (0.55\text{ ns/pF})C_L$	-	375	750	ns
			10 V	$139\text{ ns} + (0.23\text{ ns/pF})C_L$	-	150	300	ns
			15 V	$102\text{ ns} + (0.16\text{ ns/pF})C_L$	-	110	220	ns
		RS to O; 2 ¹⁰ selected; see Figure 4	5 V	$398\text{ ns} + (0.55\text{ ns/pF})C_L$	-	425	850	ns
			10 V	$154\text{ ns} + (0.23\text{ ns/pF})C_L$	-	165	330	ns
			15 V	$112\text{ ns} + (0.16\text{ ns/pF})C_L$	-	120	240	ns
		RS to O; 2 ¹³ selected; see Figure 4	5 V	$483\text{ ns} + (0.55\text{ ns/pF})C_L$	-	510	1020	ns
			10 V	$179\text{ ns} + (0.23\text{ ns/pF})C_L$	-	190	380	ns
			15 V	$127\text{ ns} + (0.16\text{ ns/pF})C_L$	-	135	270	ns
		RS to O; 2 ¹⁶ selected; see Figure 4	5 V	$548\text{ ns} + (0.55\text{ ns/pF})C_L$	-	575	1150	ns
			10 V	$199\text{ ns} + (0.23\text{ ns/pF})C_L$	-	210	420	ns
			15 V	$142\text{ ns} + (0.16\text{ ns/pF})C_L$	-	150	300	ns
t_W	pulse width	RS LOW; MR HIGH; see Figure 4	5 V ^[3]		60	30	-	ns
			10 V		30	15	-	ns
			15 V		24	12	-	ns
$f_{clk(max)}$	maximum clock frequency	RS; see Figure 4	5 V		8	16	-	MHz
			10 V		15	30	-	MHz
			15 V		18	36	-	MHz
f_{osc}	oscillator frequency	$R_t = 5\text{ k}\Omega$; $C_t = 1\text{ nF}$; $R_S = 10\text{ k}\Omega$; see Figure 6	5 V		-	90	-	kHz
			10 V		-	90	-	kHz
			15 V		-	90	-	kHz
		$R_t = 56\text{ k}\Omega$; $C_t = 1\text{ nF}$; $R_S = 120\text{ k}\Omega$; see Figure 6	5 V		-	8	-	kHz
			10 V		-	8	-	kHz
			15 V		-	8	-	kHz

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

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

[3] t_W is the same as $t_{WL(min)}$ and $t_{WH(min)}$.

Table 10. Dynamic power dissipation

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

Symbol	Parameter	V_{DD}	Typical formula
P_D	dynamic power dissipation	Per package	
		5 V	$P_D = 1300 \times f_i + (f_o \times C_L \times V_{DD}^2)\ \mu\text{W}$
		10 V	$P_D = 5300 \times f_i + (f_o \times C_L \times V_{DD}^2)\ \mu\text{W}$
		15 V	$P_D = 12000 \times f_i + (f_o \times C_L \times V_{DD}^2)\ \mu\text{W}$
		Total, using the on-chip oscillator	
		5 V	$P_D = 1300 \times f_{osc} + f_o C_L V_{DD}^2 + 2C_{TC} V_{DD}^2 f_{osc} + 10V_{DD}\ \mu\text{W}$
		10 V	$P_D = 5300 \times f_{osc} + f_o C_L V_{DD}^2 + 2C_{TC} V_{DD}^2 f_{osc} + 100V_{DD}\ \mu\text{W}$
15 V	$P_D = 12000 \times f_{osc} + f_o C_L V_{DD}^2 + 2C_{TC} V_{DD}^2 f_{osc} + 400V_{DD}\ \mu\text{W}$		

[1] 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; f_{osc} = oscillator frequency in MHz; C_{TC} = timing capacitance in pF.

11. Waveforms

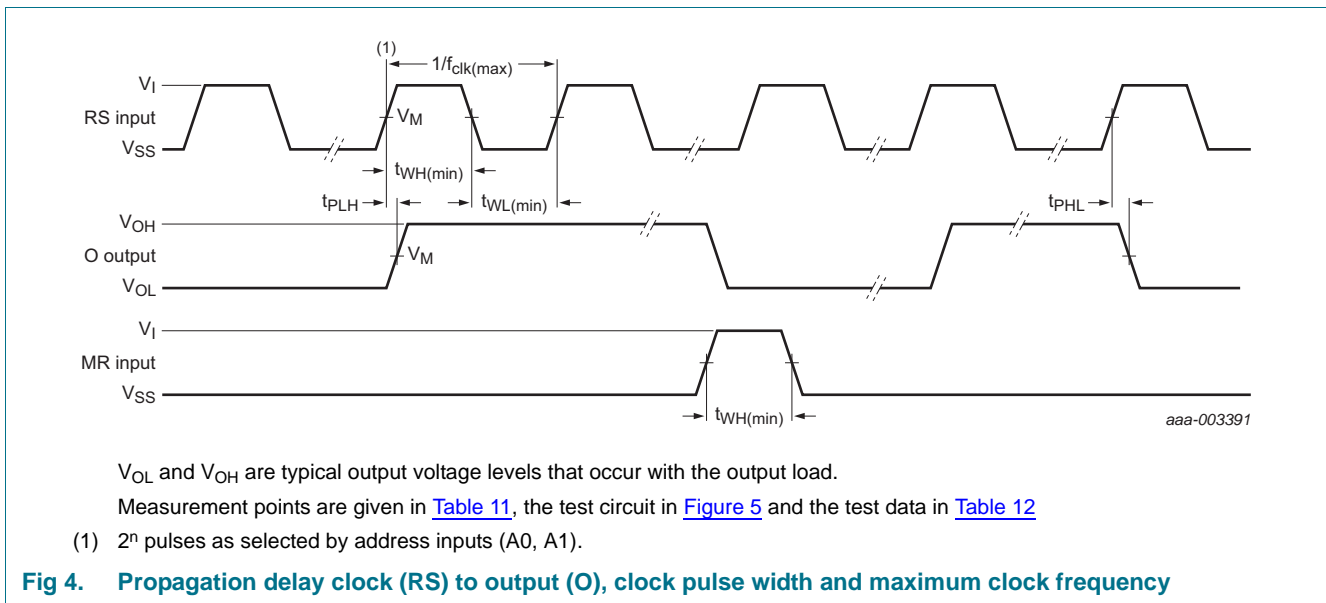
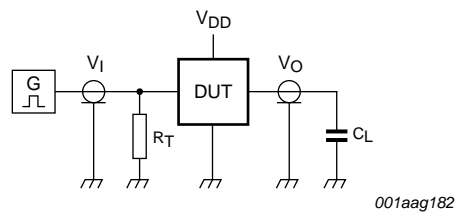


Table 11. Measurement points

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 12](#).

Definitions for test circuit:

DUT - Device Under Test.

R_L = Load resistance.

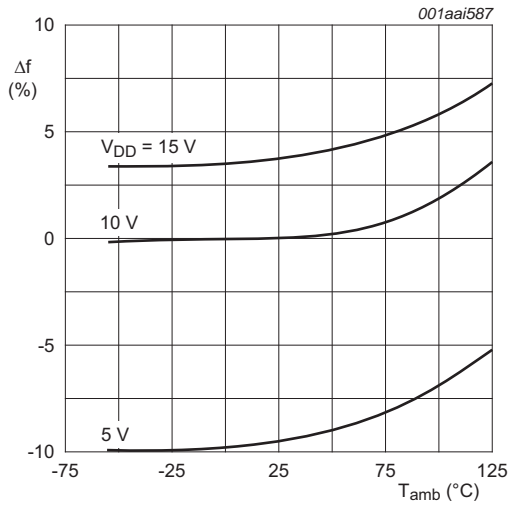
C_L = load capacitance.

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

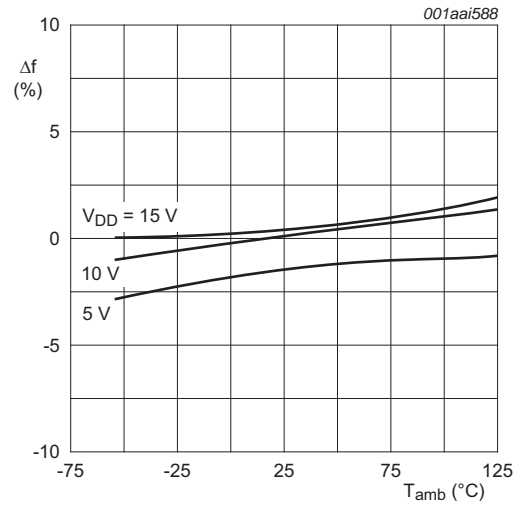
Fig 5. Test circuit for measuring switching times

Table 12. Test data

Supply	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



a. $R_{TC} = 56\text{ k}\Omega$; $C_{TC} = 1\text{ nF}$; $R_S = 0\ \Omega$.



b. $R_{TC} = 56\text{ k}\Omega$; $C_{TC} = 1\text{ nF}$; $R_S = 120\text{ k}\Omega$.

Fig 8. Frequency deviation (Δf) as a function of ambient temperature

13. Package outline

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

SOT108-1

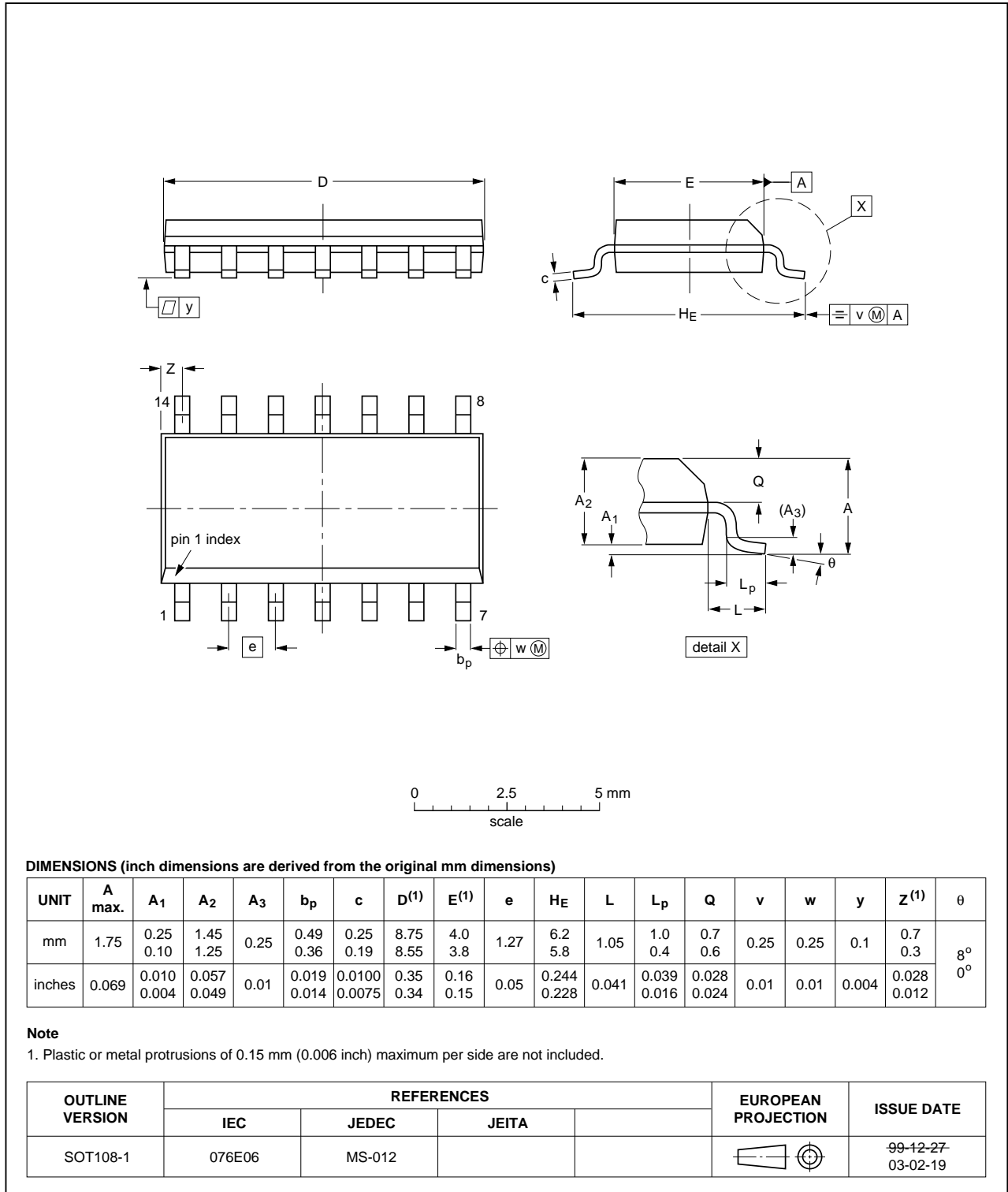


Fig 9. Package outline SOT108-1 (SO14)

14. Abbreviations

Table 13. Abbreviations

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

15. Revision history

Table 14. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF4541B_Q100 v.2	20131231	Product data sheet	-	HEF4541B_Q100 v.1
Modifications:	• Maximum temperature changed to 125 °C throughout.			
HEF4541B_Q100 v.1	20131021	Product data sheet	-	-

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".

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18. Contents

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