

# HEF4066B-Q100

## Quad single-pole single-throw analog switch

Rev. 1 — 7 August 2012

Product data sheet

### 1. General description

The HEF4066B-Q100 provides four single-pole, single-throw analog switch functions. Each switch has two input/output terminals (nY and nZ) and an active HIGH enable input (nE). When nE is LOW, the analog switch is turned off.

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-883C, method 3015 exceeds 2000 V
  - ◆ HBM JESD22-A114F exceeds 2000 V
  - ◆ MM JESD22-A115-A exceeds 200 V ( $C = 200\text{ pF}$ ,  $R = 0\text{ }\Omega$ )
- Inputs and outputs are protected against electrostatic effects
- Complies with JEDEC standard JESD 13-B

### 3. Applications

- Industrial and automotive
- Analog multiplexing and demultiplexing
- Digital multiplexing and demultiplexing
- Signal gating

### 4. Ordering information

Table 1. Ordering information

Type number	Package			Version
	Temperature range	Name	Description	
HEF4066BT-Q100	$-40\text{ }^{\circ}\text{C}$ to $+125\text{ }^{\circ}\text{C}$	SO14	plastic small outline package; 14 leads; body width 3.9 mm	SOT108-1



## 5. Functional diagram

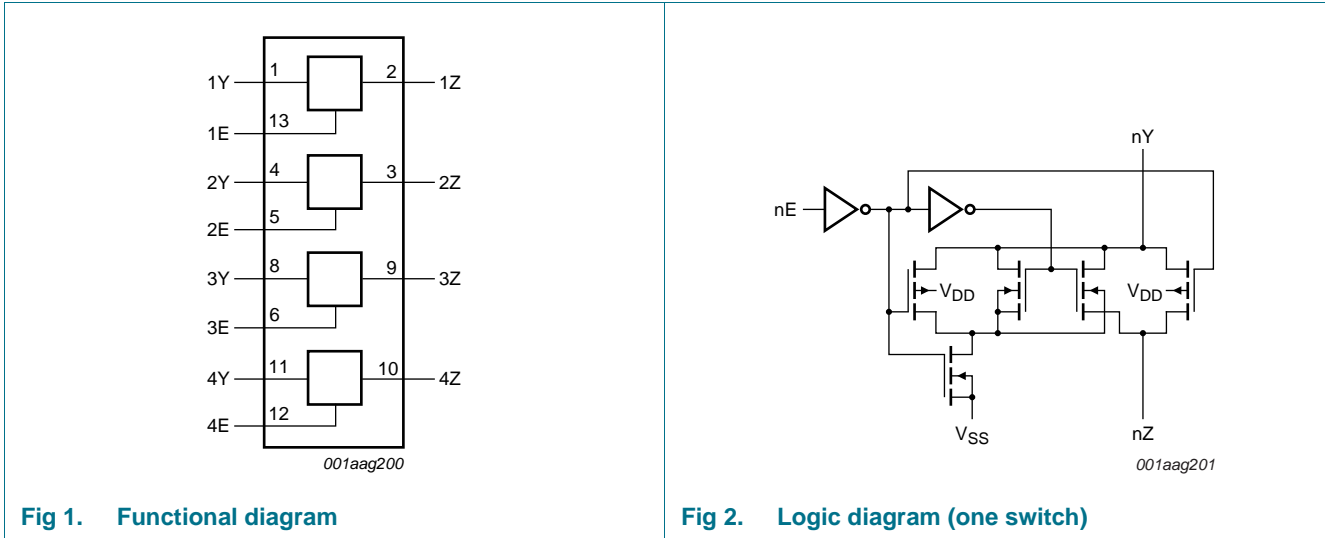


Fig 1. Functional diagram

Fig 2. Logic diagram (one switch)

## 6. Pinning information

### 6.1 Pinning

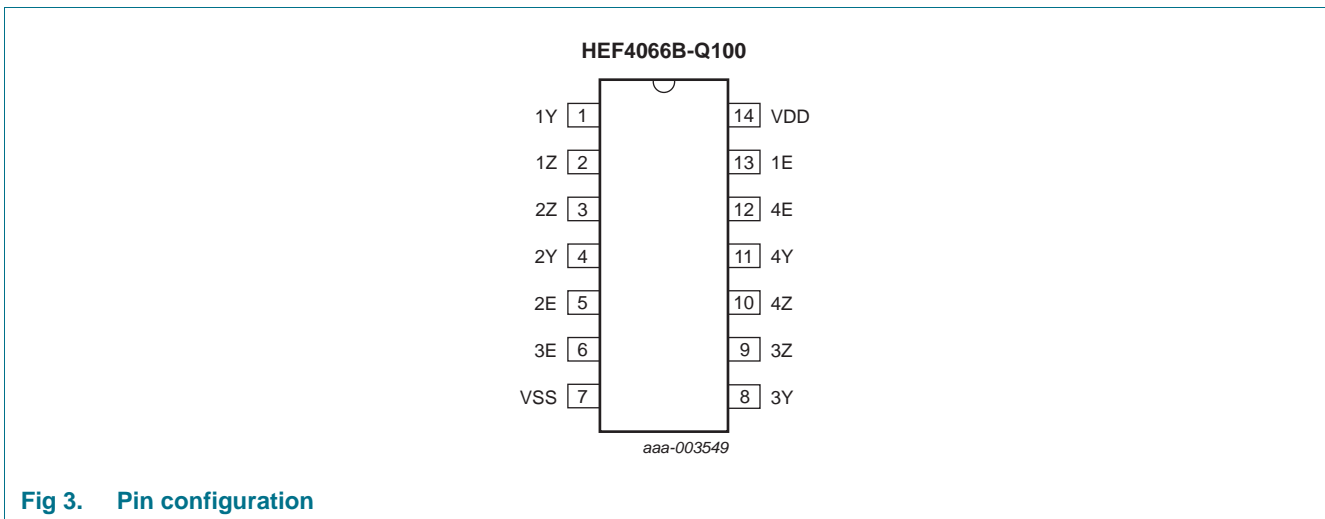


Fig 3. Pin configuration

### 6.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
1Y, 2Y, 3Y, 4Y	1, 4, 8, 11	independent input or output
1Z, 2Z, 3Z, 4Z	2, 3, 9, 10	independent input or output
1E, 2E, 3E, 4E	13, 5, 6, 12	enable input (active HIGH)
V <sub>SS</sub>	7	ground (0 V)
V <sub>DD</sub>	14	supply voltage

## 7. Functional description

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

Input nE	Switch
H	ON
L	OFF

[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  $V_{SS} = 0$  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	-	$\pm 10$	mA
$V_I$	input voltage		-0.5	$V_{DD} + 0.5$	V
$I_{I/O}$	input/output current		<sup>[1]</sup> -	$\pm 10$	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	<sup>[2]</sup> -	500	mW
P	power dissipation	per switch	-	100	mW

[1] To avoid drawing  $V_{DD}$  current out of terminal nZ, when switch current flows into terminals nY, the voltage drop across the bidirectional switch must not exceed 0.4 V. If the switch current flows into terminal nZ, no  $V_{DD}$  current flows out of terminals nY. In this case, there is no limit for the voltage drop across the switch, but the voltages at nY and nZ may not exceed  $V_{DD}$  or  $V_{SS}$ .

[2] For SO14 packages: above  $T_{amb} = 70$  °C,  $P_{tot}$  derates linearly with 8 mW/K.

## 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	-	+125	°C
$\Delta t/\Delta V$	input transition rise and fall rate	$V_{DD} = 5$ V	-	-	3.75	$\mu$ s/V
		$V_{DD} = 10$ V	-	-	0.5	$\mu$ s/V
		$V_{DD} = 15$ V	-	-	0.08	$\mu$ s/V

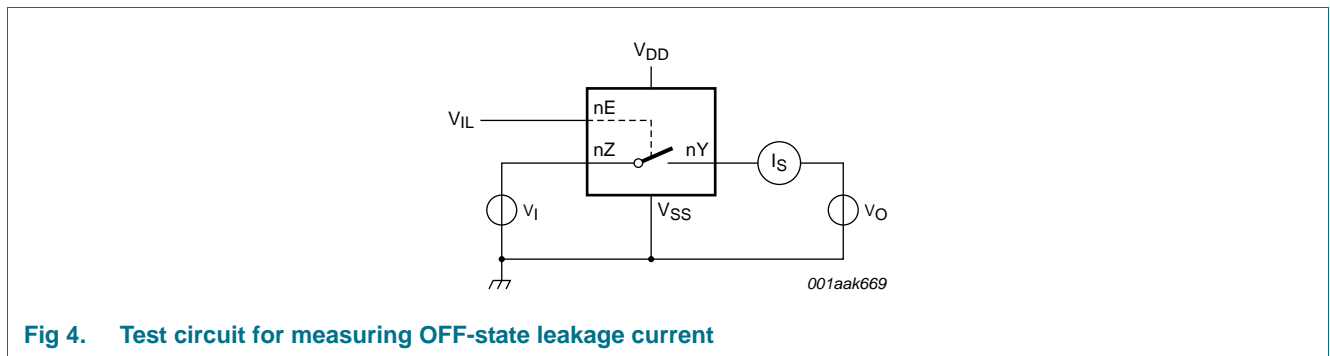
### 10. Static characteristics

**Table 6. Static characteristics**

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

Symbol	Parameter	Conditions	$V_{DD}$	$T_{amb} = -40\text{ }^\circ\text{C}$		$T_{amb} = 25\text{ }^\circ\text{C}$		$T_{amb} = 85\text{ }^\circ\text{C}$		$T_{amb} = 125\text{ }^\circ\text{C}$		Unit
				Min	Max	Min	Max	Min	Max	Min	Max	
$V_{IH}$	HIGH-level input voltage	$ I_O  < 1\text{ }\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\text{ }\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
$I_I$	input leakage current		15 V	-	$\pm 0.1$	-	$\pm 0.1$	-	$\pm 1.0$	-	$\pm 1.0$	$\mu\text{A}$
$I_{S(OFF)}$	OFF-state leakage current	per channel; see <a href="#">Figure 4</a>	15 V	-	-	-	200	-	-	-	-	nA
$I_{DD}$	supply current	all valid input combinations	5 V	-	1.0	-	1.0	-	7.5	-	7.5	$\mu\text{A}$
			10 V	-	2.0	-	2.0	-	15.0	-	15.0	$\mu\text{A}$
			15 V	-	4.0	-	4.0	-	30.0	-	30.0	$\mu\text{A}$
$C_I$	input capacitance	nE input	-	-	-	-	7.5	-	-	-	-	pF

#### 10.1 Test circuit



**Fig 4. Test circuit for measuring OFF-state leakage current**

10.2 ON resistance

Table 7. ON resistance

$T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $I_{SW} = 200\text{ }\mu\text{A}$ ;  $V_{SS} = 0\text{ V}$ .

Symbol	Parameter	Conditions	$V_{DD}$	Typ	Max	Unit
$R_{ON(peak)}$	ON resistance (peak)	$V_I = 0\text{ V to }V_{DD}$ ; see <a href="#">Figure 5</a> and <a href="#">Figure 6</a>	5 V	350	2500	$\Omega$
			10 V	80	245	$\Omega$
			15 V	60	175	$\Omega$
$R_{ON(rail)}$	ON resistance (rail)	$V_I = 0\text{ V}$ ; see <a href="#">Figure 5</a> and <a href="#">Figure 6</a>	5 V	115	340	$\Omega$
			10 V	50	160	$\Omega$
			15 V	40	115	$\Omega$
		$V_I = V_{DD}$ ; see <a href="#">Figure 5</a> and <a href="#">Figure 6</a>	5 V	120	365	$\Omega$
			10 V	65	200	$\Omega$
			15 V	50	155	$\Omega$
$\Delta R_{ON}$	ON resistance mismatch between channels	$V_I = 0\text{ V to }V_{DD}$ ; see <a href="#">Figure 5</a>	5 V	25	-	$\Omega$
			10 V	10	-	$\Omega$
			15 V	5	-	$\Omega$

10.2.1 ON resistance waveform and test circuit

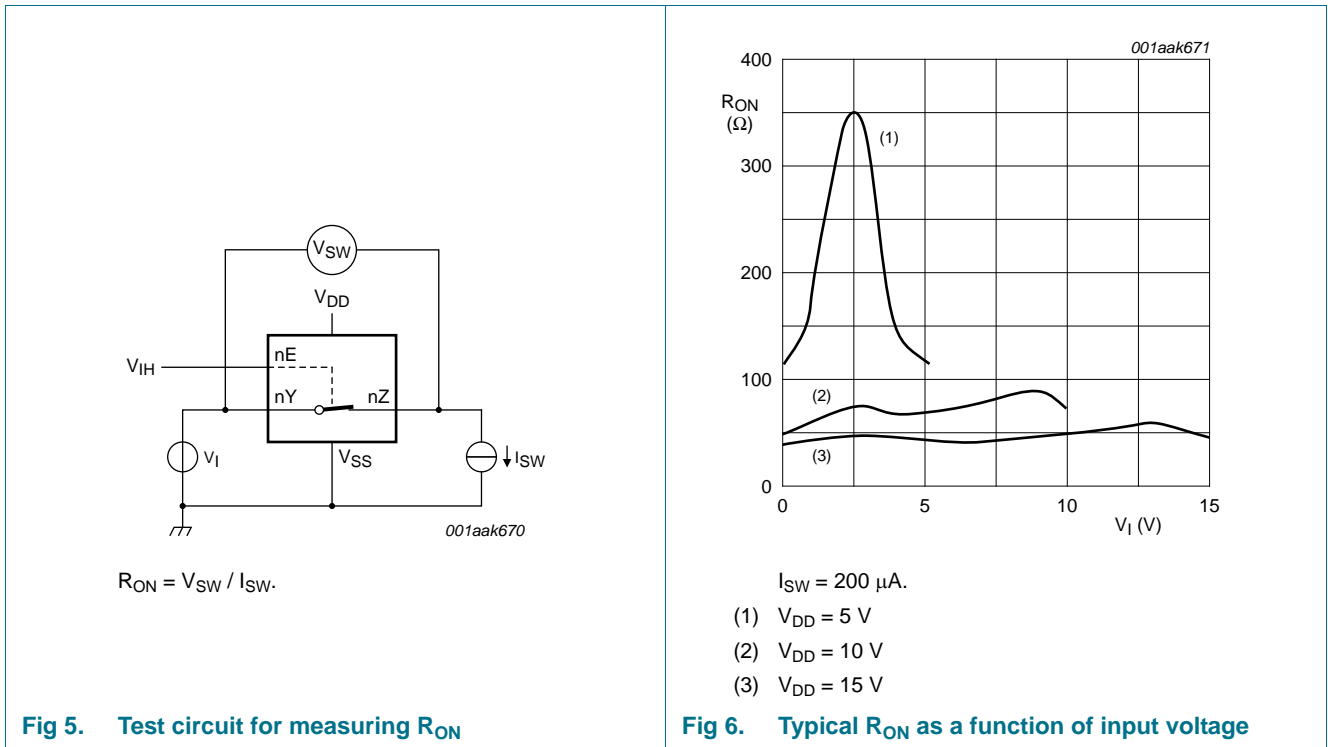


Fig 5. Test circuit for measuring  $R_{ON}$

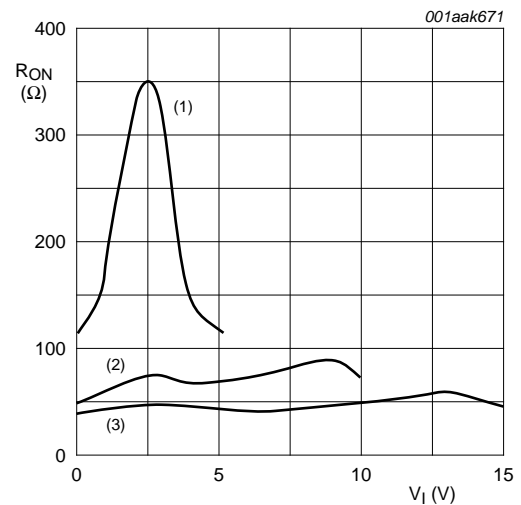


Fig 6. Typical  $R_{ON}$  as a function of input voltage

## 11. Dynamic characteristics

**Table 8. Dynamic characteristics**

$T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $V_{SS} = 0\text{ V}$ ; for test circuit see [Figure 9](#).

Symbol	Parameter	Conditions	$V_{DD}$	Typ	Max	Unit	
t <sub>PHL</sub>	HIGH to LOW propagation delay	nY, nZ to nZ, nY; see <a href="#">Figure 7</a>	5 V	10	20	ns	
			10 V	5	10	ns	
			15 V	5	10	ns	
			nY, nZ to nZ, nY; see <a href="#">Figure 7</a>	5 V	10	20	ns
				10 V	5	10	ns
				15 V	5	10	ns
t <sub>PHZ</sub>	HIGH to OFF-state propagation delay	nE to nY, nZ; see <a href="#">Figure 8</a>	5 V	80	160	ns	
			10 V	65	130	ns	
			15 V	60	120	ns	
t <sub>PZH</sub>	OFF-state to HIGH propagation delay	nE to nY, nZ; see <a href="#">Figure 8</a>	5 V	40	80	ns	
			10 V	20	40	ns	
			15 V	15	30	ns	
t <sub>PLZ</sub>	LOW to OFF-state propagation delay	nE to nY, nZ; see <a href="#">Figure 8</a>	5 V	80	160	ns	
			10 V	70	140	ns	
			15 V	70	140	ns	
t <sub>PZL</sub>	OFF-state to LOW propagation delay	nE to nY, nZ; see <a href="#">Figure 8</a>	5 V	45	90	ns	
			10 V	20	40	ns	
			15 V	15	30	ns	

**Table 9. Dynamic power dissipation P<sub>D</sub>**

$P_D$  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 for P <sub>D</sub> (μW)	where:
P <sub>D</sub>	dynamic power dissipation	5 V	$P_D = 2500 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	$f_i$ = input frequency in MHz;
		10 V	$P_D = 11500 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	$f_o$ = output frequency in MHz;
		15 V	$P_D = 29000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	$C_L$ = output load capacitance in pF;
				$V_{DD}$ = supply voltage in V;
				$\Sigma(C_L \times f_o)$ = sum of the outputs.

11.1 Waveforms and test circuit

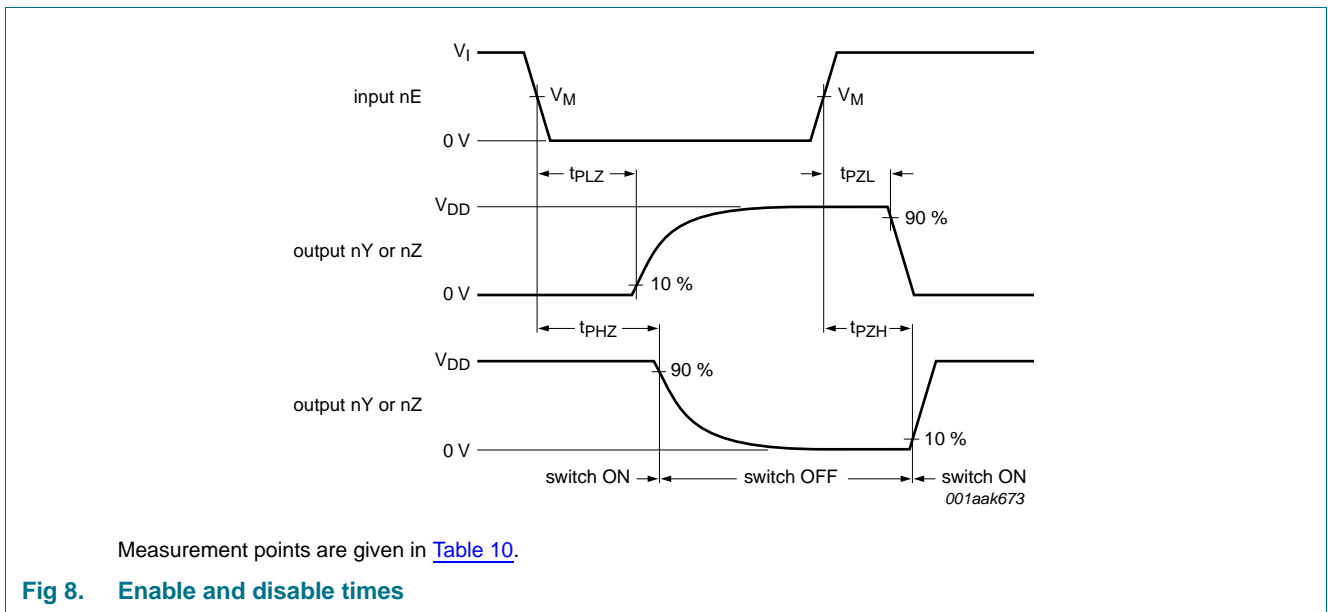
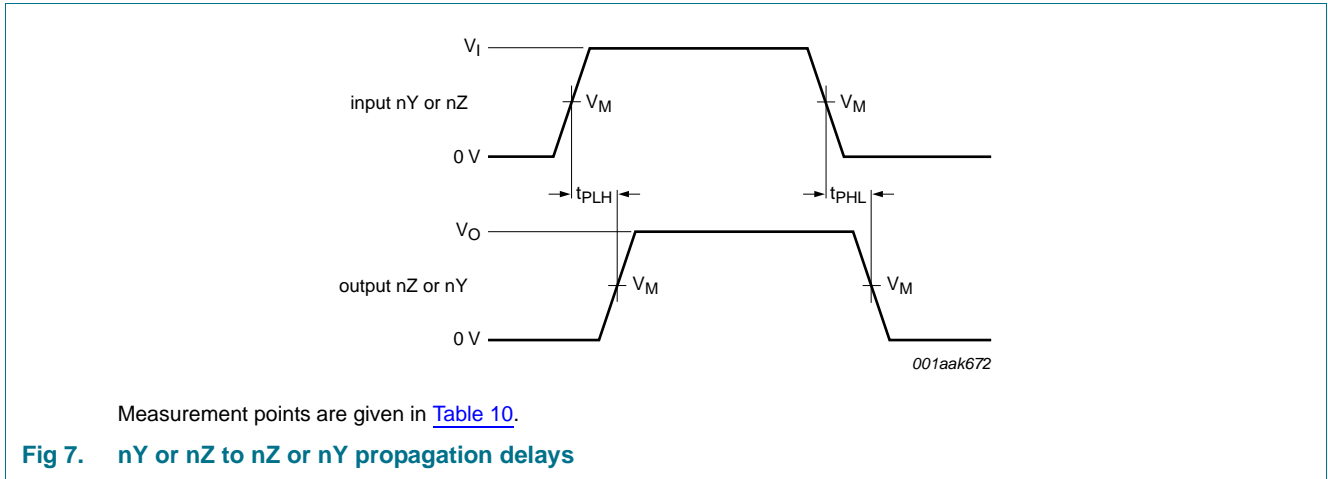
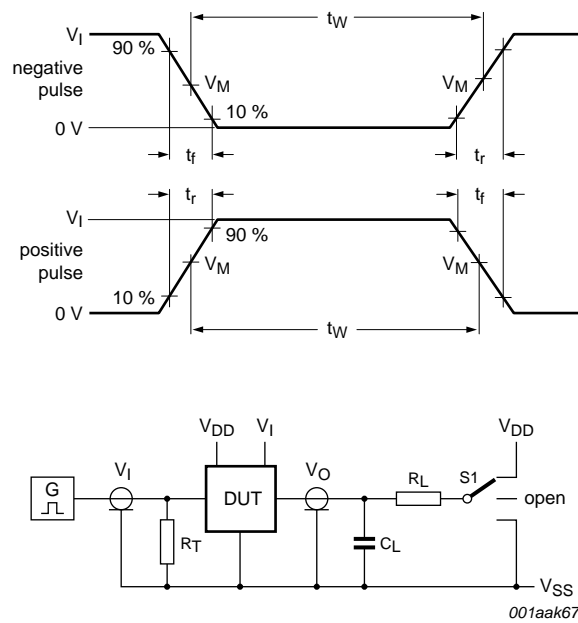


Table 10. Measurement points

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 11](#).

Definitions:

DUT = Device Under Test.

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

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

$R_L$  = Load resistance.

Fig 9. Test circuit for measuring switching times

Table 11. Test data

Supply voltage	Input		Load		S1 position		
$V_{DD}$	$V_I$	$t_r, t_f$	$C_L$	$R_L$	$t_{PHL}, t_{PLH}$	$t_{PZH}, t_{PHZ}$	$t_{PZL}, t_{PLZ}$
5 V to 15 V	0 V or $V_{DD}$	$\leq 20$ ns	50 pF	10 k $\Omega$	$V_{SS}$	$V_{SS}$	$V_{DD}$

## 11.2 Additional dynamic parameters

Table 12. Additional dynamic characteristics

$V_{SS} = 0$  V;  $T_{amb} = 25$  °C.

Symbol	Parameter	Conditions	$V_{DD}$	Typ	Max	Unit
THD	total harmonic distortion	see <a href="#">Figure 10</a> ; $R_L = 10$ k $\Omega$ ; $C_L = 15$ pF; channel ON; $V_I = 0.5V_{DD}$ (p-p); $f_i = 1$ kHz	5 V	[1] 0.25	-	%
			10 V	[1] 0.04	-	%
			15 V	[1] 0.04	-	%
$V_{ct}$	crosstalk voltage	nE input to switch; see <a href="#">Figure 11</a> ; $R_L = 10$ k $\Omega$ ; $C_L = 15$ pF; nE = $V_{DD}$ (square-wave)	10 V	50	-	mV



Table 12. Additional dynamic characteristics ...continued

$V_{SS} = 0\text{ V}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

Symbol	Parameter	Conditions	$V_{DD}$	Typ	Max	Unit
Xtalk	crosstalk	between switches; see Figure 12; $f_i = 1\text{ MHz}$ ; $R_L = 1\text{ k}\Omega$ ; $V_I = 0.5V_{DD}$ (p-p)	10 V	[1] -50	-	dB
$\alpha_{iso}$	isolation (OFF-state)	see Figure 13; $f_i = 1\text{ MHz}$ ; $R_L = 1\text{ k}\Omega$ ; $C_L = 5\text{ pF}$ ; $V_I = 0.5V_{DD}$ (p-p)	10 V	[1] -50	-	dB
$f_{(-3dB)}$	-3 dB frequency response	see Figure 14; $R_L = 1\text{ k}\Omega$ ; $C_L = 5\text{ pF}$ ; $V_I = 0.5V_{DD}$ (p-p)	10 V	[1] 90	-	MHz

[1]  $f_i$  is biased at  $0.5V_{DD}$ .

11.2.1 Test circuits

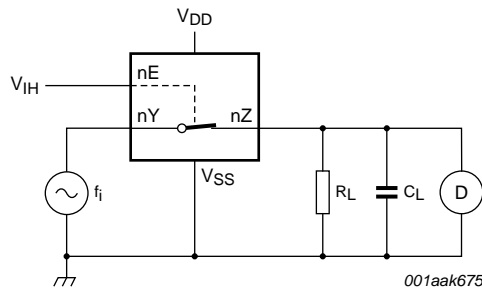
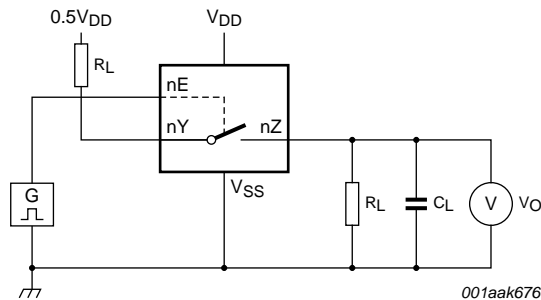
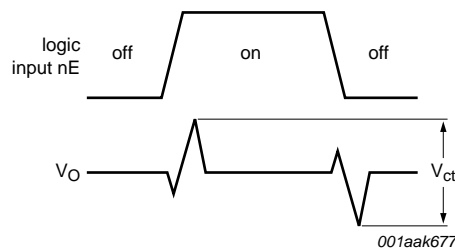


Fig 10. Test circuit for measuring total harmonic distortion

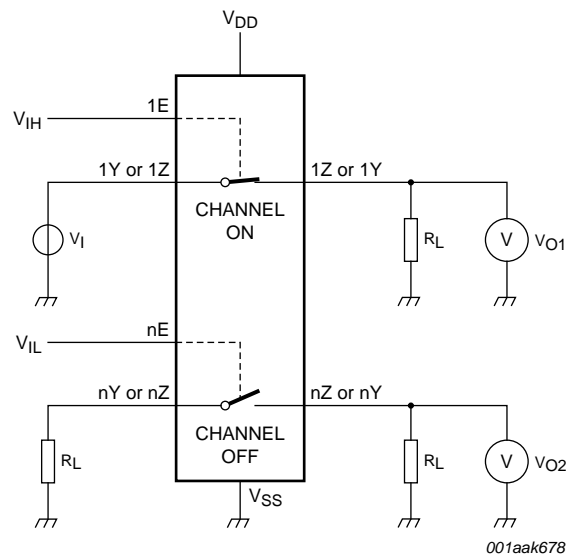


a. Test circuit



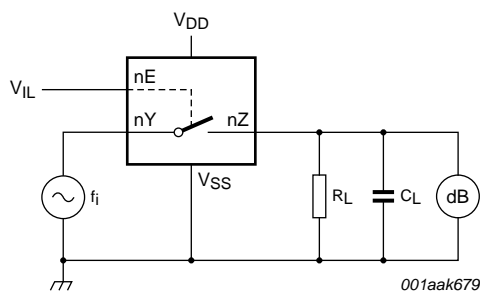
b. Input and output pulse definitions

Fig 11. Test circuit for measuring crosstalk voltage between digital input and switch



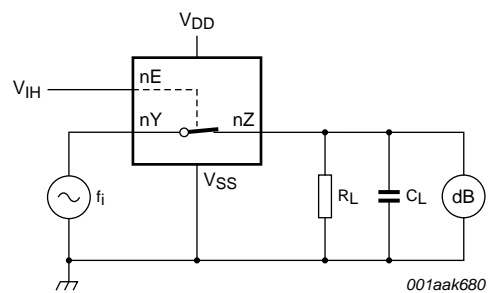
$20 \log_{10} (V_{O2} / V_{O1})$  or  $20 \log_{10} (V_{O1} / V_{O2})$ .

Fig 12. Test circuit for measuring crosstalk between switches



Adjust  $f_i$  voltage to obtain 0 dBm level at input.

Fig 13. Test circuit for measuring isolation (OFF-state)



Adjust  $f_i$  voltage to obtain 0 dBm level at output. Increase  $f_i$  frequency until dB meter reads -3 dB.

Fig 14. Test circuit for measuring frequency response

12. Package outline

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

SOT108-1

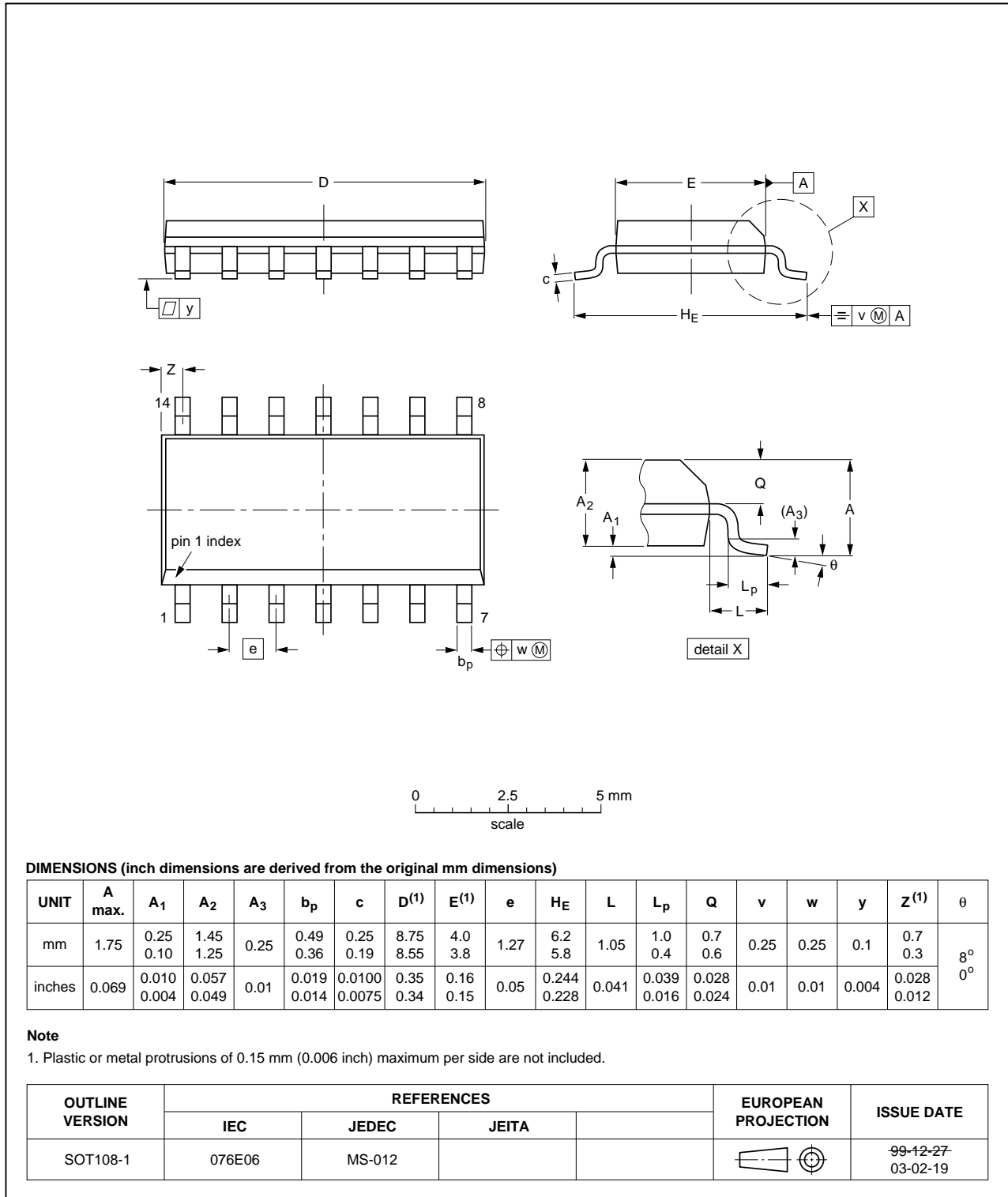


Fig 15. Package outline SOT108-1 (SO14)

## 13. Abbreviations

Table 13. Abbreviations

Acronym	Description
HBM	Human Body Model
ESD	ElectroStatic Discharge
MM	Machine Model
MIL	Military

## 14. Revision history

Table 14. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF4066B_Q100 v.1	20120807	Product specification	-	-

## 15. Legal information

### 15.1 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.
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