

# HEF4052B-Q100

## Dual 4-channel analog multiplexer/demultiplexer

Rev. 1 — 12 July 2012

Product data sheet

### 1. General description

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The HEF4052B-Q100 is a dual 4-channel analog multiplexer/demultiplexer with common channel select logic. Each multiplexer/demultiplexer has four independent inputs/outputs (nY0 to nY3) and a common input/output (nZ). The common channel select logic includes two select inputs (S1 and S2) and an active LOW enable input ( $\bar{E}$ ). Both multiplexers/demultiplexers contain four bidirectional analog switches, each with one side connected to an independent input/output (nY0 to nY3) and the other side connected to a common input/output (nZ). With  $\bar{E}$  LOW, one of the four switches is selected (low-impedance ON-state) by S1 and S2. With  $\bar{E}$  HIGH, all switches are in the high-impedance OFF-state, independent of S1 and S2. If break before make is needed, then it is necessary to use the enable input.

$V_{DD}$  and  $V_{SS}$  are the supply voltage connections for the digital control inputs (S1 and S2, and  $\bar{E}$ ). The  $V_{DD}$  to  $V_{SS}$  range is 3 V to 15 V. The analog inputs/outputs (nY0 to nY3, and nZ) can swing between  $V_{DD}$  as a positive limit and  $V_{EE}$  as a negative limit.  $V_{DD} - V_{EE}$  may not exceed 15 V. Unused inputs must be connected to  $V_{DD}$ ,  $V_{SS}$ , or another input. For operation as a digital multiplexer/demultiplexer,  $V_{EE}$  is connected to  $V_{SS}$  (typically ground).  $V_{EE}$  and  $V_{SS}$  are the supply voltage connections for the switches.

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

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- 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 pf, R = 0  $\Omega$ )
- 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  
All types operate from -40 °C to +125 °C.

Type number	Package		Version
	Name	Description	
HEF4052BT-Q100	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
HEF4052BTT-Q100	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1

5. Functional diagram

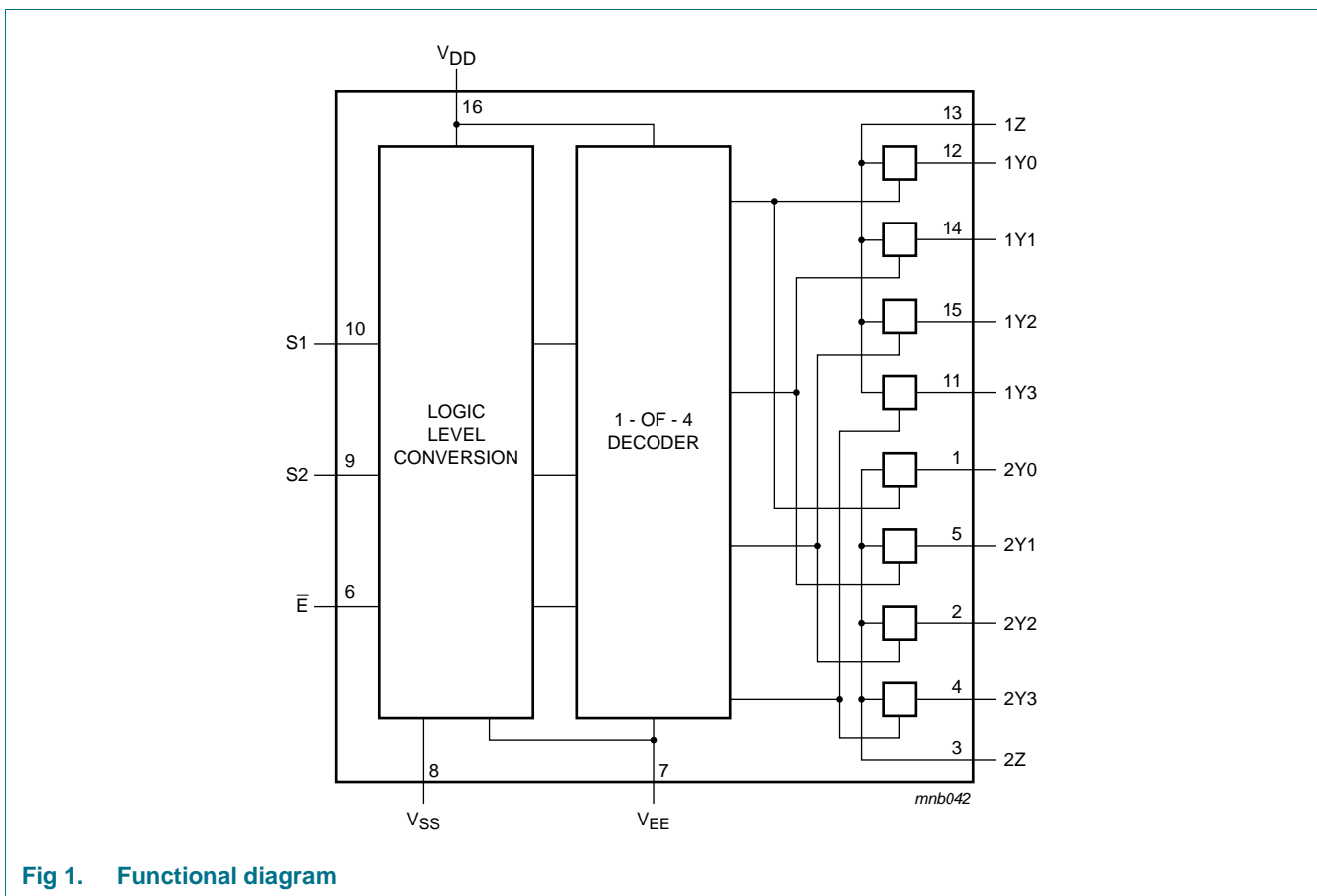


Fig 1. Functional diagram

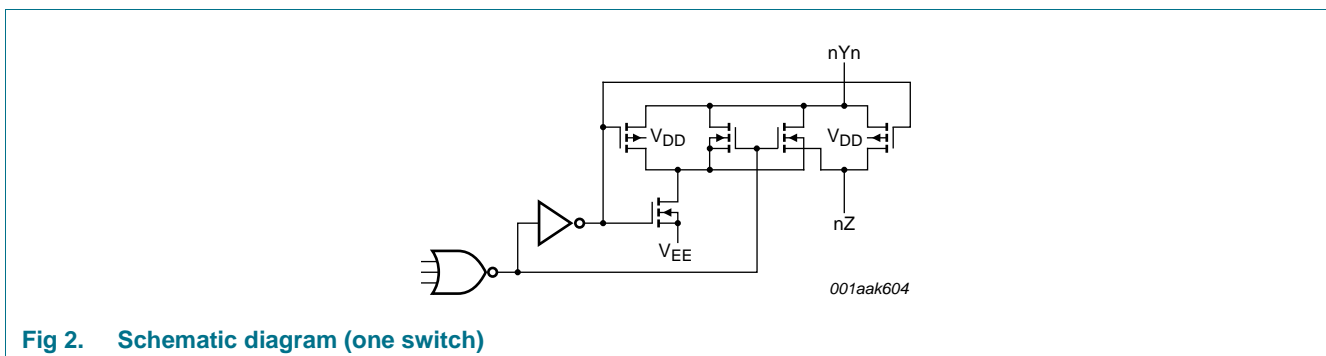


Fig 2. Schematic diagram (one switch)

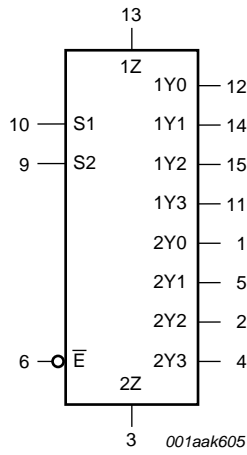


Fig 3. Logic symbol

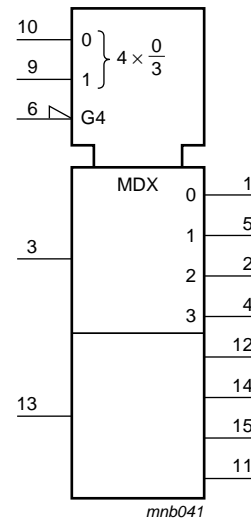


Fig 4. IEC logic symbol

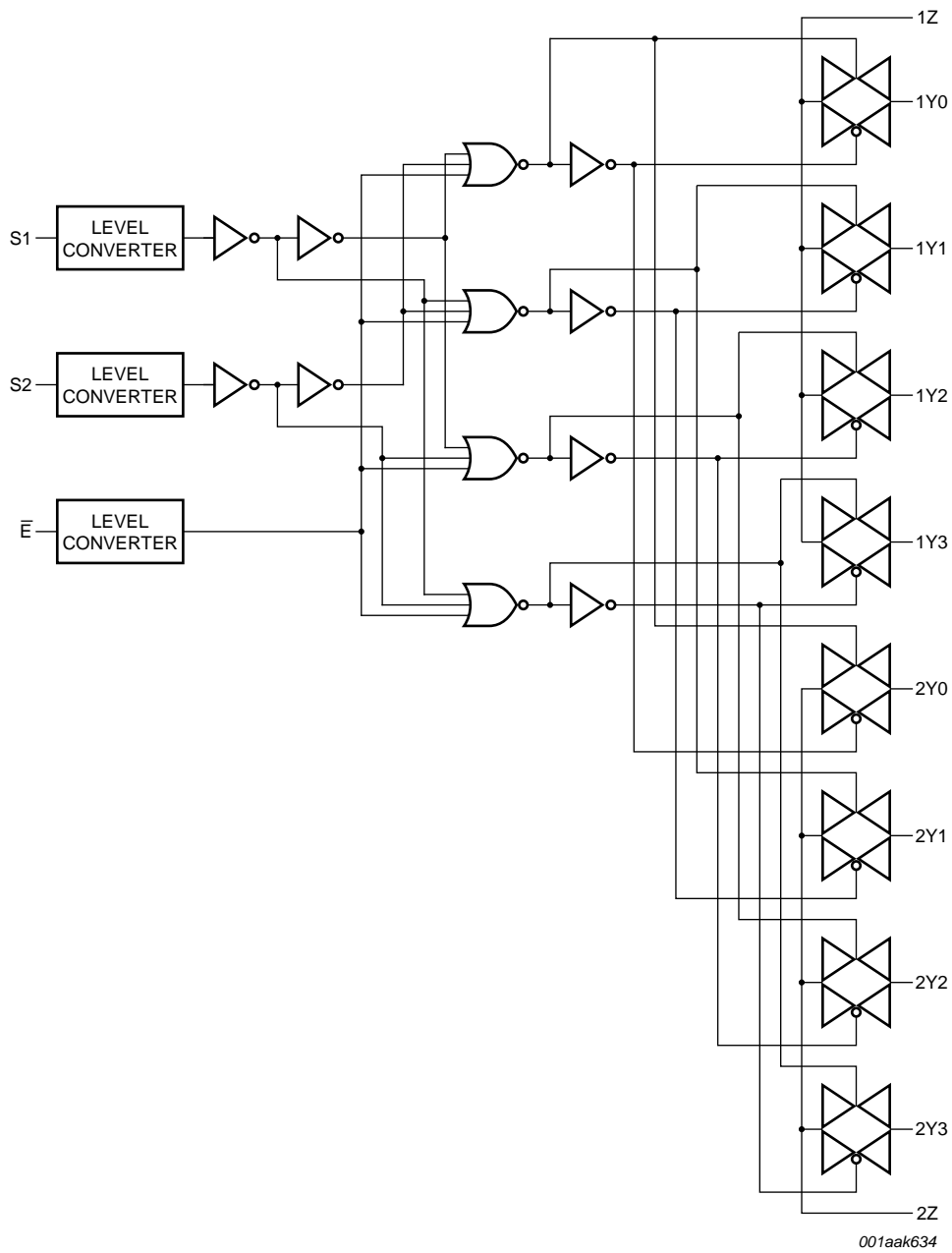


Fig 5. Logic diagram

## 6. Pinning information

### 6.1 Pinning

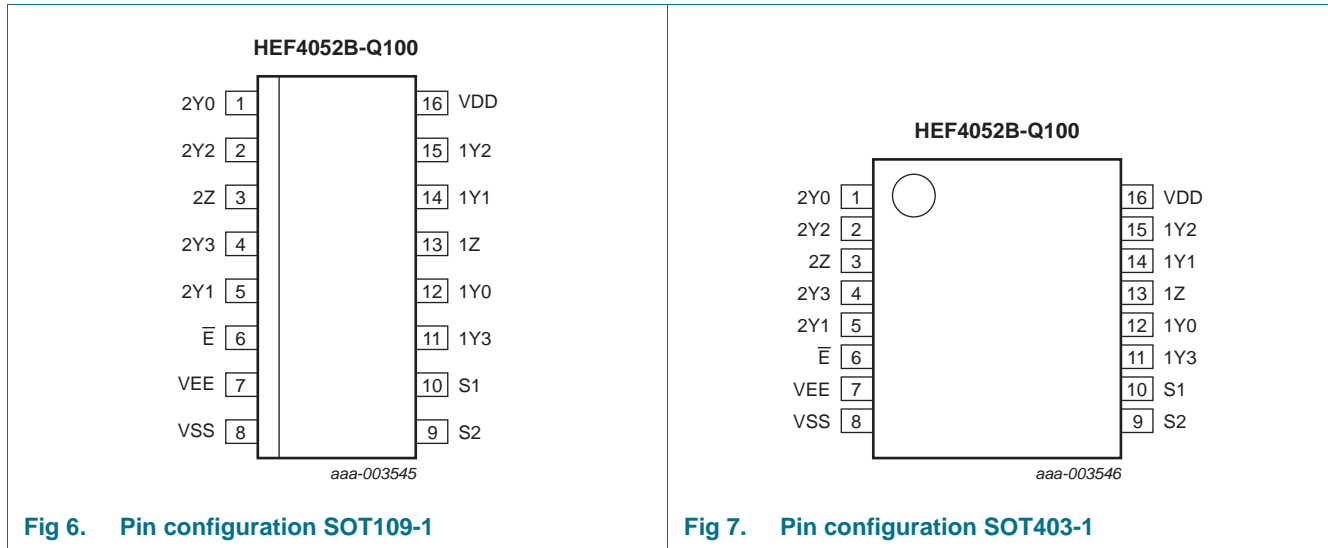


Fig 6. Pin configuration SOT109-1

Fig 7. Pin configuration SOT403-1

### 6.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
$\bar{E}$	6	enable input (active LOW)
V <sub>EE</sub>	7	supply voltage
V <sub>SS</sub>	8	ground supply voltage
S1, S2	10, 9	select input
1Y0, 1Y1, 1Y2, 1Y3, 2Y0, 2Y1, 2Y2, 2Y3	12, 14, 15, 11, 1, 5, 2, 4	independent input or output
1Z, 2Z	13, 3	common output or input
V <sub>DD</sub>	16	supply voltage

## 7. Functional description

### 7.1 Function table

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

Input			Channel on
$\overline{E}$	S2	S1	
L	L	L	nY0 to nZ
L	L	H	nY1 to nZ
L	H	L	nY2 to nZ
L	H	H	nY3 to nZ
H	X	X	switches off

- [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
$V_{EE}$	supply voltage	referenced to $V_{DD}$	<sup>[1]</sup> -18	+0.5	V
$I_{IK}$	input clamping current	pins Sn and $\overline{E}$ ; $V_I < -0.5$ 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		-	$\pm 10$	mA
$I_{DD}$	supply current		-	50	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			
		SO16 and TSSOP16 package	<sup>[1]</sup> -	500	mW
P	power dissipation	per output	-	100	mW

- [1] To avoid drawing  $V_{DD}$  current out of terminal Z, when switch current flows into terminals Y, 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 will flow out of terminals Y, and 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  $V_{EE}$ .

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

For TSSOP16 package:  $P_{tot}$  derates linearly with 5.5 mW/K above 60 °C.

## 9. Recommended operating conditions

Table 5. Recommended operating conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
$V_{DD}$	supply voltage	see <a href="#">Figure 8</a>	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	$\mu\text{s/V}$

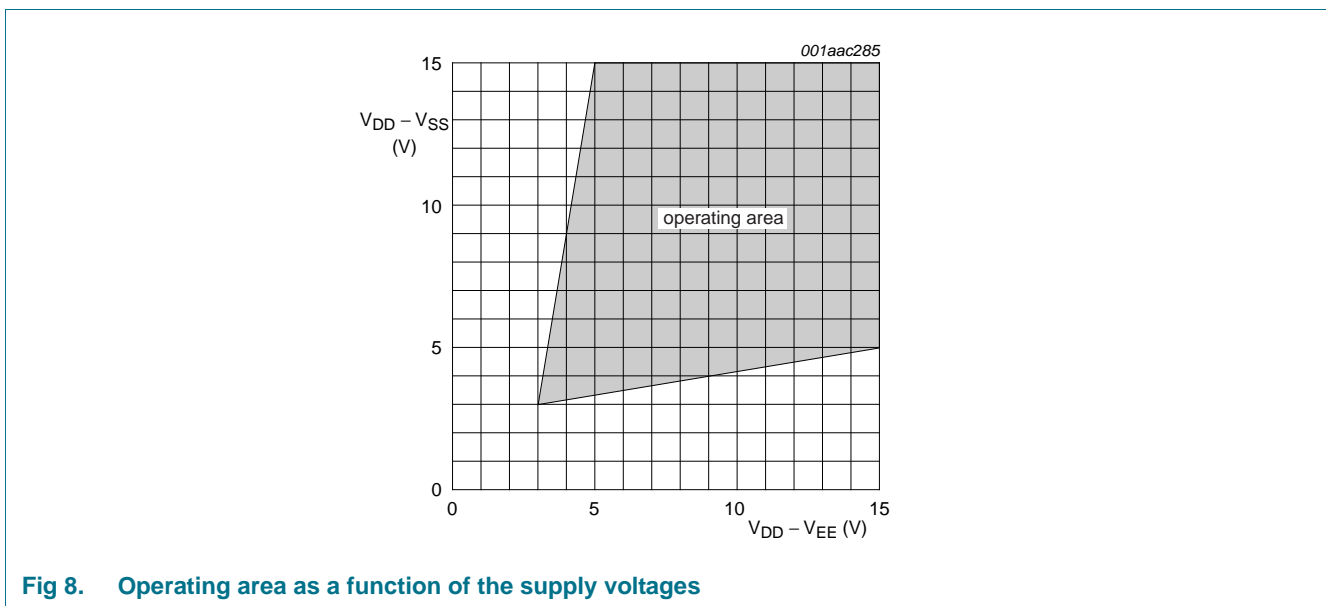


Fig 8. Operating area as a function of the supply voltages

## 10. Static characteristics

Table 6. Static characteristics

$V_{SS} = V_{EE} = 0\text{ V}$ ;  $V_I = V_{SS}$  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
$I_I$	input leakage current		15 V	-	$\pm 0.1$	-	$\pm 0.1$	-	$\pm 1.0$	-	$\pm 1.0$	$\mu\text{A}$

**Table 6. Static characteristics ...continued**  
 $V_{SS} = V_{EE} = 0\text{ V}$ ;  $V_I = V_{SS}$  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	
$I_{S(OFF)}$	OFF-state leakage current	Z port; all channels OFF; see <a href="#">Figure 9</a>	15 V	-	-	-	1000	-	-	-	-	nA
		Y port; per channel; see <a href="#">Figure 10</a>	15 V	-	-	-	200	-	-	-	-	nA
$I_{DD}$	supply current	$I_O = 0\text{ A}$	5 V	-	5	-	5	-	150	-	150	$\mu\text{A}$
			10 V	-	10	-	10	-	300	-	300	$\mu\text{A}$
			15 V	-	20	-	20	-	600	-	600	$\mu\text{A}$
$C_I$	input capacitance	$S_n, \bar{E}$ inputs	-	-	-	7.5	-	-	-	-	pF	

10.1 Test circuits

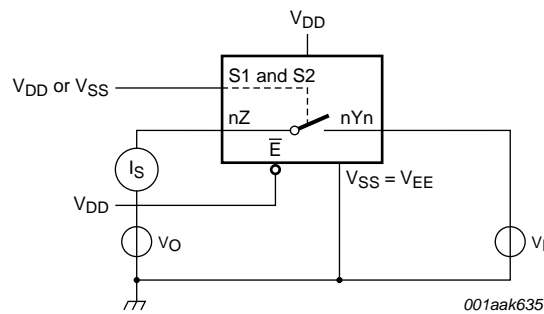


Fig 9. Test circuit for measuring OFF-state leakage current Z port

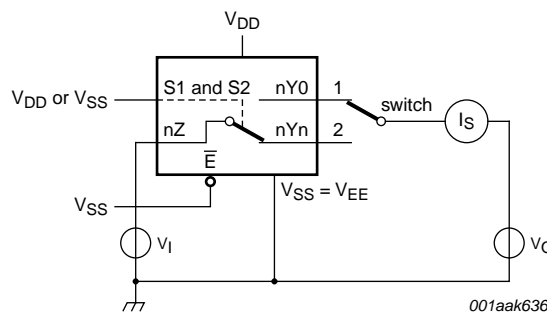


Fig 10. Test circuit for measuring OFF-state leakage current nYn port



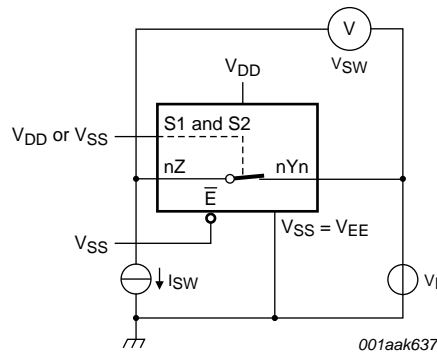
10.2 On resistance

Table 7. ON resistance

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

Symbol	Parameter	Conditions	$V_{DD} - V_{EE}$	Typ	Max	Unit
$R_{ON(peak)}$	ON resistance (peak)	$V_I = 0\text{ V to }V_{DD} - V_{EE}$ ; see <a href="#">Figure 11</a> and <a href="#">Figure 12</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 11</a> and <a href="#">Figure 12</a>	5 V	115	340	$\Omega$
			10 V	50	160	$\Omega$
			15 V	40	115	$\Omega$
		$V_I = V_{DD} - V_{EE}$ ; see <a href="#">Figure 11</a> and <a href="#">Figure 12</a>	5 V	120	365	$\Omega$
			10 V	65	200	$\Omega$
			15 V	50	155	$\Omega$
$\Delta R_{ON}$	ON resistance mismatch between channels	$V_I = 0\text{ V to }V_{DD} - V_{EE}$ ; see <a href="#">Figure 11</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 11. Test circuit for measuring  $R_{ON}$

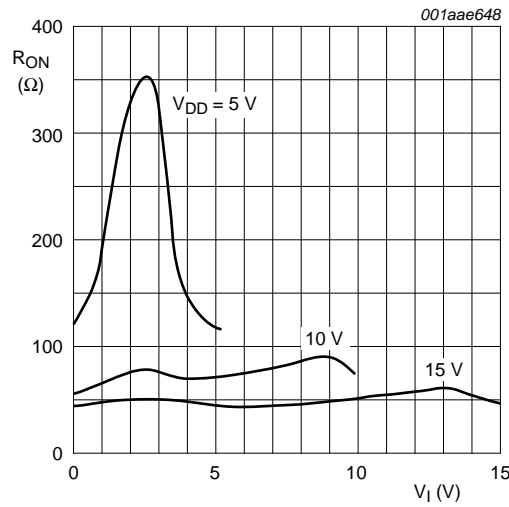


Fig 12. Typical  $R_{ON}$  as a function of input voltage

## 11. Dynamic characteristics

Table 8. Dynamic characteristics

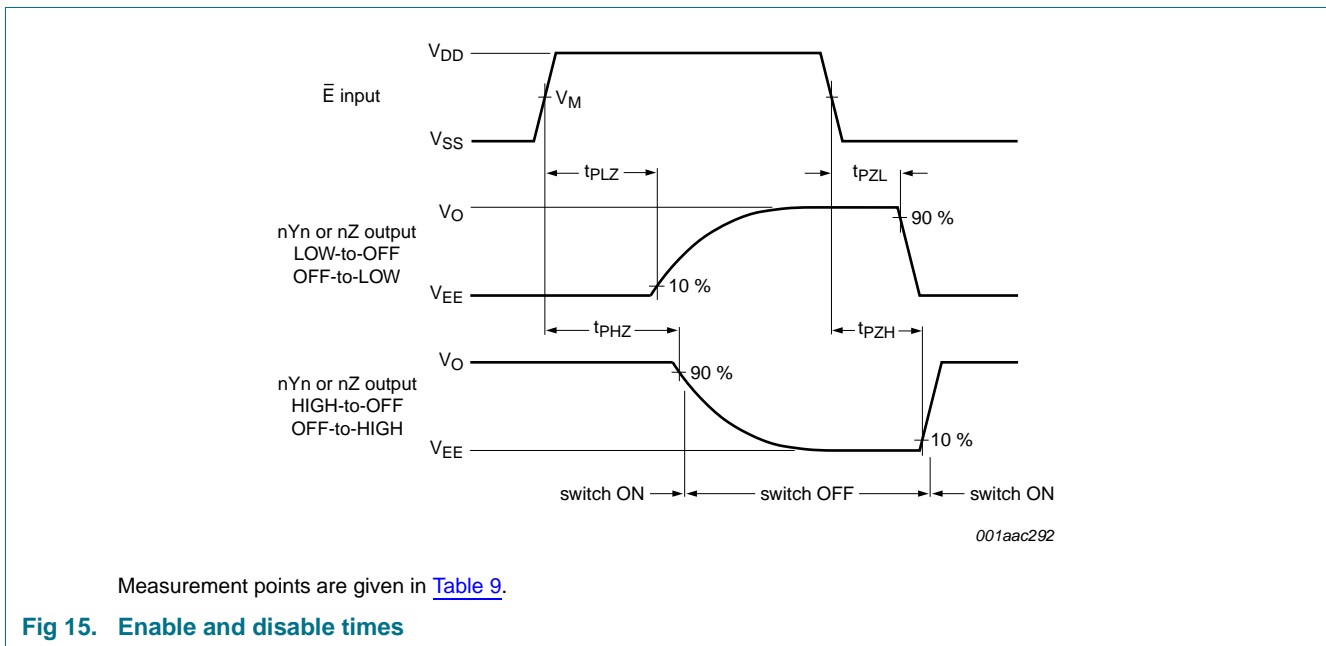
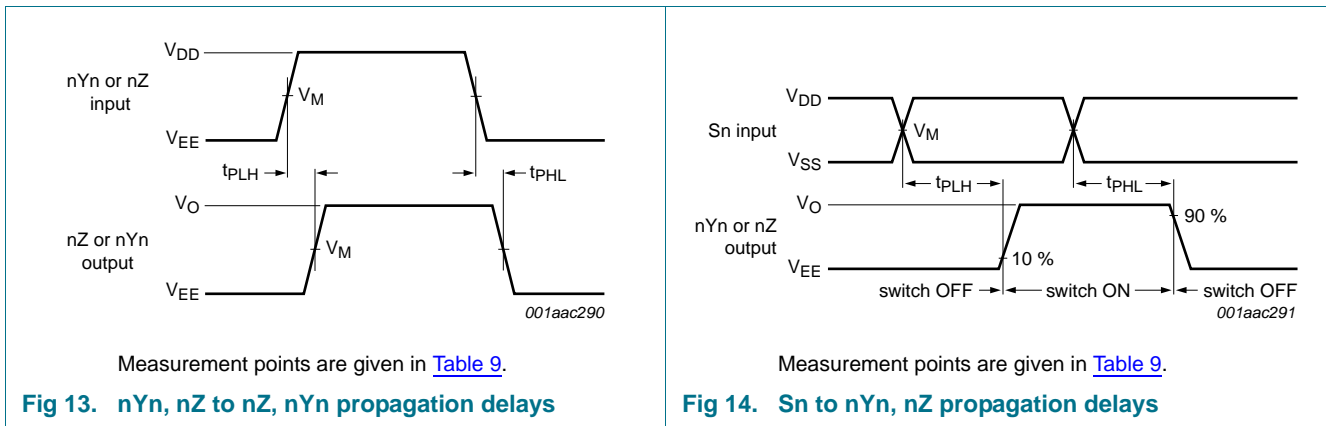
$T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $V_{SS} = V_{EE} = 0\text{ V}$ ; for test circuit see [Figure 16](#).

Symbol	Parameter	Conditions	$V_{DD}$	Typ	Max	Unit
$t_{PHL}$	HIGH to LOW propagation delay	nYn, nZ to nZ, nYn; see <a href="#">Figure 13</a>	5 V	10	20	ns
			10 V	5	10	ns
			15 V	5	10	ns
		Sn to nYn, nZ; see <a href="#">Figure 14</a>	5 V	150	305	ns
			10 V	65	135	ns
			15 V	50	100	ns
$t_{PLH}$	LOW to HIGH propagation delay	Yn, nZ to nZ, nYn; see <a href="#">Figure 13</a>	5 V	10	20	ns
			10 V	5	10	ns
			15 V	5	10	ns
		Sn to nYn, nZ; see <a href="#">Figure 14</a>	5 V	150	300	ns
			10 V	75	150	ns
			15 V	50	100	ns
$t_{PHZ}$	HIGH to OFF-state propagation delay	$\bar{E}$ to nYn, nZ; see <a href="#">Figure 15</a>	5 V	95	190	ns
			10 V	90	180	ns
			15 V	85	180	ns
$t_{PZH}$	OFF-state to HIGH propagation delay	$\bar{E}$ to nYn, nZ; see <a href="#">Figure 15</a>	5 V	130	260	ns
			10 V	55	115	ns
			15 V	45	85	ns
$t_{PLZ}$	LOW to OFF-state propagation delay	$\bar{E}$ to nYn, nZ; see <a href="#">Figure 15</a>	5 V	100	205	ns
			10 V	90	180	ns
			15 V	90	180	ns

**Table 8. Dynamic characteristics ...continued**  
 $T_{amb} = 25\text{ }^{\circ}\text{C}$ ;  $V_{SS} = V_{EE} = 0\text{ V}$ ; for test circuit see [Figure 16](#).

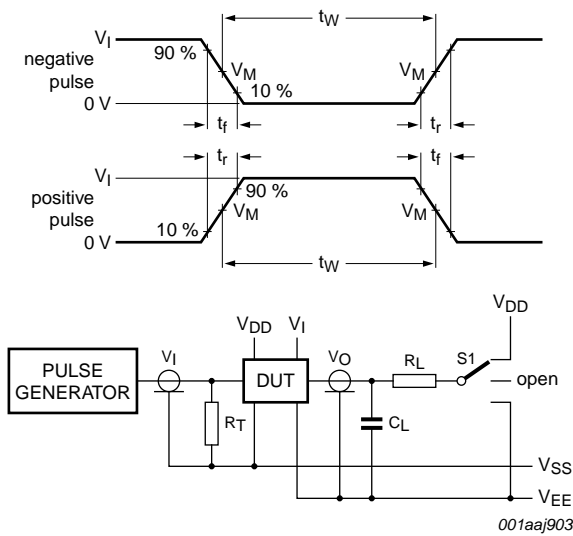
Symbol	Parameter	Conditions	$V_{DD}$	Typ	Max	Unit
$t_{PZL}$	OFF-state to LOW propagation delay	$\bar{E}$ to nYn, nZ; see <a href="#">Figure 15</a>	5 V	120	240	ns
			10 V	50	100	ns
			15 V	35	75	ns

11.1 Waveforms and test circuit



**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 is given in [Table 10](#).

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 16. Test circuit for measuring switching times

Table 10. Test data

Input				Load		S1 position				
nYn, nZ	Sn and $\bar{E}$	$t_r, t_f$	$V_M$	$C_L$	$R_L$	$t_{PHL}$ <sup>[1]</sup>	$t_{PLH}$	$t_{PZH}, t_{PHZ}$	$t_{PZL}, t_{PLZ}$	other
$V_{DD}$ or $V_{EE}$	$V_{DD}$ or $V_{SS}$	$\leq 20$ ns	$0.5V_{DD}$	50 pF	10 k $\Omega$	$V_{DD}$ or $V_{EE}$	$V_{EE}$	$V_{EE}$	$V_{DD}$	$V_{EE}$

[1] For nYn to nZ propagation delays use  $V_{EE}$ . For Sn to nYn or nZ propagation delays use  $V_{DD}$ .

11.2 Additional dynamic parameters

Table 11. Additional dynamic characteristics

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

Symbol	Parameter	Conditions	$V_{DD}$	Typ	Max	Unit
THD	total harmonic distortion	see <a href="#">Figure 17</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 18</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 19</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 20</a> ; $R_L = 10\text{ k}\Omega$ ; $C_L = 15\text{ pF}$ ; $\bar{E}$ or $S_n = V_{DD}$ (square-wave)	10 V	50	-	mV
Xtalk	crosstalk	between switches; see <a href="#">Figure 21</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;  $V_{EE} = V_{SS} = 0\text{ V}$ ;  $t_r = t_f \leq 20\text{ ns}$ ;  $T_{amb} = 25\text{ }^{\circ}\text{C}$ .

Symbol	Parameter	$V_{DD}$	Typical formula for $P_D$ ( $\mu\text{W}$ )	where:
$P_D$	dynamic power dissipation	5 V	$P_D = 1300 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	$f_i$ = input frequency in MHz;
		10 V	$P_D = 6100 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	$f_o$ = output frequency in MHz;
		15 V	$P_D = 15600 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	$C_L$ = 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

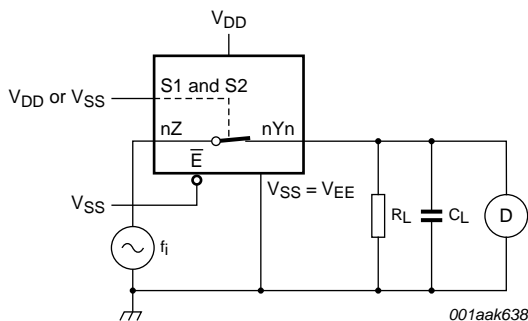


Fig 17. Test circuit for measuring total harmonic distortion

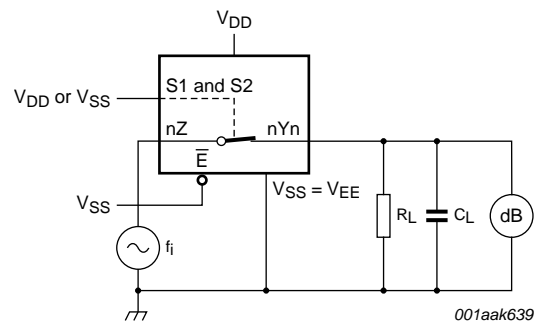


Fig 18. Test circuit for measuring frequency response

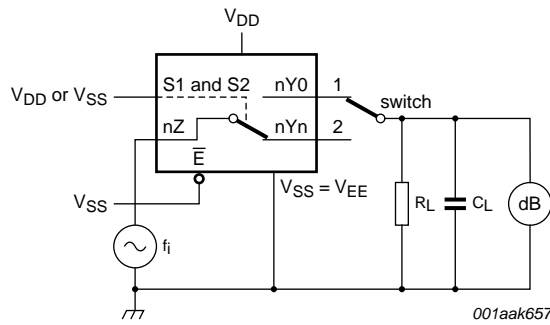
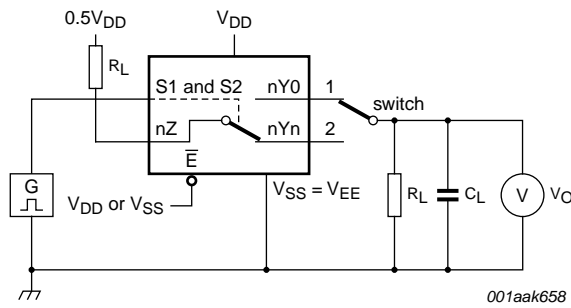
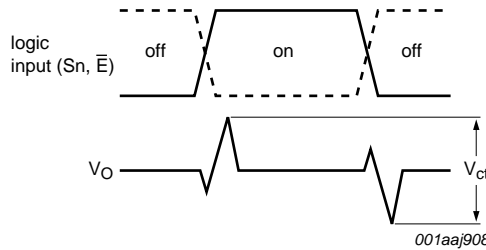


Fig 19. Test circuit for measuring isolation (OFF-state)

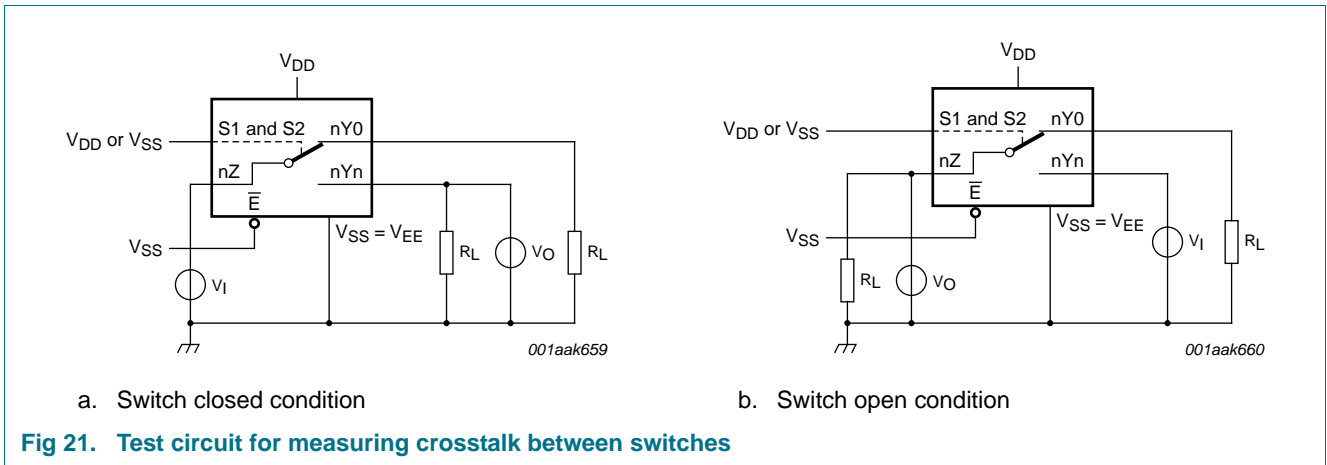


a. Test circuit



b. Input and output pulse definitions

Fig 20. Test circuit for measuring crosstalk voltage between digital inputs and switch



12. Package outline

SO16: plastic small outline package; 16 leads; body width 3.9 mm

SOT109-1

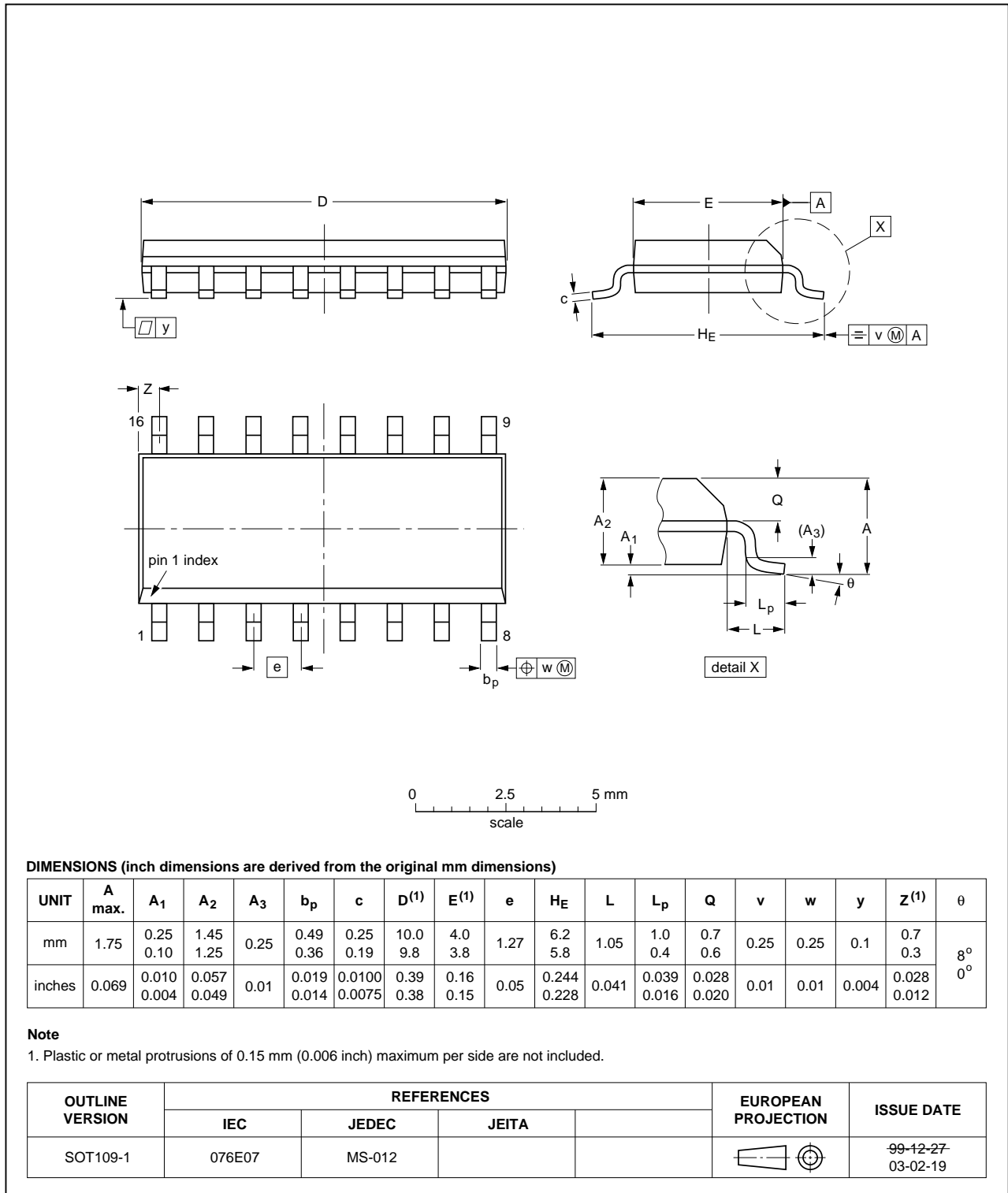


Fig 22. Package outline SOT109-1 (SO16)



TSSOP16: plastic thin shrink small outline package; 16 leads; body width 4.4 mm

SOT403-1

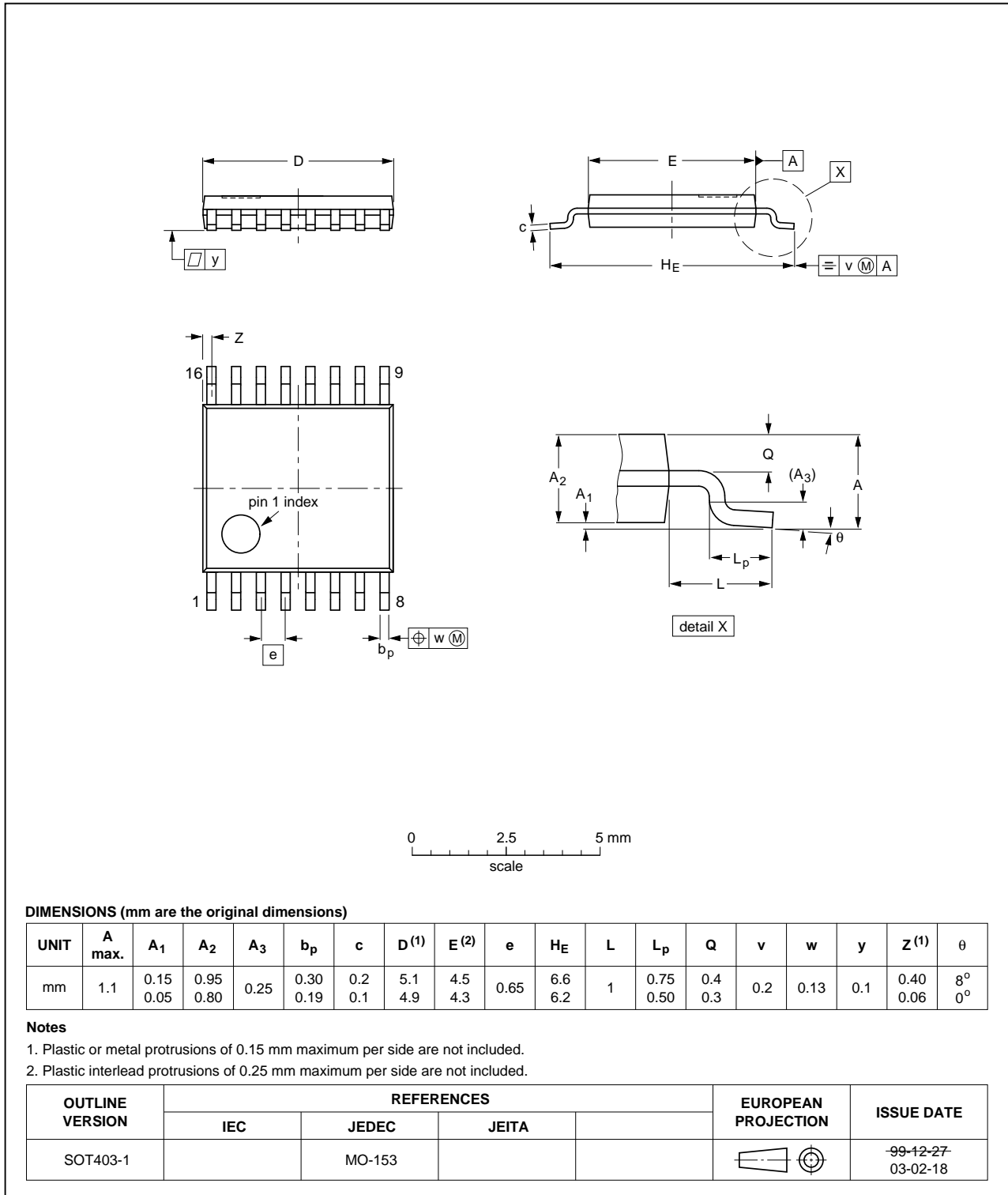


Fig 23. Package outline SOT403-1 (TSSOP16)

## 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
HEF4052B_Q100_1	20120712	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>.

### 15.2 Definitions

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**17. Contents**

**1 General description . . . . . 1**

**2 Features and benefits . . . . . 1**

**3 Applications . . . . . 1**

**4 Ordering information . . . . . 2**

**5 Functional diagram . . . . . 2**

**6 Pinning information . . . . . 5**

6.1 Pinning . . . . . 5

6.2 Pin description . . . . . 5

**7 Functional description . . . . . 6**

7.1 Function table . . . . . 6

**8 Limiting values . . . . . 6**

**9 Recommended operating conditions . . . . . 7**

**10 Static characteristics . . . . . 7**

10.1 Test circuits . . . . . 8

10.2 On resistance . . . . . 9

10.2.1 On resistance waveform and test circuit . . . . . 9

**11 Dynamic characteristics . . . . . 10**

11.1 Waveforms and test circuit . . . . . 11

11.2 Additional dynamic parameters . . . . . 13

11.2.1 Test circuits . . . . . 13

**12 Package outline . . . . . 16**

**13 Abbreviations . . . . . 18**

**14 Revision history . . . . . 18**

**15 Legal information . . . . . 19**

15.1 Data sheet status . . . . . 19

15.2 Definitions . . . . . 19

15.3 Disclaimers . . . . . 19

15.4 Trademarks . . . . . 20

**16 Contact information . . . . . 20**

**17 Contents . . . . . 21**

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