

HEF4052B-Q100

Dual 4-channel analog multiplexer/demultiplexer

Rev. 2 — 11 September 2014

Product data sheet

1. General description

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

- 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 ($C = 200\text{ pf}$, $R = 0\text{ }\Omega$)
- Complies with JEDEC standard JESD 13-B

3. Applications

- 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		
	Name	Description	Version
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

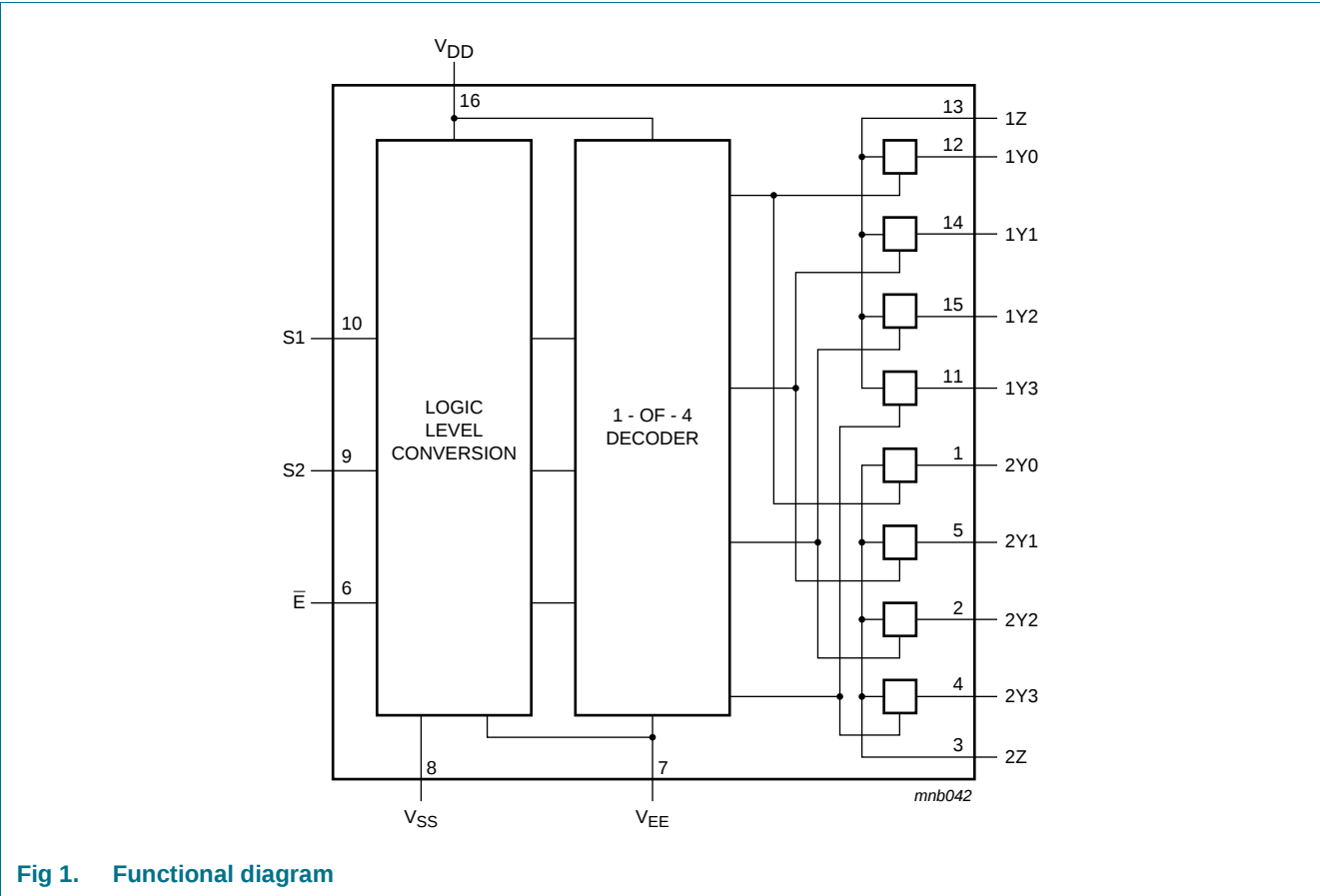


Fig 1. Functional diagram

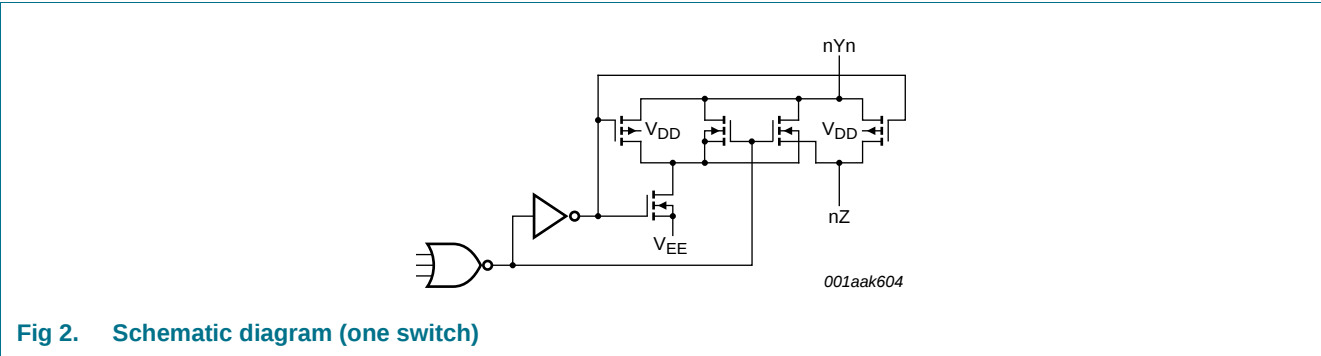


Fig 2. Schematic diagram (one switch)

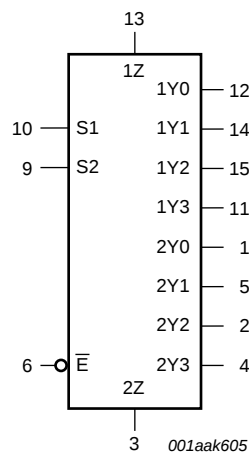


Fig 3. Logic symbol

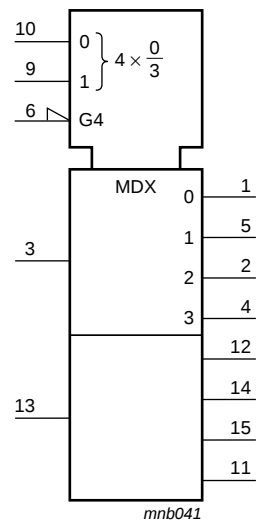


Fig 4. IEC logic symbol

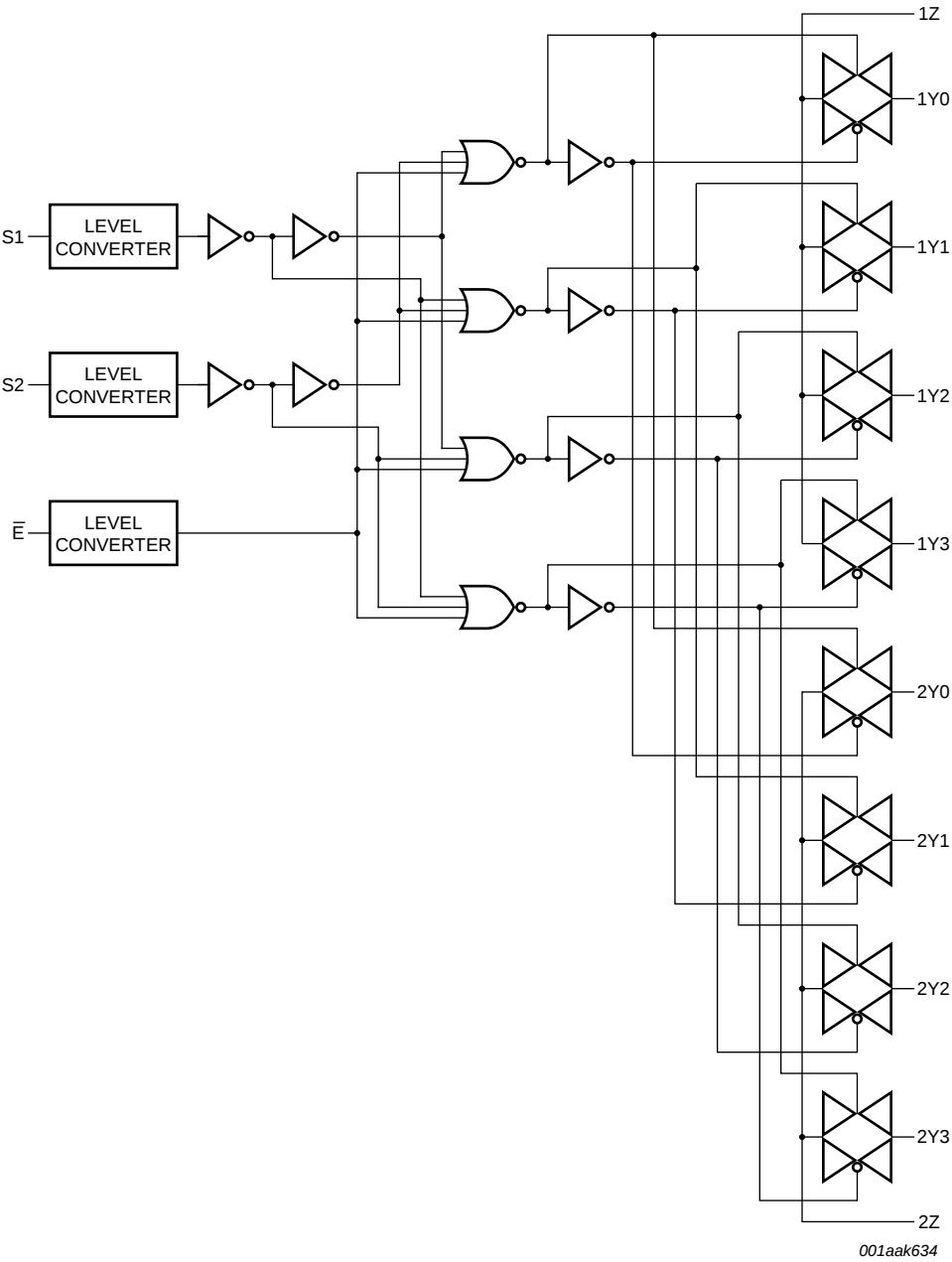


Fig 5. Logic diagram

6. Pinning information

6.1 Pinning

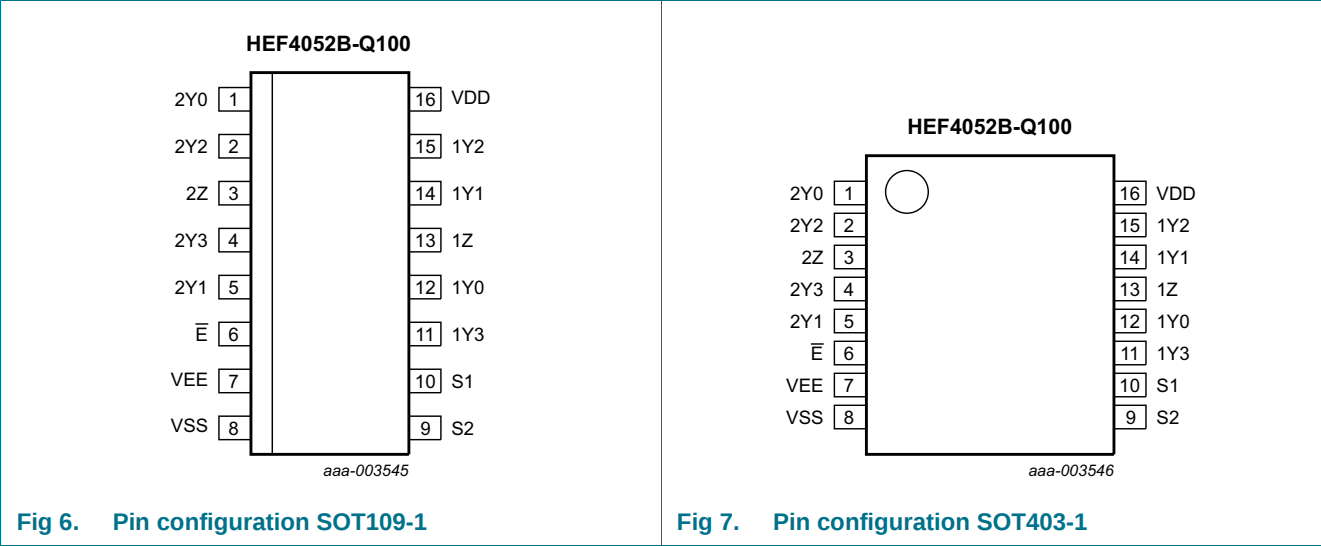


Fig 6. Pin configuration SOT109-1

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_{EE}	7	supply voltage
V_{SS}	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_{DD}	16	supply voltage

7. Functional description

7.1 Function table

Table 3. Function table^[1]

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}	[1]	-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		-	± 10	mA
V_I	input voltage			-0.5	$V_{DD} + 0.5$	V
$I_{I/O}$	input/output current			-	± 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	[2]	-	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} .
- [2] 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 Figure 8	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	$\mu\text{s/V}$

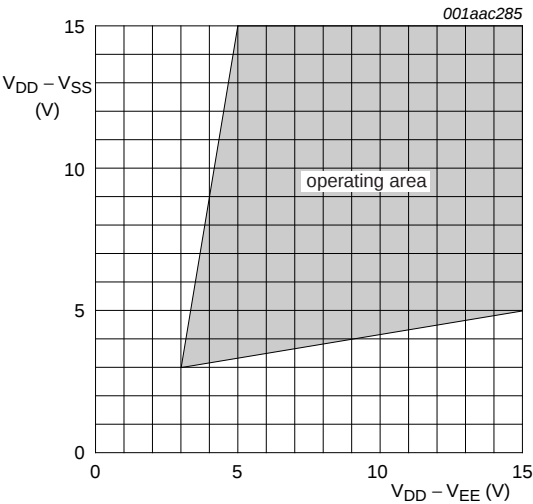


Fig 8. Operating area as a function of the supply voltages

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\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	-	± 0.1	-	± 0.1	-	± 1.0	-	± 1.0	μA

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 Figure 9	15 V	-	-	-	1000	-	-	-	-	nA
		Y port; per channel; see Figure 10	15 V	-	-	-	200	-	-	-	-	nA
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	$S_n, \overline{E}$ inputs	-	-	-	-	7.5	-	-	-	-	pF

10.1 Test circuits

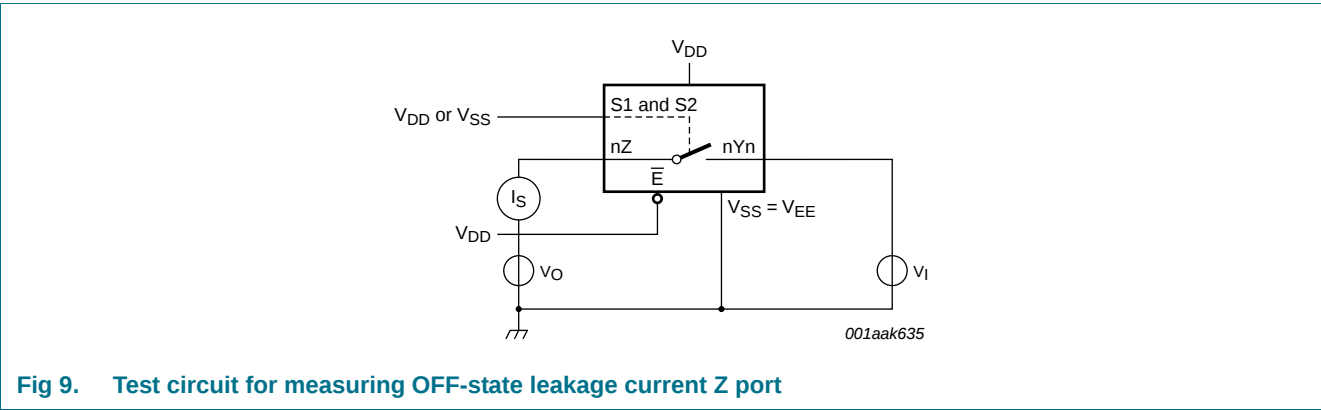


Fig 9. Test circuit for measuring OFF-state leakage current Z port

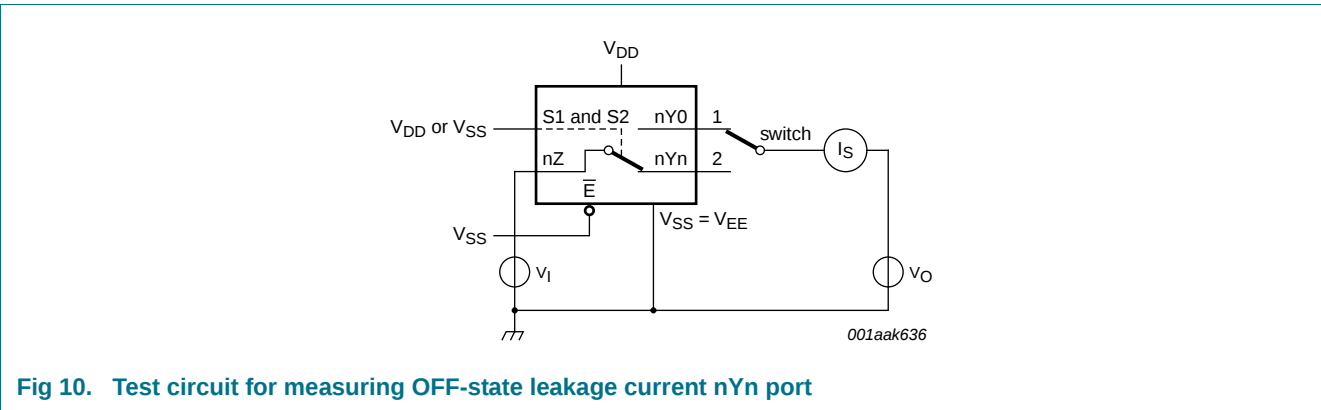


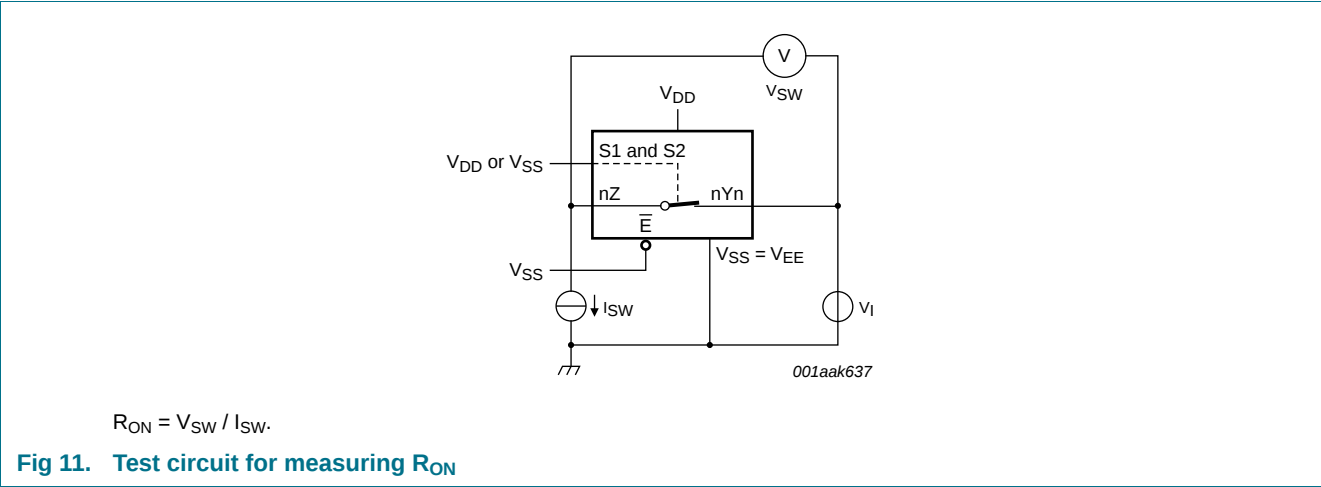
Fig 10. Test circuit for measuring OFF-state leakage current nYn port

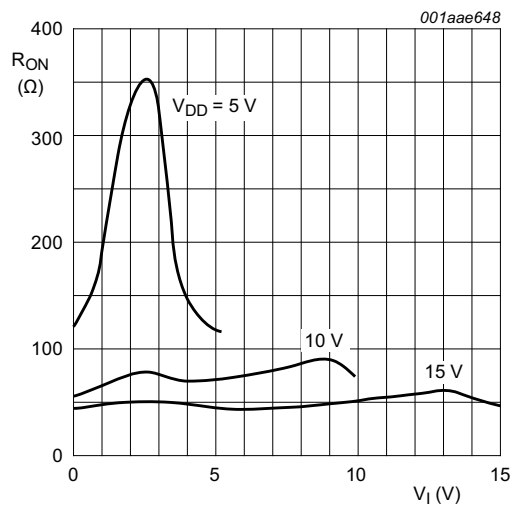
10.2 On resistance

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 Figure 11 and Figure 12	5 V	350	2500	Ω
			10 V	80	245	Ω
			15 V	60	175	Ω
$R_{ON(rail)}$	ON resistance (rail)	$V_I = 0\text{ V}$; see Figure 11 and Figure 12	5 V	115	340	Ω
			10 V	50	160	Ω
			15 V	40	115	Ω
		$V_I = V_{DD} - V_{EE}$; see Figure 11 and Figure 12	5 V	120	365	Ω
			10 V	65	200	Ω
			15 V	50	155	Ω
ΔR_{ON}	ON resistance mismatch between channels	$V_I = 0\text{ V to }V_{DD} - V_{EE}$; see Figure 11	5 V	25	-	Ω
			10 V	10	-	Ω
			15 V	5	-	Ω

10.2.1 On resistance waveform and test circuit



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 Figure 13	5 V	10	20	ns
			10 V	5	10	ns
			15 V	5	10	ns
		Sn to nYn, nZ; see Figure 14	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 Figure 13	5 V	10	20	ns
			10 V	5	10	ns
			15 V	5	10	ns
		Sn to nYn, nZ; see Figure 14	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 Figure 15	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 Figure 15	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 Figure 15	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 Figure 15	5 V	120	240	ns
			10 V	50	100	ns
			15 V	35	75	ns

11.1 Waveforms and test circuit

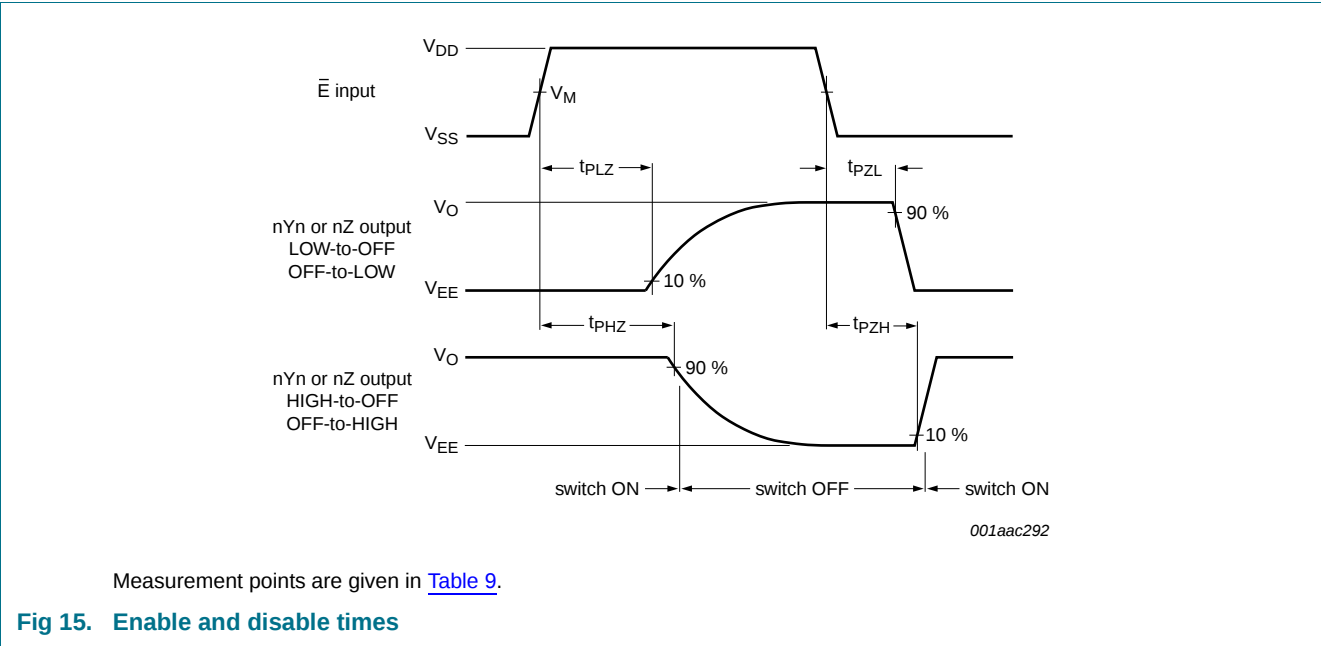
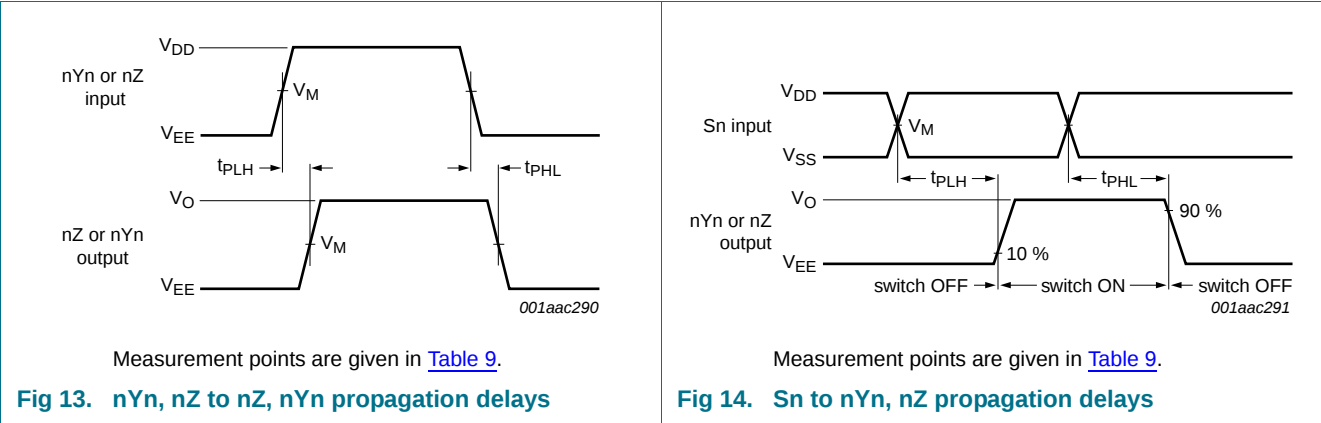
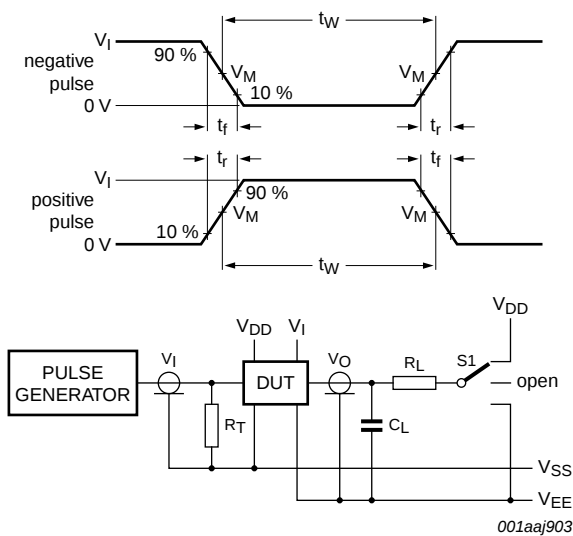


Table 9. Measurement points

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} [1]	t_{PLH}	t_{PZH}, t_{PHZ}	t_{PZL}, t_{PLZ}	other
V_{DD} or V_{EE}	V_{DD} or V_{SS}	≤ 20 ns	$0.5V_{DD}$	50 pF	10 k Ω	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 Figure 17; $R_L = 10\text{ k}\Omega$; $C_L = 15\text{ pF}$; 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	- %
$f_{(-3\text{dB})}$	-3 dB frequency response	see Figure 18; $R_L = 1\text{ k}\Omega$; $C_L = 5\text{ pF}$; channel ON; $V_I = 0.5V_{DD}$ (p-p)	5 V	[1]	13	- MHz
			10 V	[1]	40	- MHz
			15 V	[1]	70	- MHz
α_{iso}	isolation (OFF-state)	see Figure 19; $f_i = 1\text{ MHz}$; $R_L = 1\text{ k}\Omega$; $C_L = 5\text{ pF}$; channel OFF; $V_I = 0.5V_{DD}$ (p-p)	10 V	[1]	-50	- dB
V_{ct}	crosstalk voltage	digital inputs to switch; see Figure 20; $R_L = 10\text{ k}\Omega$; $C_L = 15\text{ pF}$; E or Sn = V_{DD} (square-wave)	10 V		50	- mV
Xtalk	crosstalk	between switches; see Figure 21; $f_i = 1\text{ MHz}$; $R_L = 1\text{ k}\Omega$; $V_I = 0.5V_{DD}$ (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 (μW)	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; f_o = output frequency in MHz; C_L = output load capacitance in pF; V_{DD} = supply voltage in V; $\Sigma(C_L \times f_o)$ = sum of the outputs.
		10 V	$P_D = 6100 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	
		15 V	$P_D = 15600 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	

11.2.1 Test circuits

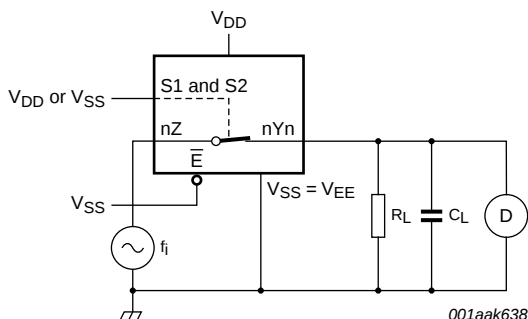


Fig 17. Test circuit for measuring total harmonic distortion

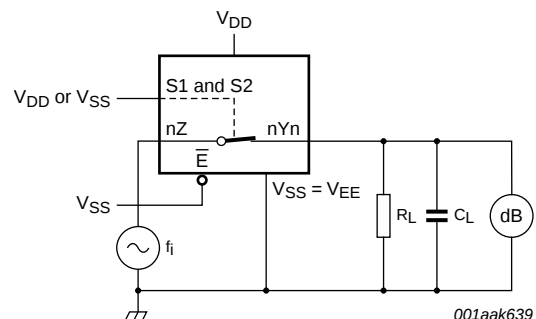


Fig 18. Test circuit for measuring frequency response

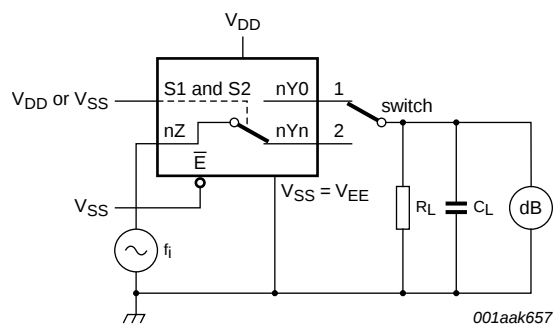
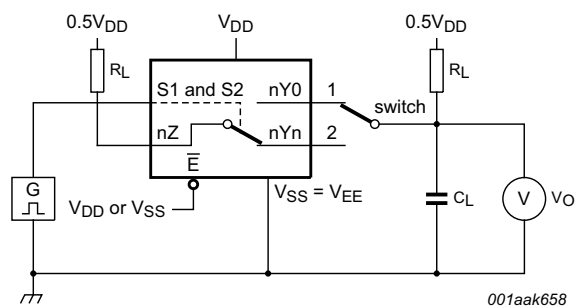
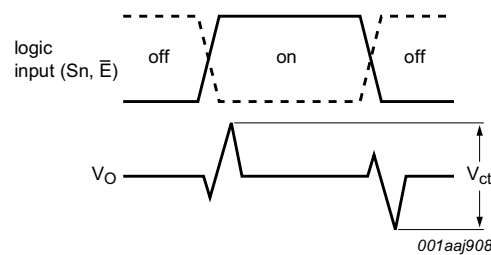


Fig 19. Test circuit for measuring isolation (OFF-state)

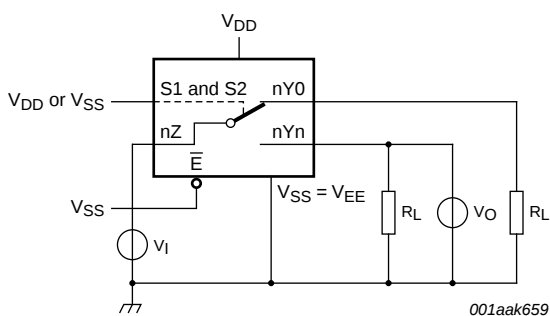


a. Test circuit

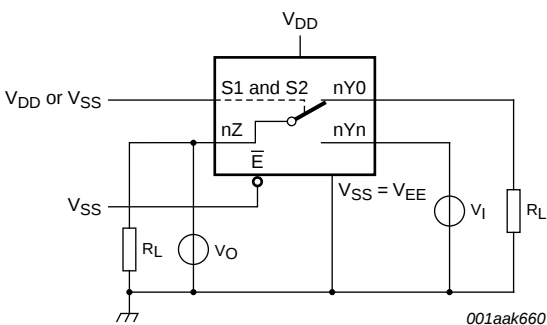


b. Input and output pulse definitions

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



a. Switch closed condition



b. Switch open condition

Fig 21. Test circuit for measuring crosstalk between switches

12. Package outline

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

SOT109-1

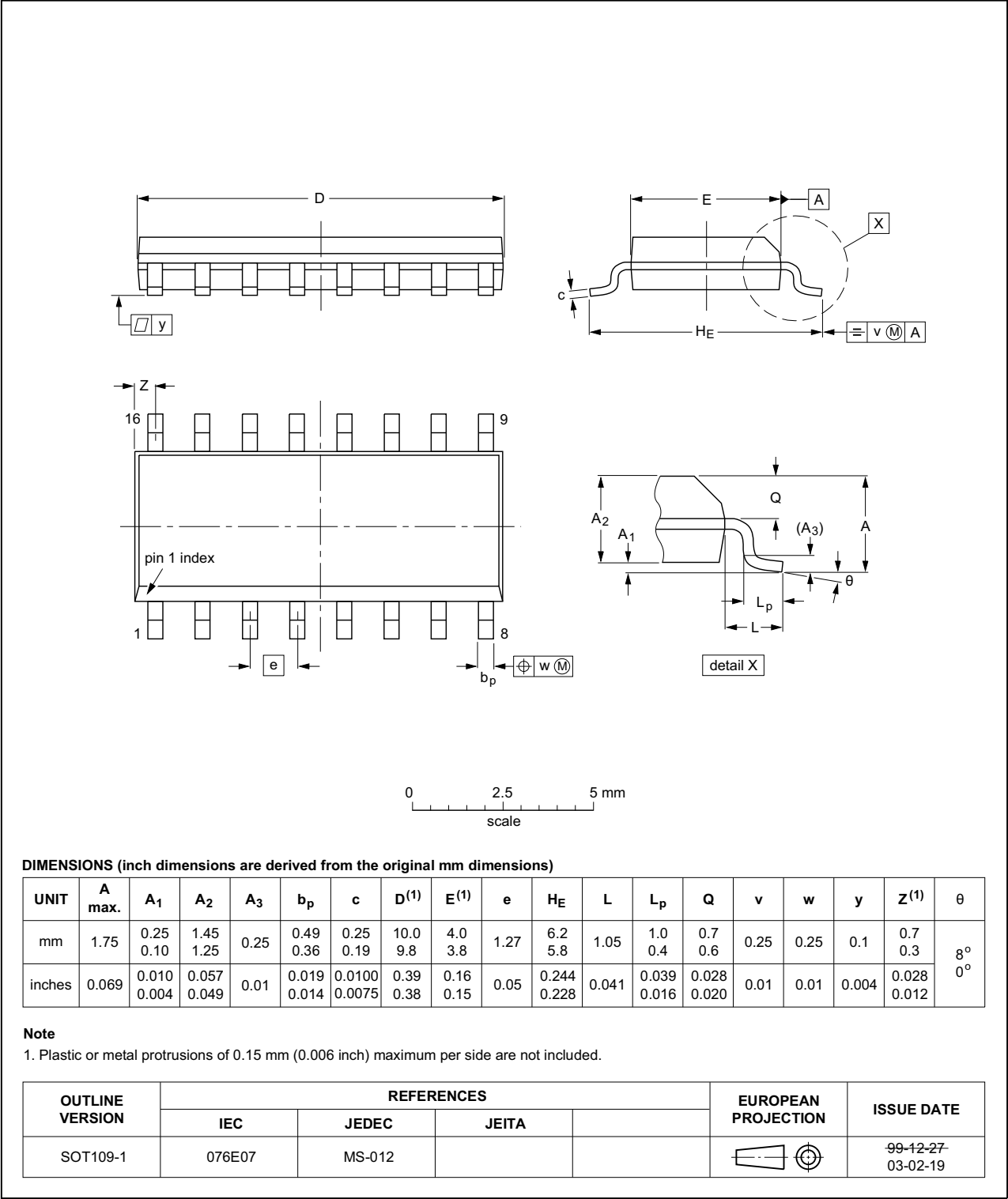


Fig 22. Package outline SOT109-1 (SO16)

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

SOT403-1

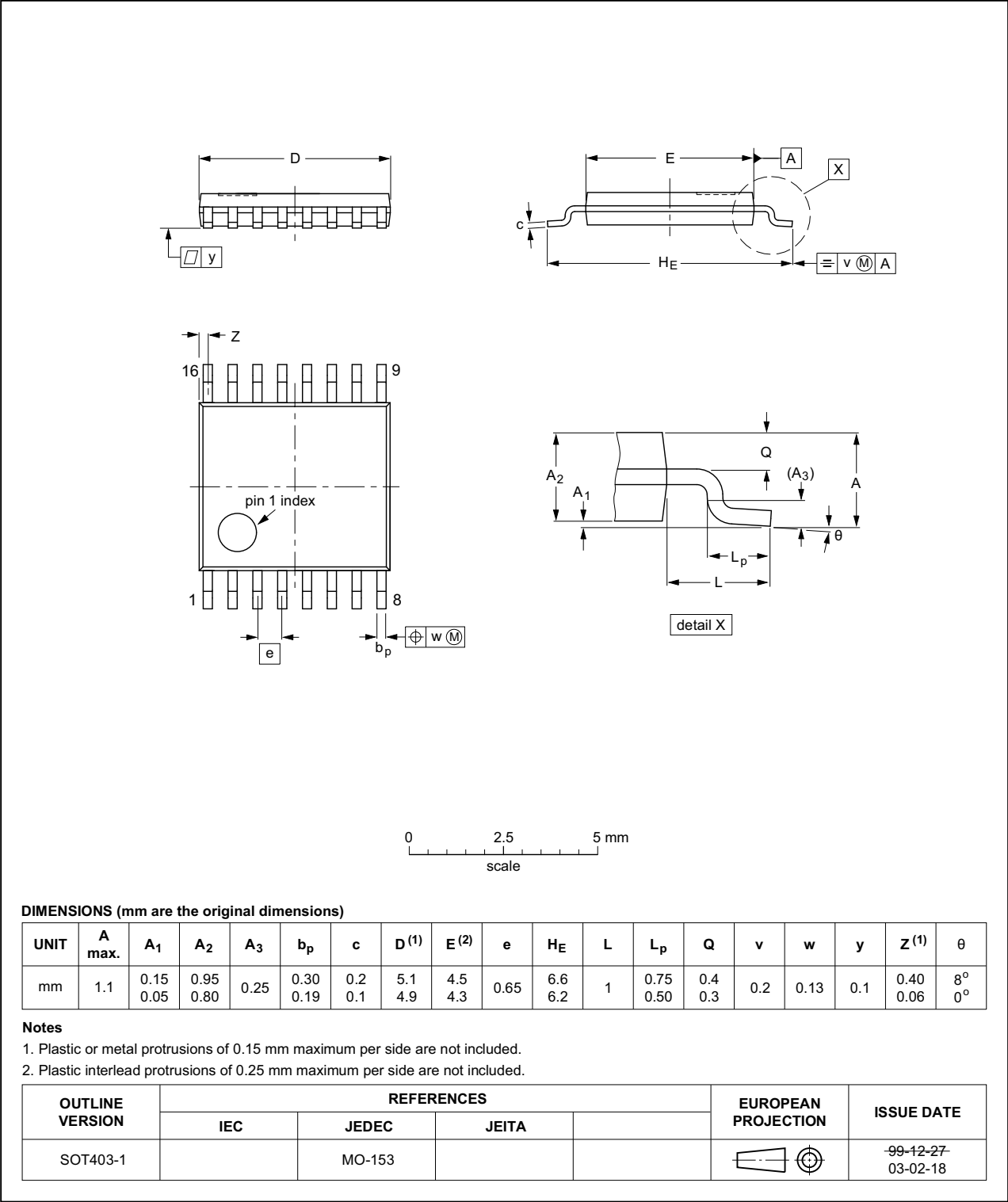


Fig 23. Package outline SOT403-1 (TSSOP16)

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 v.2	20140911	Product data sheet	-	HEF4052B_Q100 v.1
Modifications:	Figure 20: Test circuit modified			
HEF4052B_Q100 v.1	20120712	Product data sheet	-	-

15. Legal information

15.1 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".

[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.nexperia.com>.

15.2 Definitions

Draft — The document is a draft version only. The content is still under internal review and subject to formal approval, which may result in modifications or additions. Nexperia does not give any representations or warranties as to the accuracy or completeness of information included herein and shall have no liability for the consequences of use of such information.

Short data sheet — A short data sheet is an extract from a full data sheet with the same product type number(s) and title. A short data sheet is intended for quick reference only and should not be relied upon to contain detailed and full information. For detailed and full information see the relevant full data sheet, which is available on request via the local Nexperia sales office. In case of any inconsistency or conflict with the short data sheet, the full data sheet shall prevail.

Product specification — The information and data provided in a Product data sheet shall define the specification of the product as agreed between Nexperia and its customer, unless Nexperia and customer have explicitly agreed otherwise in writing. In no event however, shall an agreement be valid in which the Nexperia product is deemed to offer functions and qualities beyond those described in the Product data sheet.

15.3 Disclaimers

Limited warranty and liability — Information in this document is believed to be accurate and reliable. However, Nexperia does not give any representations or warranties, expressed or implied, as to the accuracy or completeness of such information and shall have no liability for the consequences of use of such information. Nexperia takes no responsibility for the content in this document if provided by an information source outside of Nexperia.

In no event shall Nexperia be liable for any indirect, incidental, punitive, special or consequential damages (including - without limitation - lost profits, lost savings, business interruption, costs related to the removal or replacement of any products or rework charges) whether or not such damages are based on tort (including negligence), warranty, breach of contract or any other legal theory.

Notwithstanding any damages that customer might incur for any reason whatsoever, Nexperia's aggregate and cumulative liability towards customer for the products described herein shall be limited in accordance with the *Terms and conditions of commercial sale* of Nexperia.

Right to make changes — Nexperia reserves the right to make changes to information published in this document, including without limitation specifications and product descriptions, at any time and without notice. This document supersedes and replaces all information supplied prior to the publication hereof.

Suitability for use in automotive applications — This Nexperia product has been qualified for use in automotive applications. Unless otherwise agreed in writing, the product is not designed, authorized or warranted to be suitable for use in life support, life-critical or safety-critical systems or equipment, nor in applications where failure or malfunction of a Nexperia product can reasonably be expected to result in personal injury, death or severe property or environmental damage. Nexperia and its suppliers accept no liability for inclusion and/or use of Nexperia products in such equipment or applications and therefore such inclusion and/or use is at the customer's own risk.

Applications — Applications that are described herein for any of these products are for illustrative purposes only. Nexperia makes no representation or warranty that such applications will be suitable for the specified use without further testing or modification.

Customers are responsible for the design and operation of their applications and products using Nexperia products, and Nexperia accepts no liability for any assistance with applications or customer product design. It is customer's sole responsibility to determine whether the Nexperia product is suitable and fit for the customer's applications and products planned, as well as for the planned application and use of customer's third party customer(s). Customers should provide appropriate design and operating safeguards to minimize the risks associated with their applications and products.

Nexperia does not accept any liability related to any default, damage, costs or problem which is based on any weakness or default in the customer's applications or products, or the application or use by customer's third party customer(s). Customer is responsible for doing all necessary testing for the customer's applications and products using Nexperia products in order to avoid a default of the applications and the products or of the application or use by customer's third party customer(s). Nexperia does not accept any liability in this respect.

Limiting values — Stress above one or more limiting values (as defined in the Absolute Maximum Ratings System of IEC 60134) will cause permanent damage to the device. Limiting values are stress ratings only and (proper) operation of the device at these or any other conditions above those given in the Recommended operating conditions section (if present) or the Characteristics sections of this document is not warranted. Constant or repeated exposure to limiting values will permanently and irreversibly affect the quality and reliability of the device.

Terms and conditions of commercial sale — Nexperia products are sold subject to the general terms and conditions of commercial sale, as published at <http://www.nexperia.com/profile/terms>, unless otherwise agreed in a valid written individual agreement. In case an individual agreement is concluded only the terms and conditions of the respective agreement shall apply. Nexperia hereby expressly objects to applying the customer's general terms and conditions with regard to the purchase of Nexperia products by customer.

No offer to sell or license — Nothing in this document may be interpreted or construed as an offer to sell products that is open for acceptance or the grant, conveyance or implication of any license under any copyrights, patents or other industrial or intellectual property rights.

Export control — This document as well as the item(s) described herein may be subject to export control regulations. Export might require a prior authorization from competent authorities.

Translations — A non-English (translated) version of a document is for reference only. The English version shall prevail in case of any discrepancy between the translated and English versions.

15.4 Trademarks

Notice: All referenced brands, product names, service names and trademarks are the property of their respective owners.

16. Contact information

For more information, please visit: <http://www.nexperia.com>

For sales office addresses, please send an email to: salesaddresses@nexperia.com

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