

HEF4051B

8-channel analog multiplexer/demultiplexer

Rev. 14 — 25 July 2024

Product data sheet

1. General description

The HEF4051B is a single-pole octal-throw analog switch (SP8T) suitable for use in analog or digital 8:1 multiplexer/demultiplexer applications. The switch features three digital select inputs (S1, S2 and S3), eight independent inputs/outputs (Yn), a common input/output (Z) and a digital enable input (E). When E is HIGH, the switches are turned off. Inputs include clamp diodes. This enables the use of current limiting resistors to interface inputs to voltages in excess of V_{CC} .

2. Features and benefits

- Wide supply voltage range from 3.0 V to 15.0 V
- CMOS low power dissipation
- High noise immunity
- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Complies with JEDEC standard JESD 13-B
- ESD protection:
 - HBM: ANSI/ESDA/JEDEC JS-001 class 2 exceeds 2000 V
 - CDM: ANSI/ESDA/JEDEC JS-002 class C3 exceeds 1000 V
- Specified from -40 °C to +85 °C and -40 °C to +125 °C

3. Applications

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

4. Ordering information

Table 1. Ordering information

Type number	Package			
	Temperature Range	Name	Description	Version
HEF4051BT	-40 °C to +125 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
HEF4051BTT	-40 °C to +125 °C	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1

5. Functional diagram

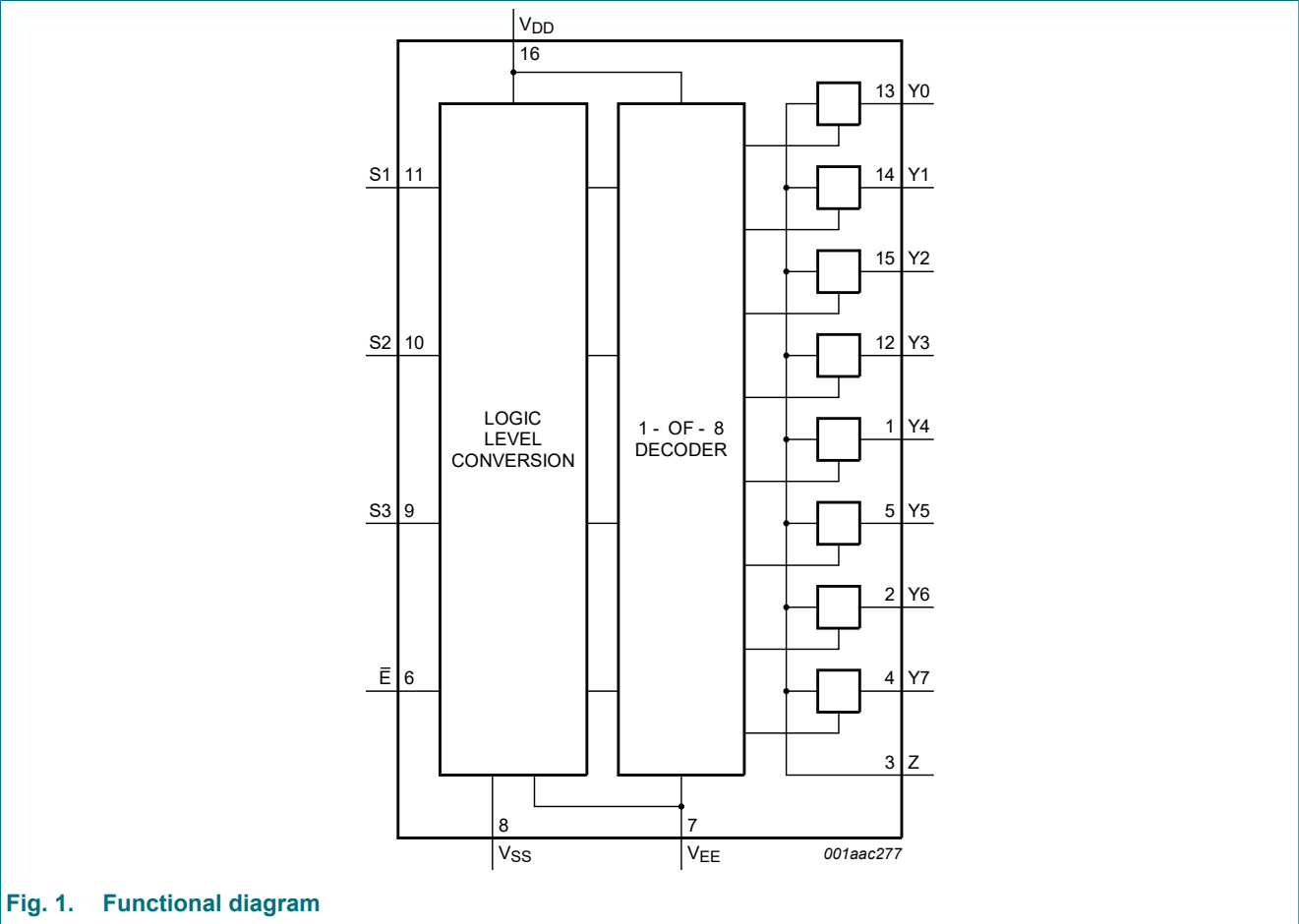


Fig. 1. Functional diagram

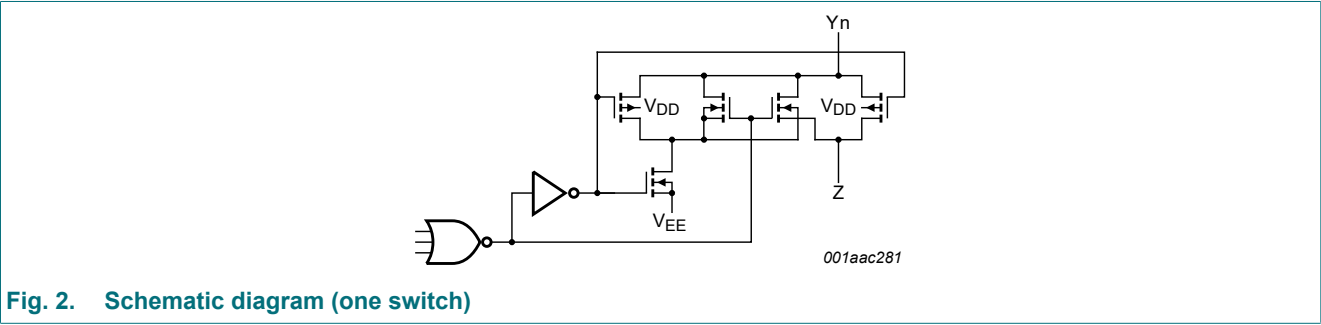


Fig. 2. Schematic diagram (one switch)

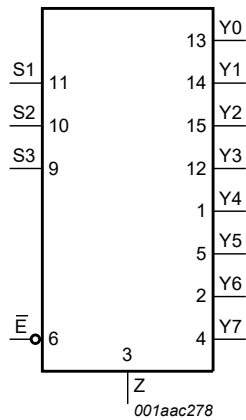


Fig. 3. Logic symbol

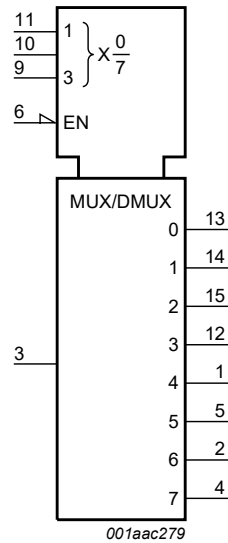


Fig. 4. IEC logic symbol

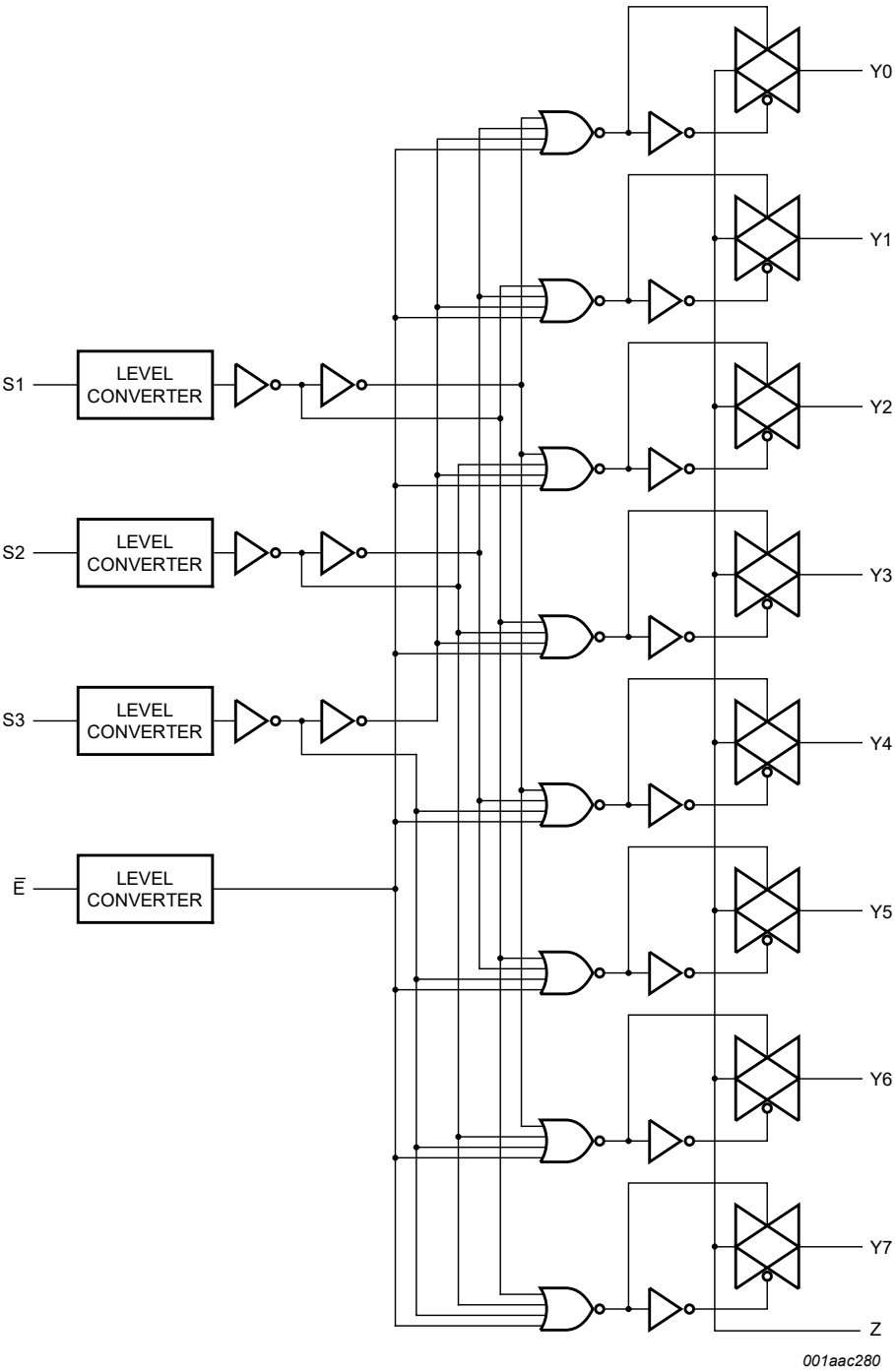
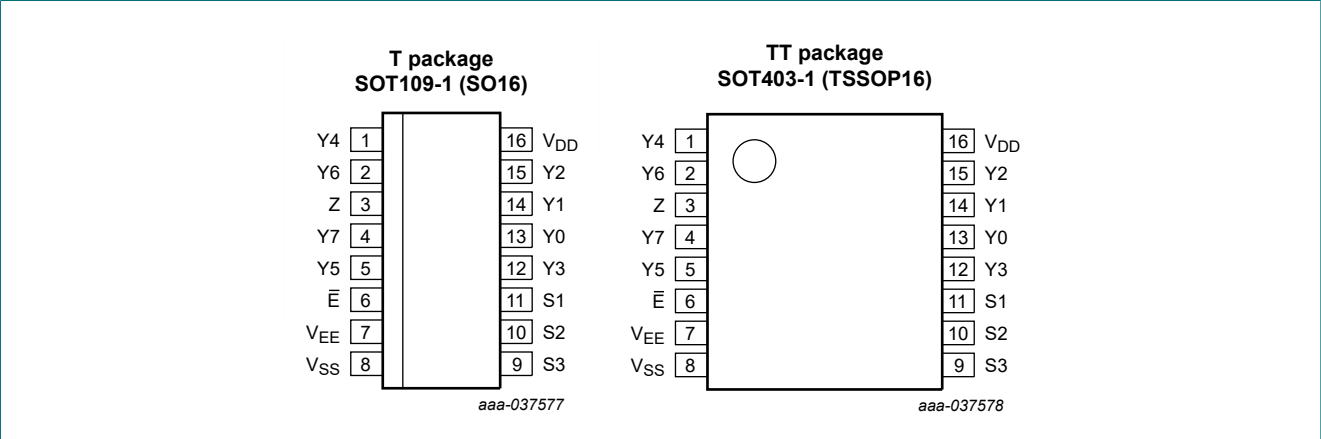


Fig. 5. Logic diagram

6. Pinning information

6.1. Pinning



6.2. Pin description

Table 2. Pin description

Symbol	Pin	Description
E̅	6	enable input (active LOW)
V _{EE}	7	supply voltage
V _{SS}	8	ground supply voltage
S1, S2, S3	11, 10, 9	select input
Y0, Y1, Y2, Y3, Y4, Y5, Y6, Y7	13, 14, 15, 12, 1, 5, 2, 4	independent input or output
Z	3	common output or input
V _{DD}	16	supply voltage

7. Functional description

Table 3. Function table

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

Input				Channel ON
E̅	S3	S2	S1	
L	L	L	L	Y0 to Z
L	L	L	H	Y1 to Z
L	L	H	L	Y2 to Z
L	L	H	H	Y3 to Z
L	H	L	L	Y4 to Z
L	H	L	H	Y5 to Z
L	H	H	L	Y6 to Z
L	H	H	H	Y7 to Z
H	X	X	X	switches off

8. Limiting values

Table 4. Limiting values
In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to $V_{SS} = 0\text{ V}$ (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 E; $V_I < -0.5\text{ V}$ or $V_I > V_{DD} + 0.5\text{ V}$	-	± 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	$T_{amb} = -40\text{ °C}$ to $+125\text{ °C}$ [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 SOT109-1 (SO16) package: P_{tot} derates linearly with 12.4 mW/K above 110 °C.
For SOT403-1 (TSSOP16) package: P_{tot} derates linearly with 8.5 mW/K above 91 °C.

9. Recommended operating conditions

Table 5. Recommended operating conditions

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
V_{DD}	supply voltage	see Fig. 6	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	$\mu\text{s/V}$

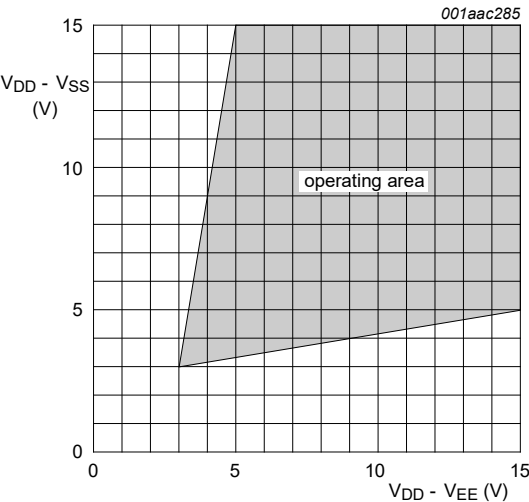


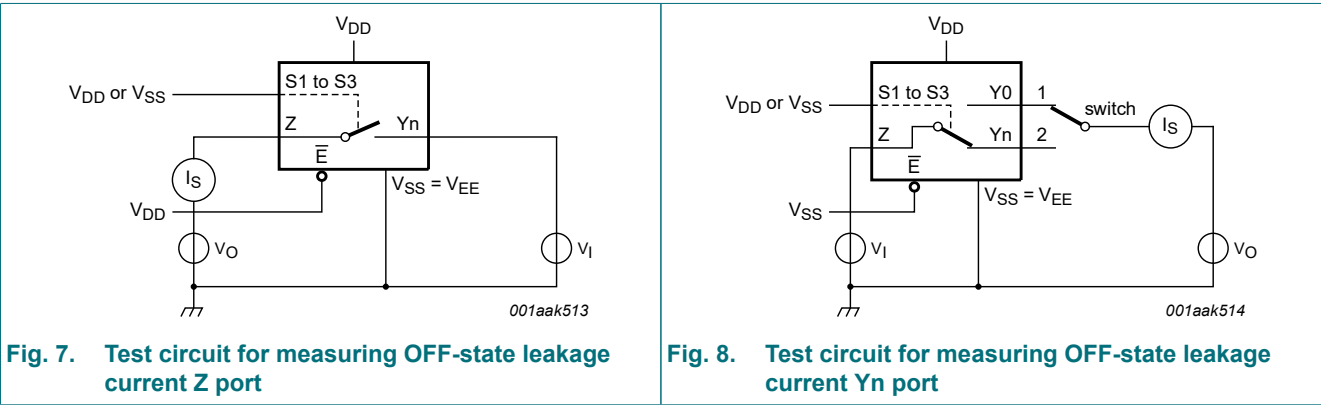
Fig. 6. Operating area as a function of the supply voltages

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 °C		T _{amb} = 25 °C		T _{amb} = 85 °C		T _{amb} = 125 °C		Unit
				Min	Max	Min	Max	Min	Max	Min	Max	
V _{IH}	HIGH-level input voltage	I _O < 1 µA	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 µA	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
I _{S(OFF)}	OFF-state leakage current	Z port; all channels OFF; see Fig. 7	15 V	-	-	-	1000	-	-	-	-	nA
		Y port; per channel; see Fig. 8	15 V	-	-	-	200	-	-	-	-	nA
I _{DD}	supply current	I _O = 0 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	Sn, E inputs	-	-	-	-	7.5	-	-	-	-	pF

10.1. Test circuits



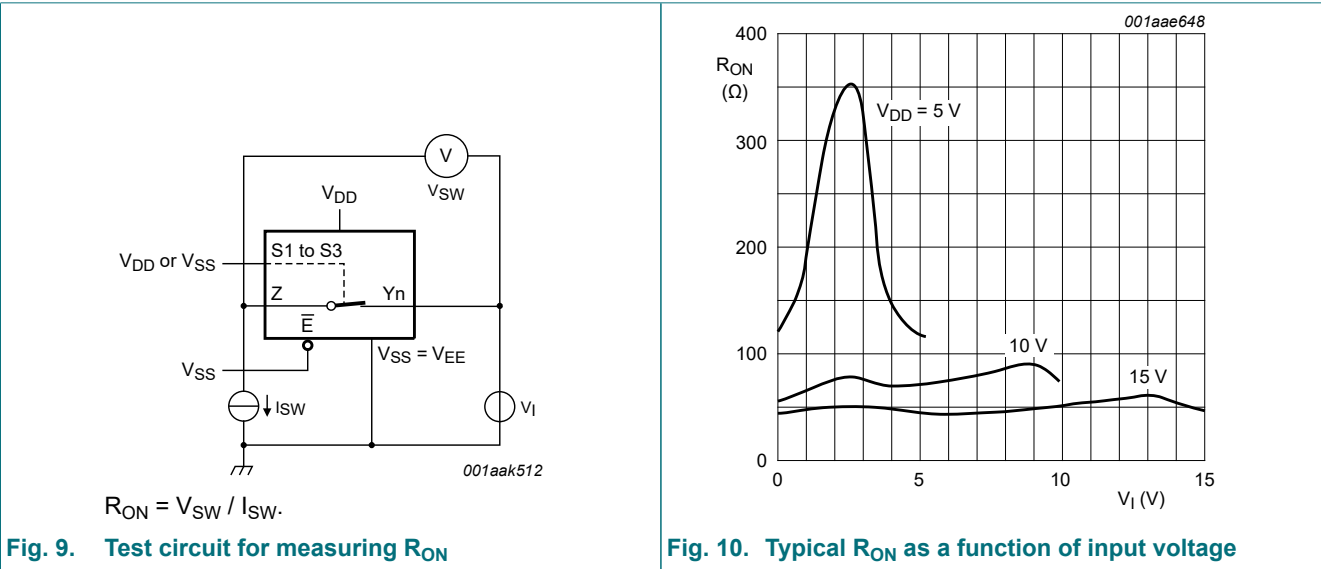
10.2. ON resistance

Table 7. ON resistance

T_{amb} = 25 °C; I_{SW} = 200 μA; V_{SS} = V_{EE} = 0 V.

Symbol	Parameter	Conditions	V _{DD} - V _{EE}	Typ	Max	Unit
R _{ON(peak)}	ON resistance (peak)	V _I = 0 V to V _{DD} - V _{EE} ; see Fig. 9 and Fig. 10	5 V	350	2500	Ω
			10 V	80	245	Ω
			15 V	60	175	Ω
R _{ON(rail)}	ON resistance (rail)	V _I = 0 V; see Fig. 9 and Fig. 10	5 V	115	340	Ω
			10 V	50	160	Ω
			15 V	40	115	Ω
		V _I = V _{DD} - V _{EE} ; see Fig. 9 and Fig. 10	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 V to V _{DD} - V _{EE} ; see Fig. 9	5 V	25	-	Ω
			10 V	10	-	Ω
			15 V	5	-	Ω

10.2.1. ON resistance waveform and test circuit



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 Fig. 14.

Symbol	Parameter	Conditions	V _{DD}	Typ	Max	Unit
t _{PHL}	HIGH to LOW propagation delay	Y _n , Z to Z, Y _n ; see Fig. 11	5 V	15	30	ns
			10 V	5	10	ns
			15 V	5	10	ns
		S _n to Y _n , Z; see Fig. 12	5 V	150	300	ns
			10 V	60	120	ns
			15 V	45	90	ns
t _{PLH}	LOW to HIGH propagation delay	Y _n , Z to Z, Y _n ; see Fig. 11	5 V	15	30	ns
			10 V	5	10	ns
			15 V	5	10	ns
		S _n to Y _n , Z; see Fig. 12	5 V	150	300	ns
			10 V	65	130	ns
			15 V	45	90	ns
t _{PHZ}	HIGH to OFF-state propagation delay	$\bar{E}$ to Y _n , Z; see Fig. 13	5 V	120	240	ns
			10 V	90	180	ns
			15 V	85	170	ns
t _{PZH}	OFF-state to HIGH propagation delay	$\bar{E}$ to Y _n , Z; see Fig. 13	5 V	140	280	ns
			10 V	55	110	ns
			15 V	40	80	ns
t _{PLZ}	LOW to OFF-state propagation delay	$\bar{E}$ to Y _n , Z; see Fig. 13	5 V	145	290	ns
			10 V	120	240	ns
			15 V	115	230	ns
t _{PZL}	OFF-state to LOW propagation delay	$\bar{E}$ to Y _n , Z; see Fig. 13	5 V	140	280	ns
			10 V	55	110	ns
			15 V	40	80	ns

11.1. Waveforms and test circuit

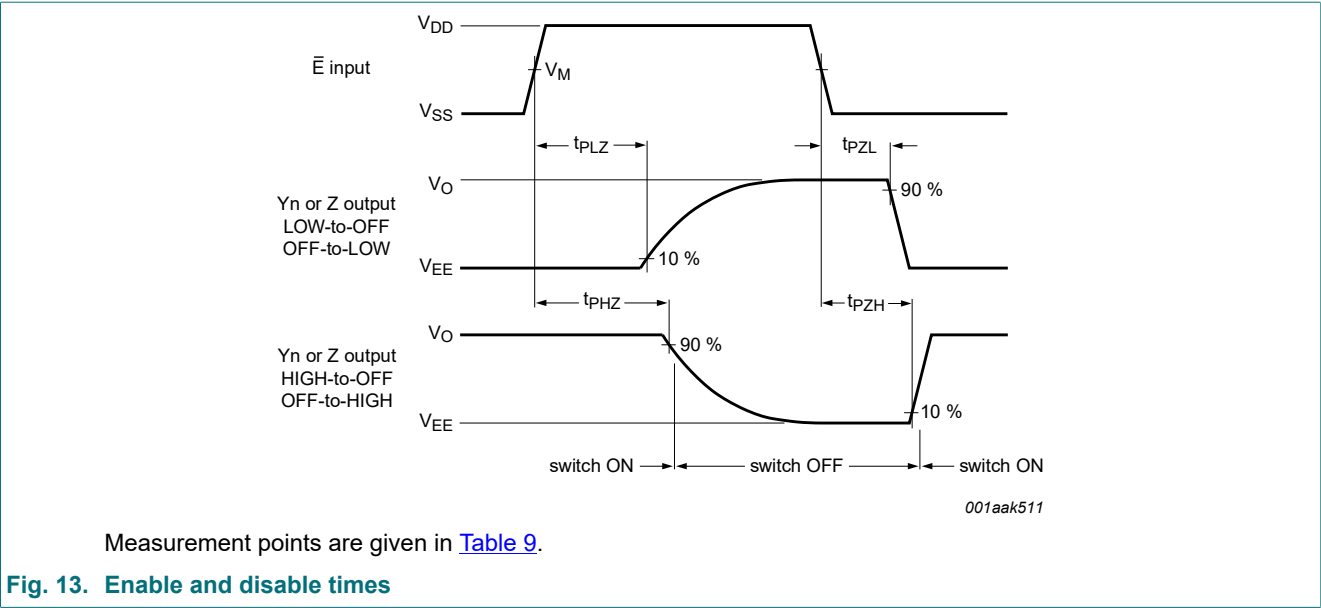
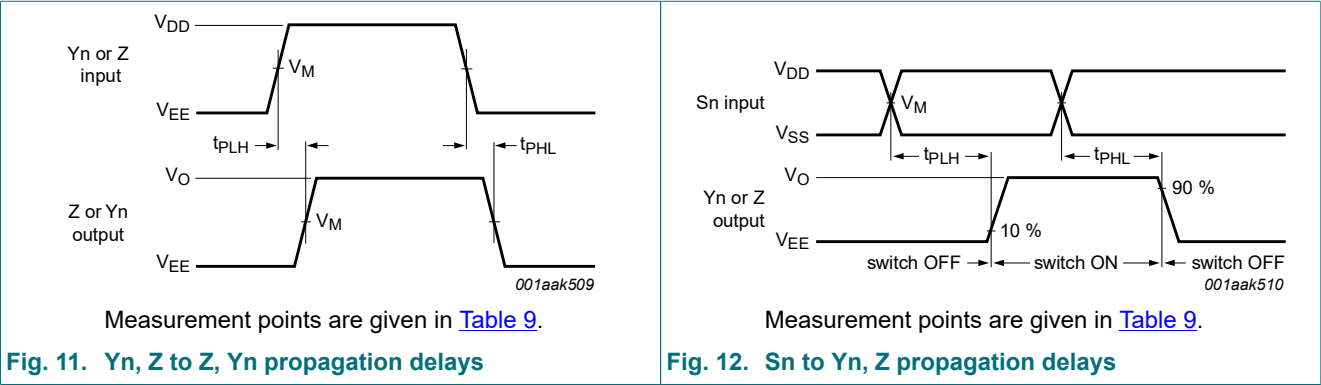


Table 9. Measurement points

Supply voltage	Input	Output
V_{DD}	V_M	V_M
5 V to 15 V	$0.5V_{DD}$	$0.5V_{DD}$

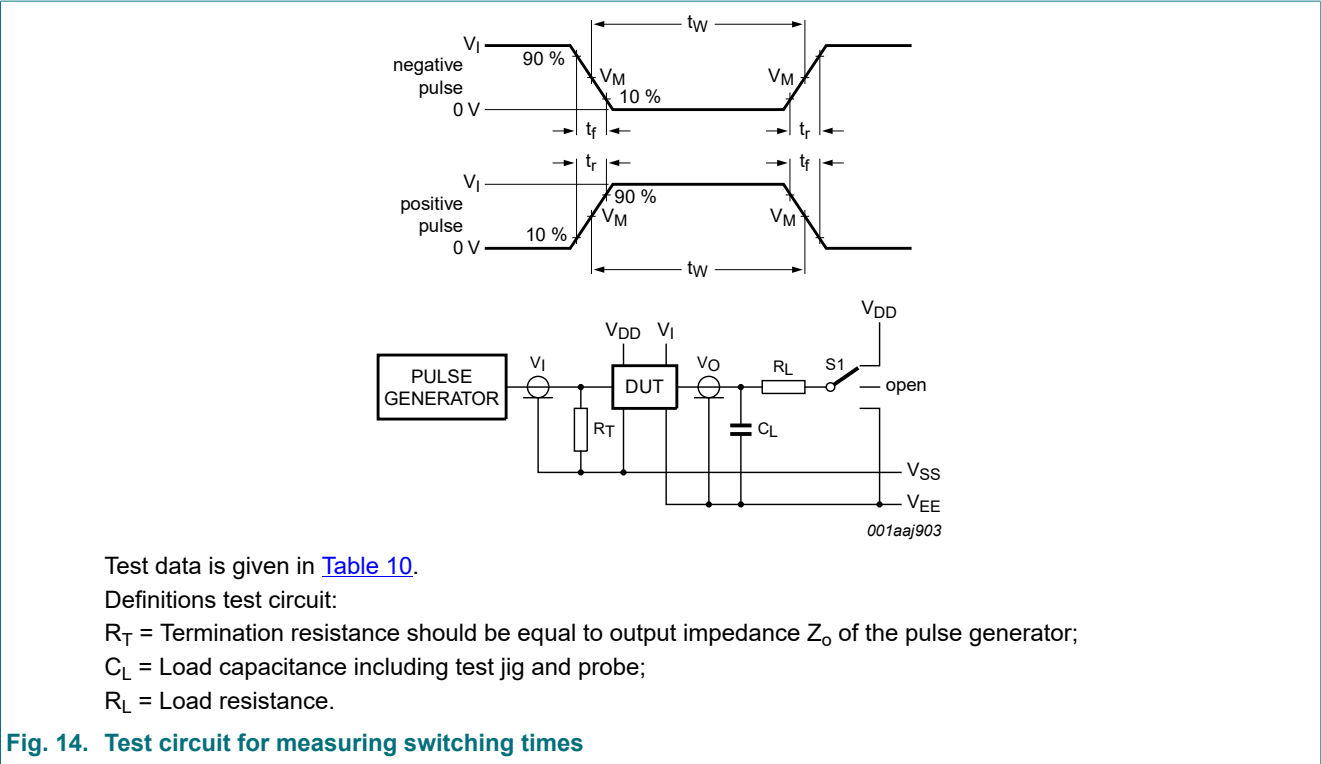


Table 10. Test data

Input				Load		S1 position				
Yn, Z	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 Yn to Z or Z to Yn propagation delays use V_{EE} . For Sn to Yn or Z propagation delays use V_{DD} .

11.2. Additional dynamic parameters

Table 11. Additional dynamic characteristics

$V_{SS} = V_{EE} = 0$ V; $T_{amb} = 25$ °C.

Symbol	Parameter	Conditions	V_{DD}	Typ	Max	Unit
THD	total harmonic distortion	see Fig. 15 ; $R_L = 10$ k Ω ; $C_L = 15$ 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	-	%
$f_{(-3dB)}$	-3 dB frequency response	see Fig. 16 ; $R_L = 1$ k Ω ; $C_L = 5$ 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 Fig. 17 ; $f_i = 1$ MHz; $R_L = 1$ k Ω ; $C_L = 5$ pF; channel OFF; $V_I = 0.5V_{DD}$ (p-p)	10 V	[1] -50	-	dB
V_{ct}	crosstalk voltage	digital inputs to switch; see Fig. 18 ; $R_L = 10$ k Ω ; $C_L = 15$ pF; $\bar{E}$ or Sn = V_{DD} (square-wave)	10 V	50	-	mV
Xtalk	crosstalk	between switches; see Fig. 19 ; $f_i = 1$ MHz; $R_L = 1$ k Ω ; $V_I = 0.5V_{DD}$ (p-p)	10 V	[1] -50	-	dB

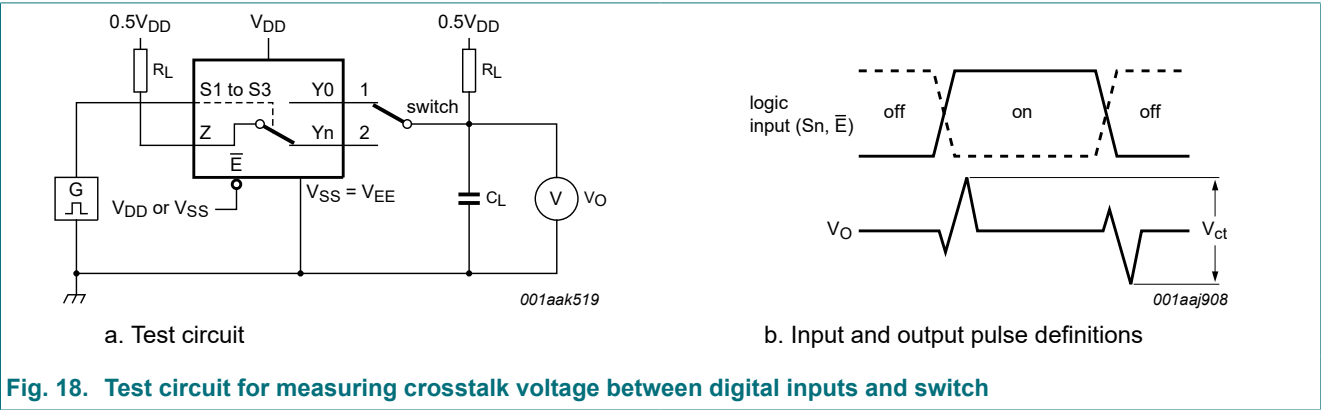
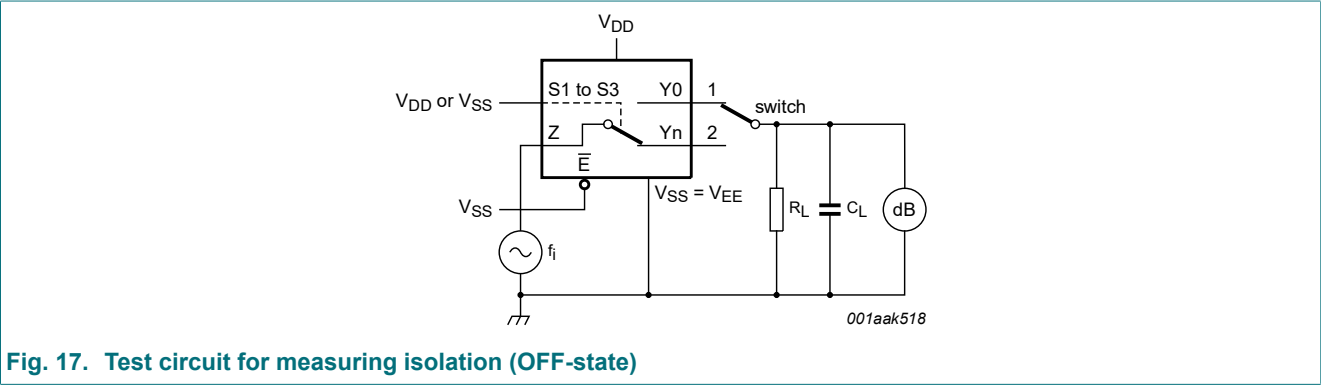
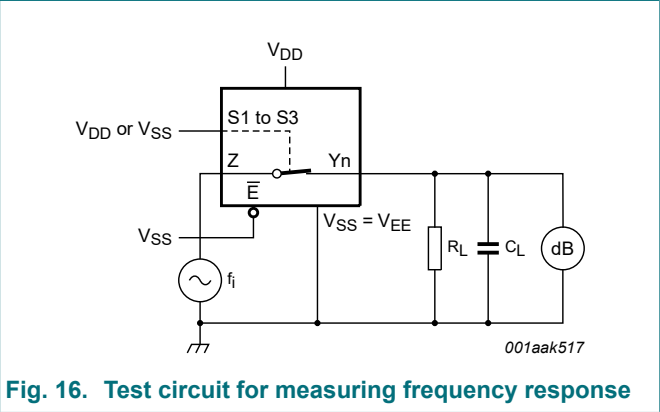
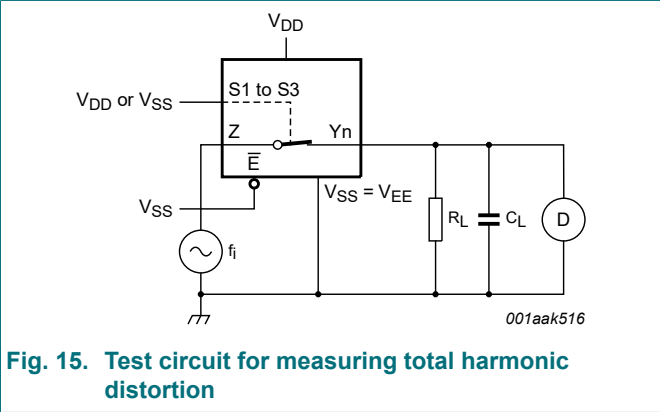
[1] f_i is biased at $0.5 V_{DD}$; $V_I = 0.5V_{DD}$ (p-p).

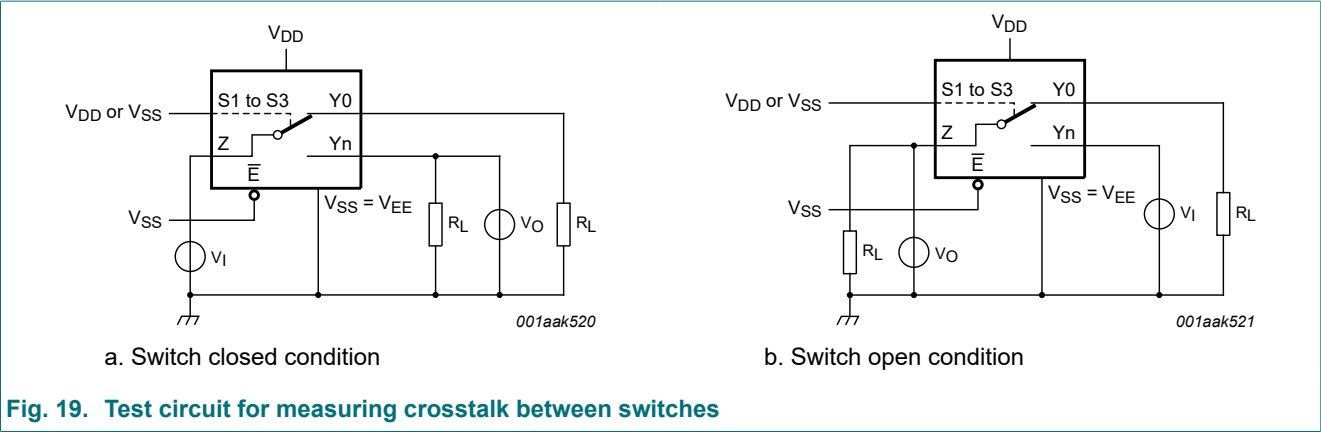
Table 12. Dynamic power dissipation P_D

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	$P_D = 1000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	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	$P_D = 5500 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	
		15 V	$P_D = 15000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	

11.2.1. Test circuits





12. Package outline

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

SOT109-1

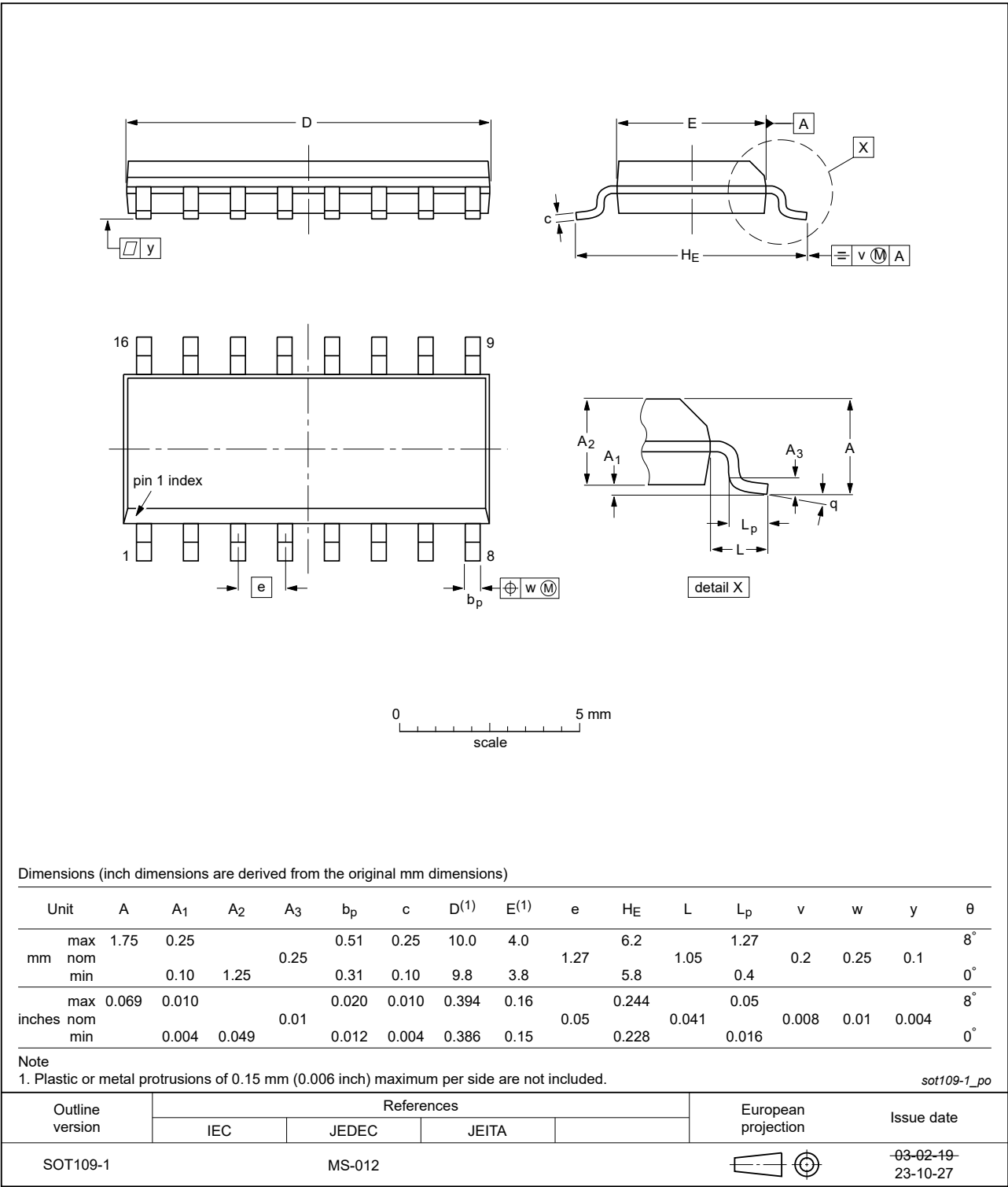


Fig. 20. Package outline SOT109-1 (SO16)

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

SOT403-1

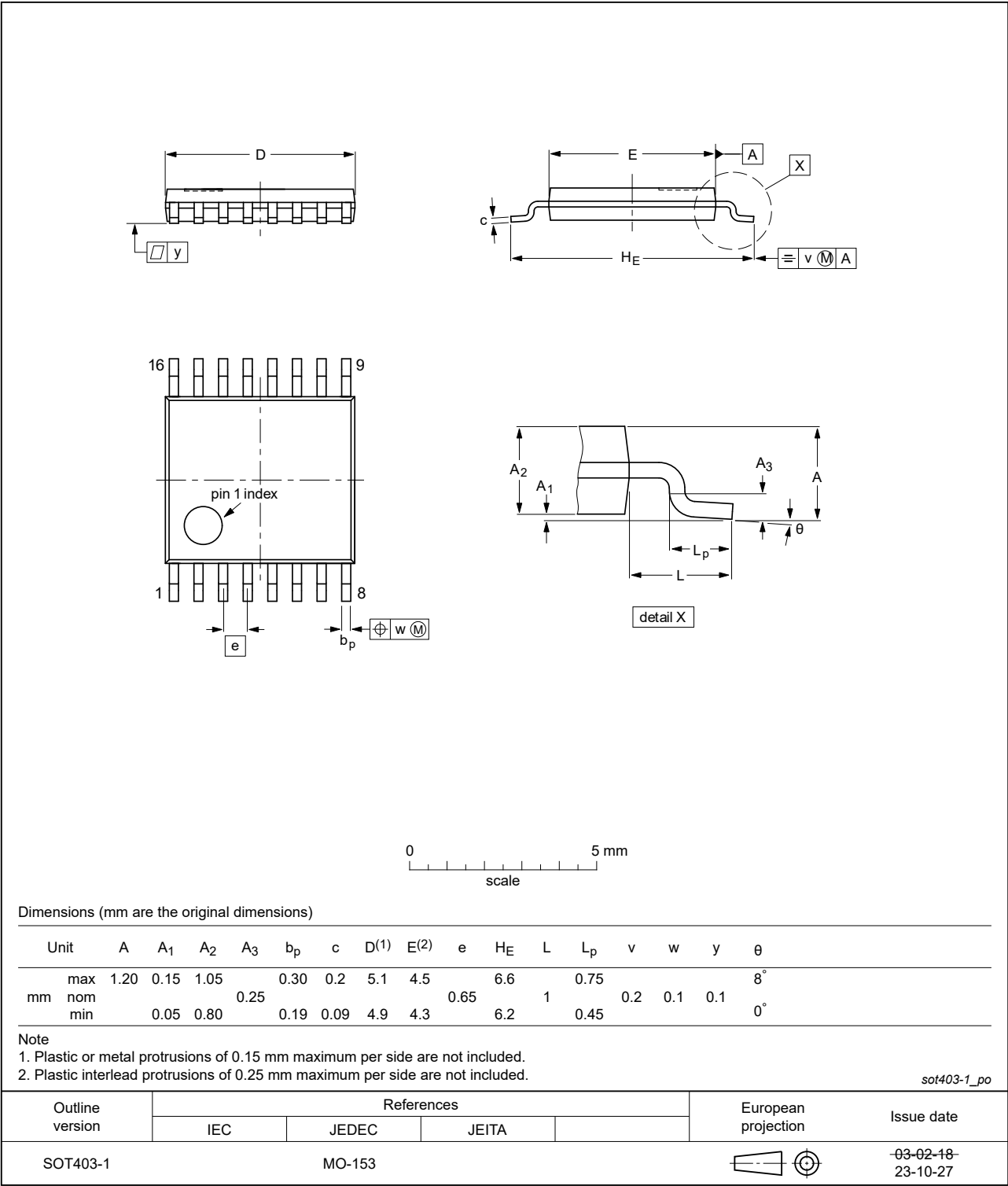


Fig. 21. Package outline SOT403-1 (TSSOP16)

13. Abbreviations

Table 13. Abbreviations

Acronym	Description
ANSI	American National Standards Institute
CDM	Charged Device Model
CMOS	Complementary Metal-Oxide Semiconductor
DUT	Device Under Test
ESD	ElectroStatic Discharge
ESDA	ElectroStatic Discharge Association
HBM	Human Body Model
JEDEC	Joint Electron Device Engineering Council

14. Revision history

Table 14. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF4051B v.14	20240725	Product data sheet	-	HEF4051B v.13
Modifications:	- Section 2: ESD specification updated according to the latest JEDEC standard. - Fig. 20, Fig. 21: Aligned SO and TSSOP package outline drawings to JEDEC MS-012 and MO-153			
HEF4051B v.13	20210729	Product data sheet	-	HEF4051B v.12
Modifications:	- The format of this data sheet has been redesigned to comply with the identity guidelines of Nexperia. - Legal texts have been adapted to the new company name where appropriate. - Type number HEF4051BTS (SOT338-1/SSOP16) removed. - Section 1 and Section 2 updated. - Section 8: Derating values for P_{tot} total power dissipation updated.			
HEF4051B v.12	20160325	Product data sheet	-	HEF4051B v.11
Modifications:	Type number HEF4051BP (SOT38-4) removed.			
HEF4051B v.11	20140911	Product data sheet	-	HEF4051B v.10
Modifications:	Fig. 18: Test circuit modified			
HEF4051B v.10	20111117	Product data sheet	-	HEF4051B v.9
Modifications:	- Legal pages updated. - Changes in "General description", "Features and benefits" and "Applications".			
HEF4051B v.9	20100325	Product data sheet	-	HEF4051B v.8
HEF4051B v.8	20100301	Product data sheet	-	HEF4051B v.7
HEF4051B v.7	20091127	Product data sheet	-	HEF4051B v.6
HEF4051B v.6	20090924	Product data sheet	-	HEF4051B v.5
HEF4051B v.5	20090826	Product data sheet	-	HEF4051B v.4
HEF4051B v.4	20050112	Product data sheet	-	HEF4051B_CNV v.3
HEF4051B_CNV v.3	19950101	Product specification	-	HEF4051B_CNV v.2
HEF4051B_CNV v.2	19950101	Product specification	-	-

15. Legal information

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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