

# HEF4067B-Q100

## 16-channel analog multiplexer/demultiplexer

Rev. 1 — 24 September 2013

Product data sheet

### 1. General description

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The HEF4067B-Q100 is a 16-channel analog multiplexer/demultiplexer. It has four address inputs (A0 to A3), an active LOW enable input ( $\overline{E}$ ), 16 independent inputs/outputs (Y0 to Y15) and a common input/output (Z). The device contains 16 bidirectional analog switches. Each switch has one side connected to an independent input/output (Y0 to Y15) and the other side connected to the common input/output (Z). With  $\overline{E}$  LOW, one of the 16 switches is selected (low-impedance ON-state) by A0 to A3. All unselected switches are in the high-impedance OFF-state. With  $\overline{E}$  HIGH all switches are in the high-impedance OFF-state, independent of A0 to A3. The analog inputs/outputs (Y0 to Y15 and Z) can swing between  $V_{DD}$  as a positive limit and  $V_{SS}$  as a negative limit.  $V_{DD}$  to  $V_{SS}$  may not exceed 15 V.

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

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- Automotive product qualification in accordance with AEC-Q100 (Grade 3)
  - ◆ Specified from  $-40\text{ }^{\circ}\text{C}$  to  $+85\text{ }^{\circ}\text{C}$
- 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. Applications

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

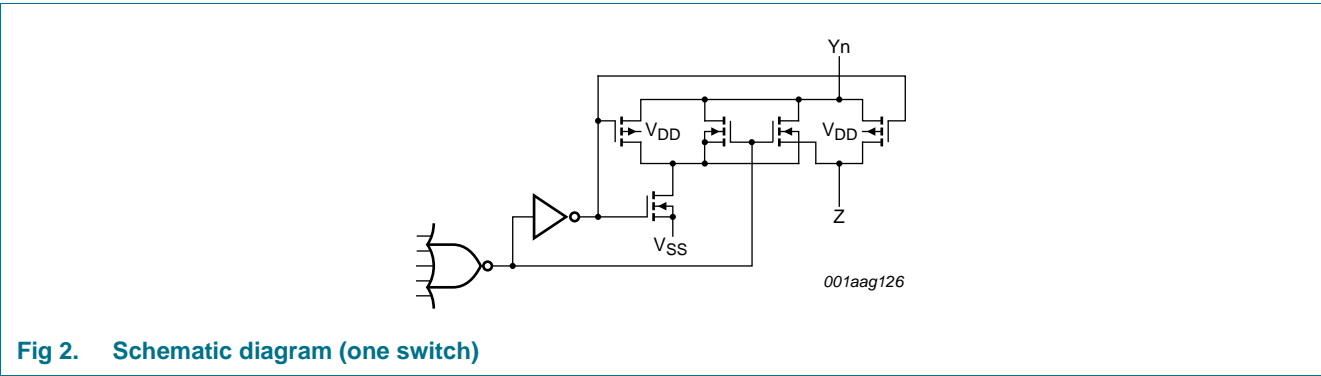
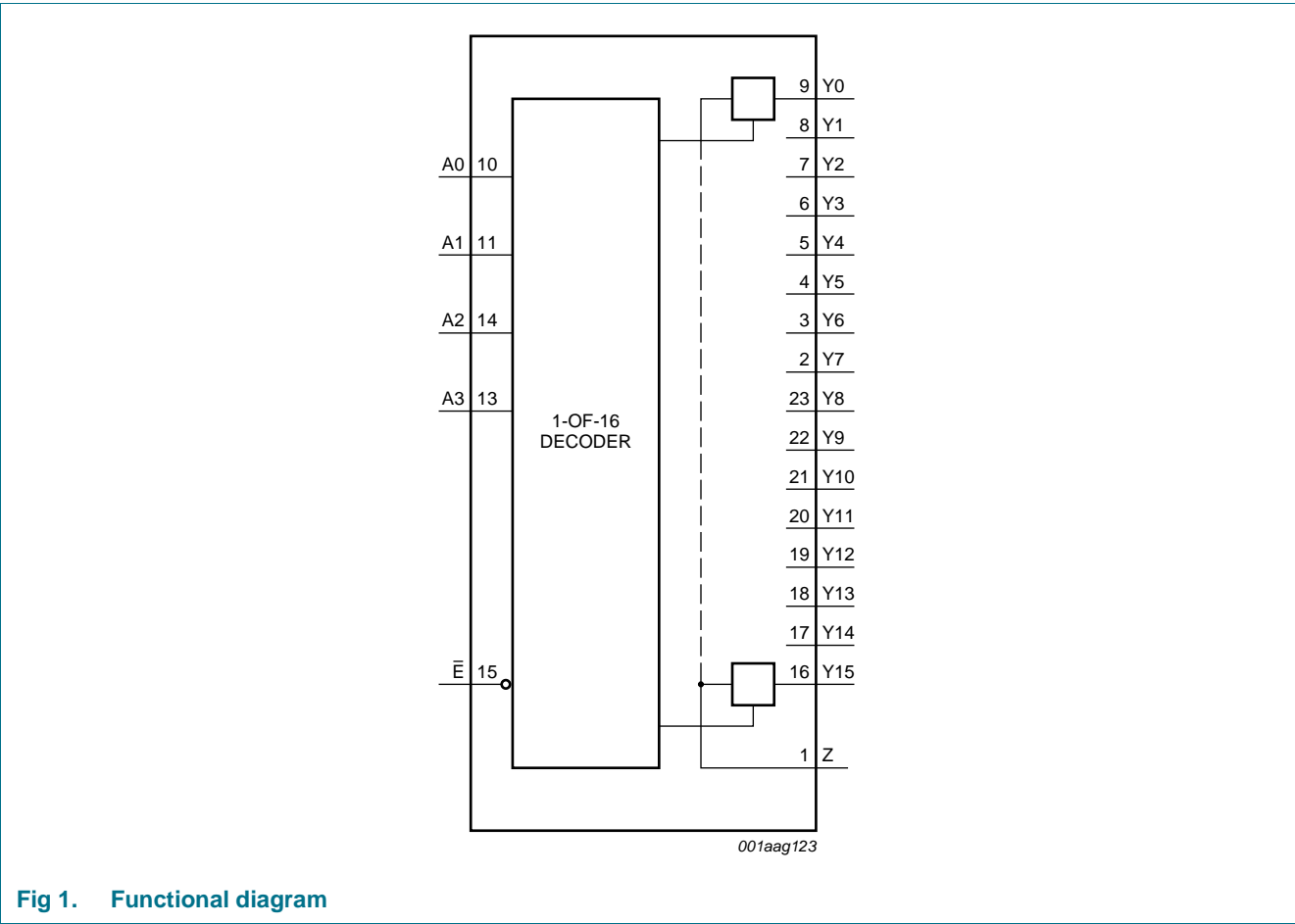


4. Ordering information

Table 1. Ordering information

Type number	Package			Description	Version
	Temperature range	Name			
HEF4067BT-Q100	−40 °C to +85 °C	SO24		plastic small outline package; 24 leads; body width 7.5 mm	SOT137-1

5. Functional diagram



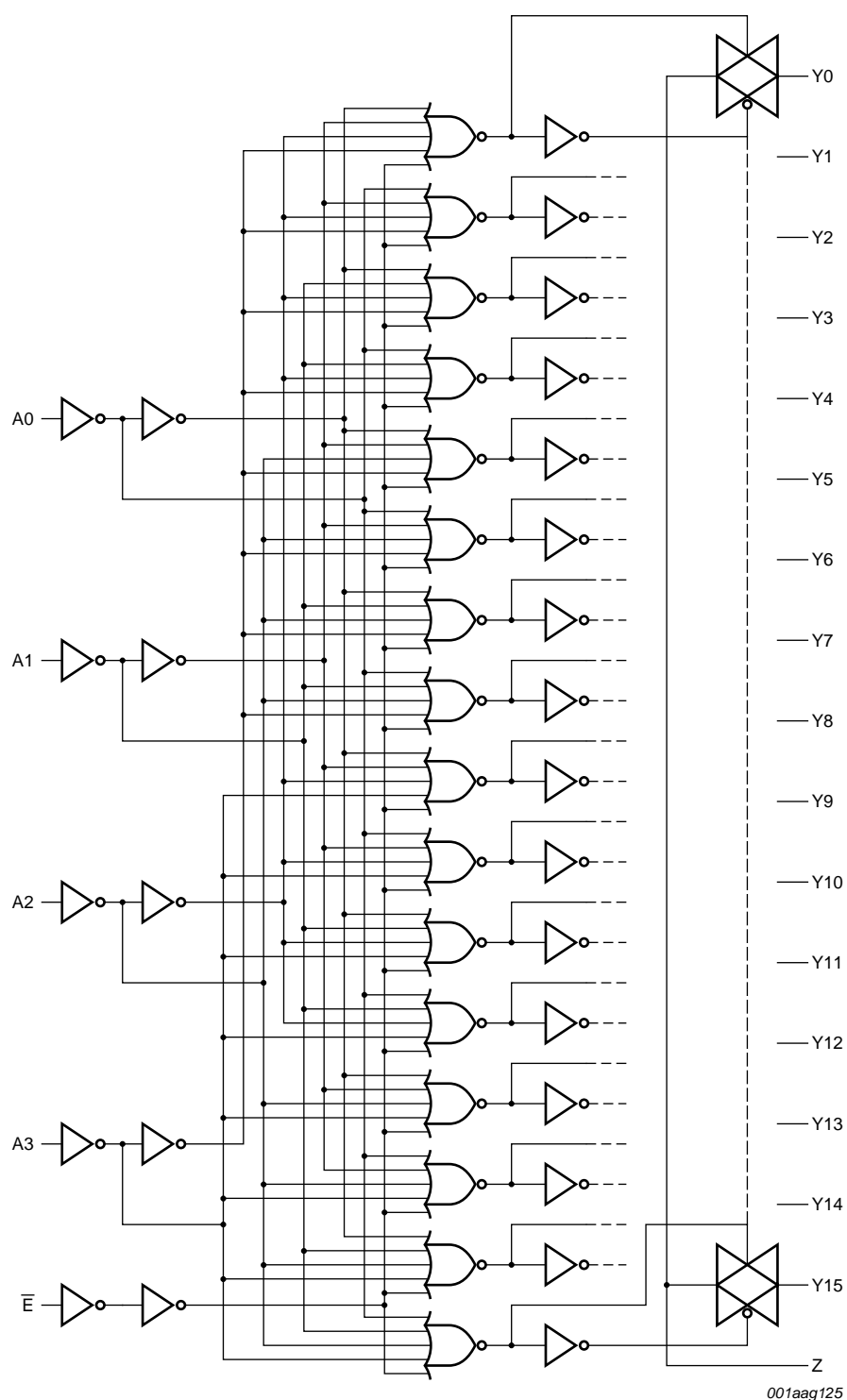
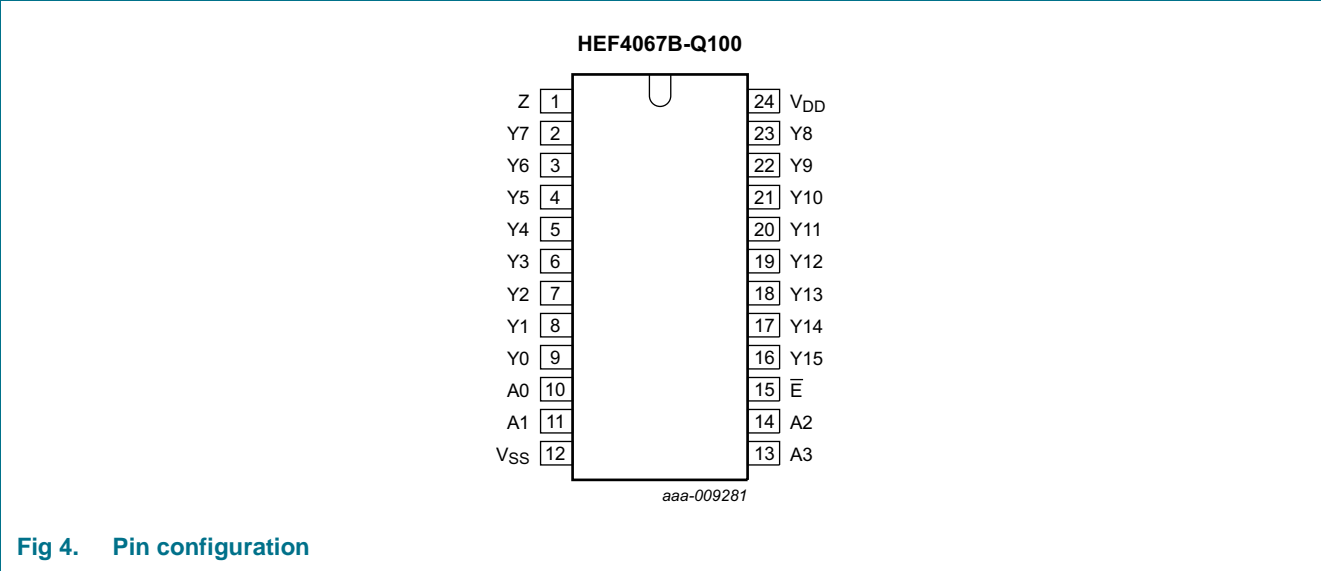


Fig 3. Logic diagram

6. Pinning information

6.1 Pinning



6.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
Z	1	common input/output
Y0 to Y15	9, 8, 7, 6, 5, 4, 3, 2, 23, 22, 21, 20, 19, 18, 17, 16	independent input/output
A0 to A3	10, 11, 14, 13	address input
V <sub>SS</sub>	12	ground (0 V)
$\overline{E}$	15	enable input (active LOW)
V <sub>DD</sub>	24	supply voltage

## 7. Functional description

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

Control	Address				Channel ON
$\bar{E}$	A3	A2	A1	A0	
L	L	L	L	L	Y0 = Z
L	L	L	L	H	Y1 = Z
L	L	L	H	L	Y2 = Z
L	L	L	H	H	Y3 = Z
L	L	H	L	L	Y4 = Z
L	L	H	L	H	Y5 = Z
L	L	H	H	L	Y6 = Z
L	L	H	H	H	Y7 = Z
L	H	L	L	L	Y8 = Z
L	H	L	L	H	Y9 = Z
L	H	L	H	L	Y10 = Z
L	H	L	H	H	Y11 = Z
L	H	H	L	L	Y12 = Z
L	H	H	L	H	Y13 = Z
L	H	H	H	L	Y14 = Z
L	H	H	H	H	Y15 = Z
H	X	X	X	X	none

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

## 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	pins An and $\bar{E}$ ; $V_I < -0.5$ 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
$I_{DD}$	supply current		-	50	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 +125 °C	<sup>[2]</sup> -	500	mW
P	power dissipation	per output	-	100	mW

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

[2] For SO24 packages: above  $T_{amb} = 70$  °C,  $P_{tot}$  derates linearly at 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	-	+85	°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	$\mu\text{s/V}$

## 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	$V_{DD}$	$T_{amb} = -40\text{ °C}$		$T_{amb} = +25\text{ °C}$		$T_{amb} = +85\text{ °C}$		Unit
				Min	Max	Min	Max	Min	Max	
$V_{IL}$	LOW-level input voltage	$ I_O  < 1\text{ }\mu\text{A}$								
		$V_O = 0.5\text{ V or }4.5\text{ V}$	5 V	-	1	-	1	-	1	V
		$V_O = 1.0\text{ V or }9.0\text{ V}$	10 V	-	2	-	2	-	2	V
		$V_O = 1.5\text{ V or }13.5\text{ V}$	15 V	-	2.5	-	2.5	-	2.5	V
$V_{IH}$	HIGH-level input voltage	$ I_O  < 1\text{ }\mu\text{A}$								
		$V_O = 0.5\text{ V or }4.5\text{ V}$	5 V	4	-	4	-	4	-	V
		$V_O = 1.0\text{ V or }9.0\text{ V}$	10 V	8	-	8	-	8	-	V
		$V_O = 1.5\text{ V or }13.5\text{ V}$	15 V	12.5	-	12.5	-	12.5	-	V
$I_I$	input leakage current	$V_I = 0\text{ V or }15\text{ V}$	15 V	-	$\pm 0.3$	-	$\pm 0.3$	-	$\pm 1.0$	$\mu\text{A}$
$I_{OZ}$	OFF-state output current	output at $V_{DD}$	15 V	-	1.6	-	1.6	-	12.0	$\mu\text{A}$
		output at $V_{SS}$	15 V	-	-1.6	-	-1.6	-	-12.0	$\mu\text{A}$
$I_{S(OFF)}$	OFF-state leakage current	Z port; all channels OFF; see <a href="#">Figure 5</a>	15 V	-	-	-	1000	-	-	nA
		Yn port; per channel; see <a href="#">Figure 6</a>	15 V	-	-	-	200	-	-	nA
$I_{DD}$	supply current	all valid input combinations; $I_O = 0\text{ A}$	5 V	-	20	-	20	-	150	$\mu\text{A}$
			10 V	-	40	-	40	-	300	$\mu\text{A}$
			15 V	-	80	-	80	-	600	$\mu\text{A}$
$C_I$	input capacitance	digital inputs	15 V	-	-	-	7.5	-	-	pF

10.1 Test circuits

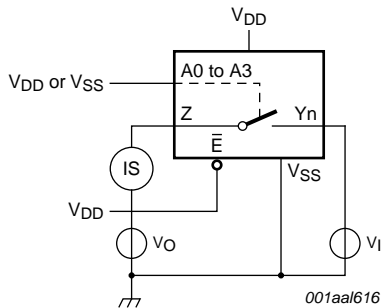


Fig 5. Test circuit for measuring OFF-state leakage current Z port

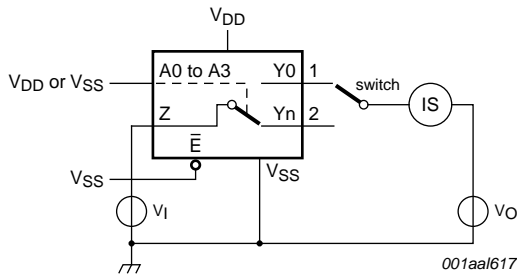


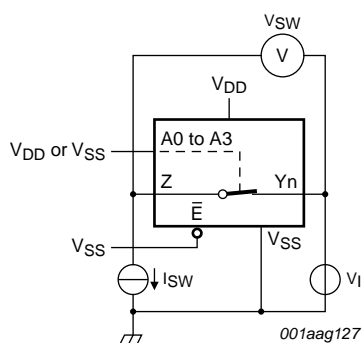
Fig 6. Test circuit for measuring OFF-state leakage current Yn port

10.2 On resistance

Table 7. ON resistance  
 $T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $I_{SW} = 200\text{ }\mu\text{A}$ ;  $V_{SS} = 0\text{ V}$ .

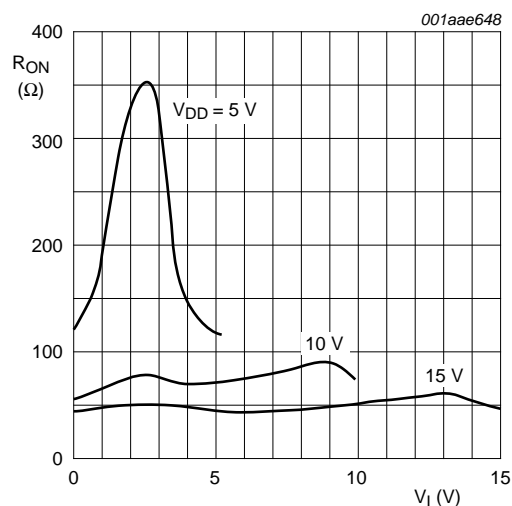
Symbol	Parameter	Conditions	V <sub>DD</sub>	Typ	Max	Unit
R <sub>ON(peak)</sub>	ON resistance (peak)	$V_I = 0\text{ V to }V_{DD}$ ; see <a href="#">Figure 7</a> and <a href="#">Figure 8</a>	5 V	350	2500	$\Omega$
			10 V	80	245	$\Omega$
			15 V	60	175	$\Omega$
R <sub>ON(rail)</sub>	ON resistance (rail)	$V_I = 0\text{ V}$ ; see <a href="#">Figure 7</a> and <a href="#">Figure 8</a>	5 V	115	340	$\Omega$
			10 V	50	160	$\Omega$
			15 V	40	115	$\Omega$
		$V_I = V_{DD}$ ; see <a href="#">Figure 7</a> and <a href="#">Figure 8</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 7</a>	5 V	25	-	$\Omega$
			10 V	10	-	$\Omega$
			15 V	5	-	$\Omega$

### 10.2.1 On resistance waveform and test circuit



$$R_{ON} = V_{SW} / I_{SW}.$$

**Fig 7. Test circuit for measuring  $R_{ON}$**


$$I_{IS} = 200 \mu A; V_{SS} = 0 V.$$

**Fig 8. 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 12](#).

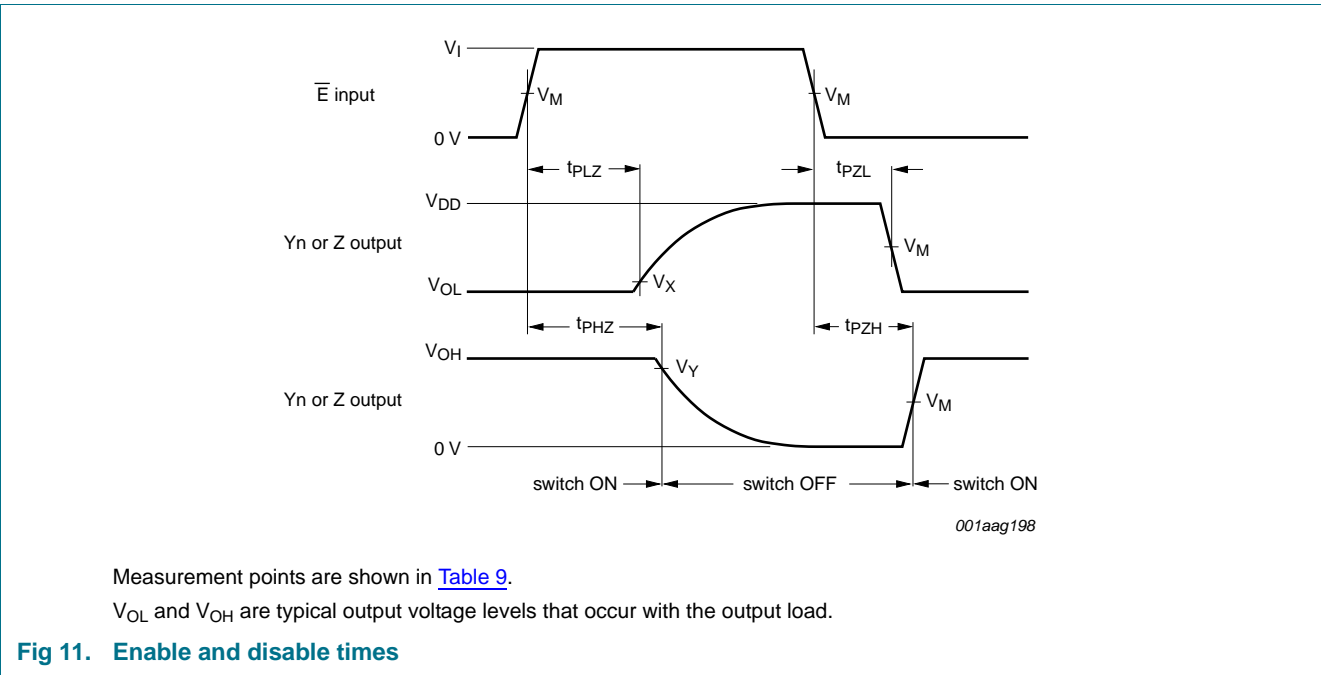
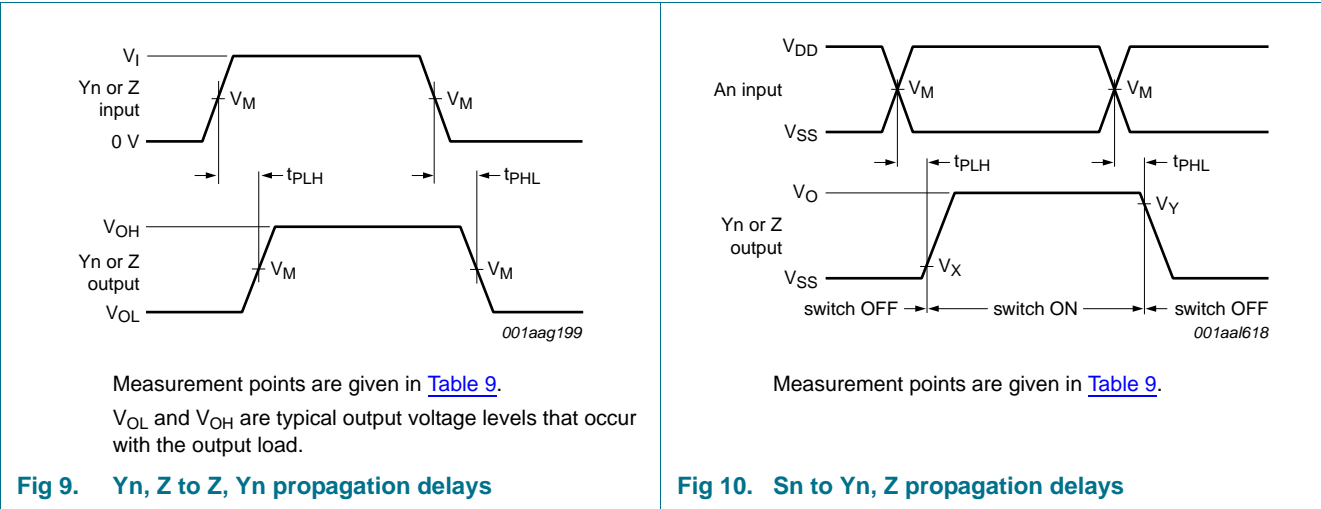
Symbol	Parameter	Conditions	V <sub>DD</sub>	Min	Typ	Max	Unit
t <sub>PHL</sub>	HIGH to LOW propagation delay	Yn, Z to Z, Yn; see <a href="#">Figure 9</a>	5 V	-	30	60	ns
			10 V	-	15	25	ns
			15 V	-	10	20	ns
		An to Yn, Z; see <a href="#">Figure 10</a>	5 V	-	190	380	ns
			10 V	-	70	145	ns
			15 V	-	50	100	ns
t <sub>PLH</sub>	LOW to HIGH propagation delay	Yn, Z to Z, Yn; see <a href="#">Figure 9</a>	5 V	-	25	50	ns
			10 V	-	10	20	ns
			15 V	-	10	20	ns
		An to Yn, Z; see <a href="#">Figure 10</a>	5 V	-	175	345	ns
			10 V	-	70	140	ns
			15 V	-	50	100	ns
t <sub>PHZ</sub>	HIGH to OFF-state propagation delay	$\overline{E}$ to Yn, Z; see <a href="#">Figure 11</a>	5 V	-	195	385	ns
			10 V	-	140	280	ns
			15 V	-	130	260	ns
t <sub>PLZ</sub>	LOW to OFF-state propagation delay	$\overline{E}$ to Yn, Z; see <a href="#">Figure 11</a>	5 V	-	215	435	ns
			10 V	-	180	355	ns
			15 V	-	170	340	ns



**Table 8. Dynamic characteristics ...continued**  
 $T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $V_{SS} = 0\text{ V}$ ; for test circuit, see [Figure 12](#).

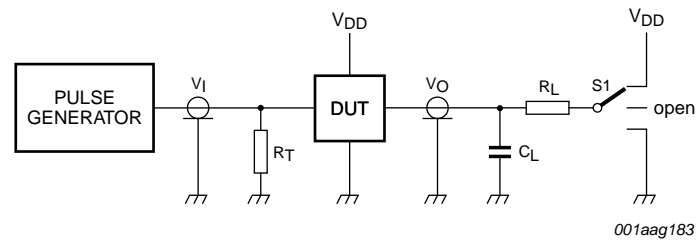
Symbol	Parameter	Conditions	$V_{DD}$	Min	Typ	Max	Unit
$t_{PZH}$	OFF-state to HIGH propagation delay	$\overline{E}$ to $Y_n, Z$ ; see <a href="#">Figure 11</a>	5 V	-	155	315	ns
			10 V	-	70	135	ns
		$\overline{E}$ to $Y_n, Z$ ; see <a href="#">Figure 11</a>	15 V	-	50	100	ns
$t_{PZL}$	OFF-state to LOW propagation delay		5 V	-	170	340	ns
			10 V	-	70	140	ns
			15 V	-	50	100	ns

11.1 Waveforms and test circuit



### Table 9. Measurement points

Supply voltage	Input		Output		
$V_{CC}$	$V_M$	$V_I$	$V_M$	$V_X$	$V_Y$
5 V to 15 V	$0.5V_{DD}$	GND to $V_{DD}$	$0.5V_{DD}$	10%	90%



Test data is given in [Table 10](#).

Definitions test circuit:

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

$C_L$  = load capacitance including jig and probe capacitance

$R_L$  = load resistor

S1 = test selection switch

**Fig 12. Test circuit for measuring switching times**

### Table 10. Test data

Input				Load		S1 position				
Yn, Z	An and $\bar{E}$	t <sub>r</sub> , t <sub>f</sub>	V <sub>M</sub>	C <sub>L</sub>	R <sub>L</sub>	t <sub>PHL</sub> <a href="#">[1]</a>	t <sub>PLH</sub>	t <sub>PZH</sub> , t <sub>PHZ</sub>	t <sub>PZL</sub> , t <sub>PLZ</sub>	other
V <sub>DD</sub> or V <sub>SS</sub>	V <sub>DD</sub> or V <sub>SS</sub>	≤ 20 ns	0.5V <sub>DD</sub>	50 pF	10 kΩ	V <sub>DD</sub> or V <sub>SS</sub>	V <sub>SS</sub>	V <sub>SS</sub>	V <sub>DD</sub>	V <sub>SS</sub>

[1] For Yn to Z or Z to Yn propagation delays, use  $V_{SS}$ . For An or to Yn or Z propagation delays, use  $V_{DD}$ .

## 11.2 Additional dynamic parameters

**Table 11. Additional dynamic characteristics**

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

Symbol	Parameter	Conditions	$V_{DD}$	Typ	Max	Unit
THD	total harmonic distortion	see <a href="#">Figure 13</a> ; $R_L = 10\text{ k}\Omega$ ; $C_L = 15\text{ pF}$ ; channel ON; $V_I = 0.5V_{DD}$ (p-p); $f_i = 1\text{ kHz}$	5 V	[1] 0.25	-	%
			10 V	[1] 0.04	-	%
			15 V	[1] 0.04	-	%
$f_{(-3dB)}$	–3 dB frequency response	see <a href="#">Figure 14</a> ; $R_L = 1\text{ k}\Omega$ ; $C_L = 5\text{ pF}$ ; channel ON; $V_I = 0.5V_{DD}$ (p-p)	5 V	[1] 13	-	MHz
			10 V	[1] 40	-	MHz
			15 V	[1] 70	-	MHz
$\alpha_{iso}$	isolation (OFF-state)	see <a href="#">Figure 15</a> ; $f_i = 1\text{ MHz}$ ; $R_L = 1\text{ k}\Omega$ ; $C_L = 5\text{ pF}$ ; channel OFF; $V_I = 0.5V_{DD}$ (p-p)	10 V	[1] –50	-	dB
$V_{ct}$	crosstalk voltage	digital inputs to switch; see <a href="#">Figure 16</a> ; $R_L = 10\text{ k}\Omega$ ; $C_L = 15\text{ pF}$ ; $E$ or $A_n = V_{DD}$ (square-wave)	10 V	50	-	mV
Xtalk	crosstalk	between switches; see <a href="#">Figure 17</a> ; $f_i = 1\text{ MHz}$ ; $R_L = 1\text{ k}\Omega$ ; $V_I = 0.5V_{DD}$ (p-p)	10 V	[1] –50	-	dB

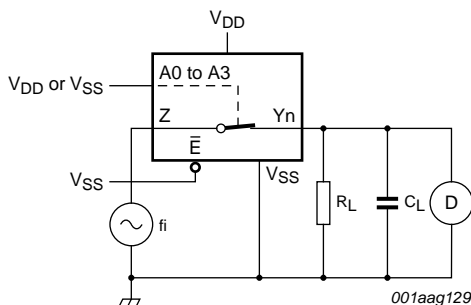
[1]  $f_i$  is biased at  $0.5 V_{DD}$ ;  $V_I = 0.5V_{DD}$  (p-p).

**Table 12. Dynamic power dissipation  $P_D$**

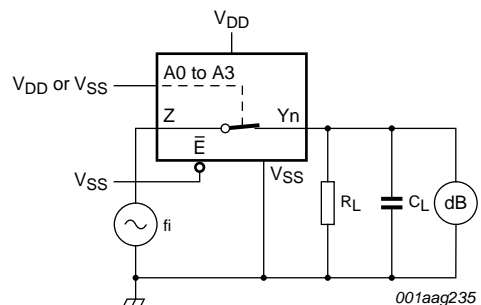
$P_D$  can be calculated from the formulas shown;  $V_{SS} = 0\text{ V}$ ;  $t_r = t_f \leq 20\text{ ns}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

Symbol	Parameter	$V_{DD}$	Typical formula for $P_D$ ( $\mu\text{W}$ )	where:
$P_D$	dynamic power dissipation	5 V	$P_D = 1000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	$f_i$ = input frequency in MHz;
		10 V	$P_D = 5500 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	$f_o$ = output frequency in MHz;
		15 V	$P_D = 15000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	$C_L$ = output load capacitance in pF; $V_{DD}$ = supply voltage in V; $\Sigma(C_L \times f_o)$ = sum of the outputs.

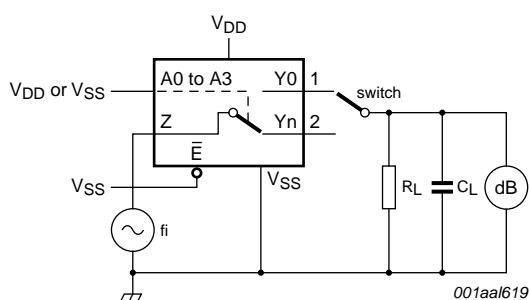
### 11.2.1 Test circuits



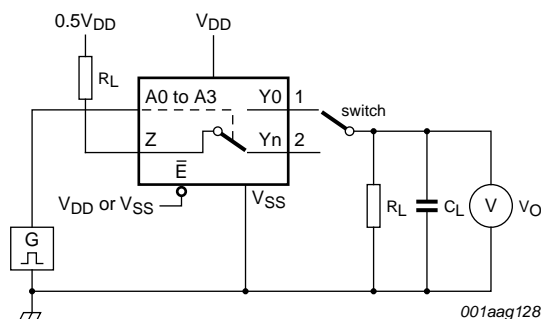
**Fig 13. Test circuit for measuring total harmonic distortion**



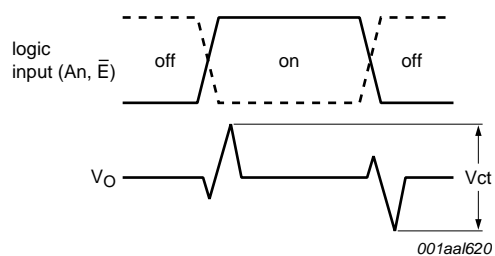
**Fig 14. Test circuit for measuring frequency response**



**Fig 15. Test circuit for measuring isolation (OFF-state)**

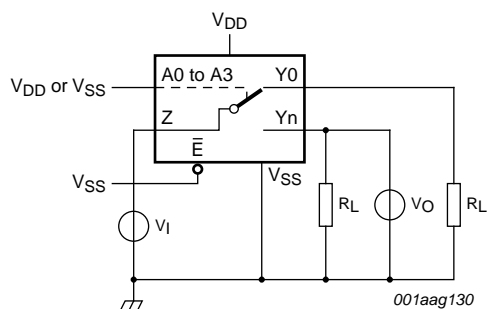


a. Test circuit

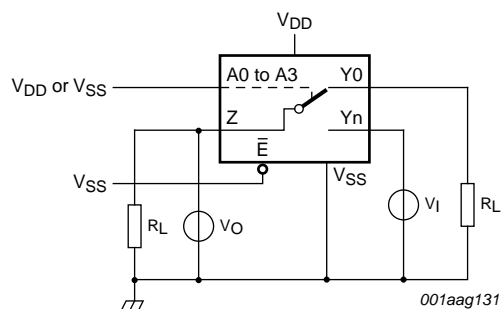


b. Input and output pulse definitions

**Fig 16. Test circuit for measuring crosstalk voltage between digital inputs and switch**



a. Switch closed condition



b. Switch open condition

**Fig 17. Test circuit for measuring crosstalk between switches**

12. Package outline

SO24: plastic small outline package; 24 leads; body width 7.5 mm

SOT137-1

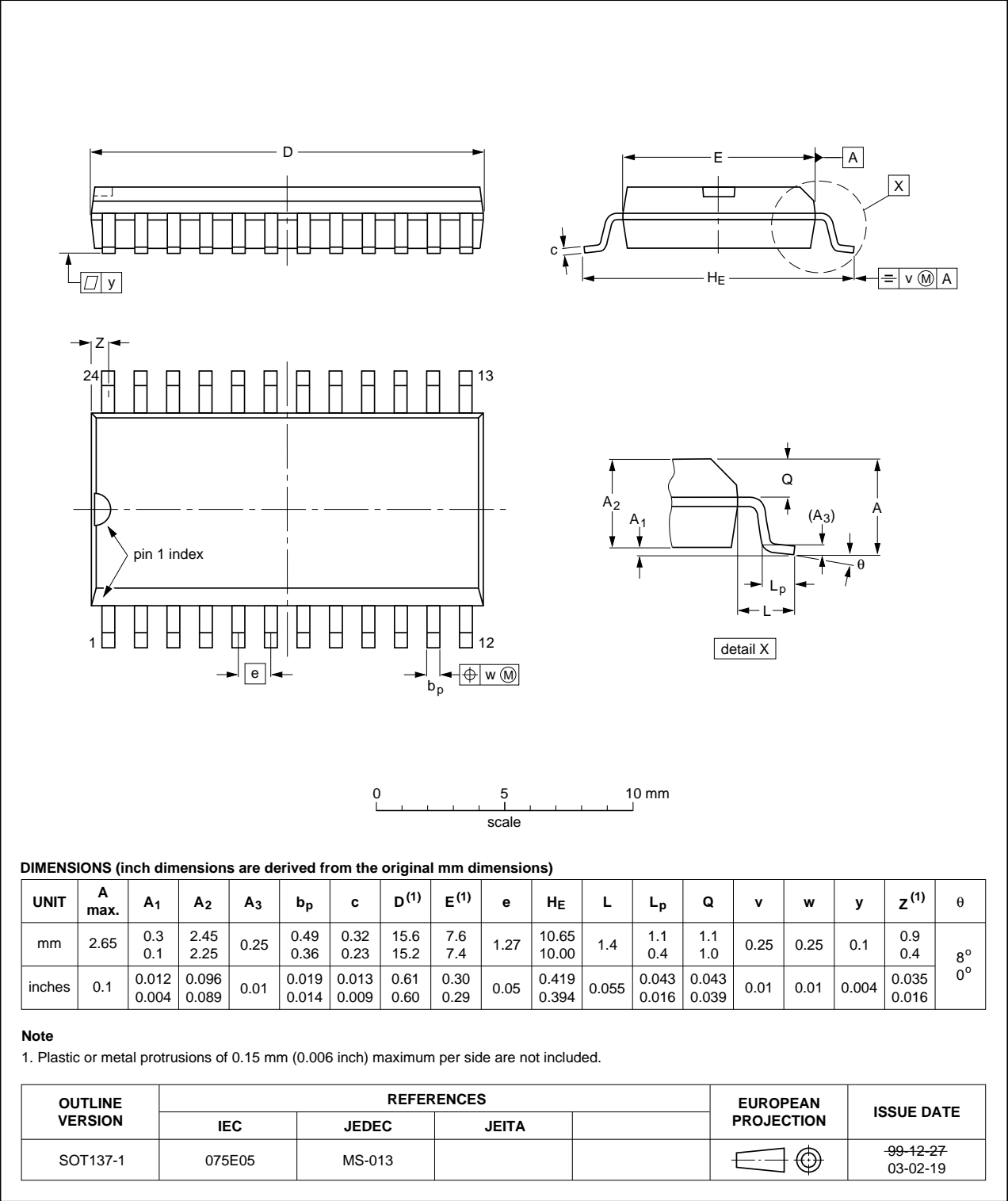


Fig 18. Package outline SOT137-1 (SO24)

## 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
HEF4067B-Q100 v.1	20130924	Product data sheet	-	-

## 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.
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.nxp.com>.

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