

HEF4051B

8-channel analog multiplexer/demultiplexer

Rev. 04 — 12 January 2005

Product data sheet

1. General description

The HEF4051B is an 8-channel analog multiplexer/demultiplexer with three address inputs (A0 to A2), an active LOW enable input (\bar{E}), eight independent inputs/outputs (Y0 to Y7) and a common input/output (Z).

The device contains eight bidirectional analog switches, each with one side connected to an independent input/output (Y0 to Y7) and the other side connected to a common input/output (Z).

With \bar{E} LOW, one of the eight switches is selected (low-impedance ON-state) by A0 to A2. With \bar{E} HIGH, all switches are in the high-impedance OFF-state, independent of A0 to A2. 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 (A0 to A2, and \bar{E}). The V_{DD} to V_{SS} range is 3 V to 15 V. The analog inputs/outputs (Y0 to Y7, and Z) 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.

For operation as a digital multiplexer/demultiplexer, V_{EE} is connected to V_{SS} (typically ground).

2. Features

- Analog multiplexing and demultiplexing
- Digital multiplexing and demultiplexing
- Signal gating
- Multiple package option
- Specified from $-40\text{ }^{\circ}\text{C}$ to $+85\text{ }^{\circ}\text{C}$

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3. Quick reference data

Table 1: Quick reference data

$T_{amb} = 25\text{ }^{\circ}\text{C}$; $R_L = 10\text{ k}\Omega$; $C_L = 50\text{ pF}$; $\bar{E} = V_{DD}$ (square wave); $V_{is} = V_{DD} = 15\text{ V}$

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
t_{PHZ}	output disable time HIGH to OFF for \bar{E} to Z or \bar{E} to Y_n		-	85	170	ns
t_{PLZ}	output disable time LOW to OFF for \bar{E} to Z or \bar{E} to Y_n		-	115	230	ns
t_{PZH} , t_{PZL}	output enable time OFF to HIGH or LOW for \bar{E} to Z or \bar{E} to Y_n		-	40	80	ns
C_i	input capacitance digital inputs		-	-	7.5	pF

4. Ordering information

Table 2: Ordering information

Type number	Package			
	Temperature range	Name	Description	Version
HEF4051BP	-40 °C to +85 °C	DIP16	plastic dual in-line package; 16 leads (300 mil); long body	SOT38-1
HEF4051BT	-40 °C to +85 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
HEF4051BTS	-40 °C to +85 °C	SSOP16	plastic shrink small outline package; 16 leads; body width 5.3 mm	SOT338-1
HEF4051BTT	-40 °C to +85 °C	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1

5. Functional diagram

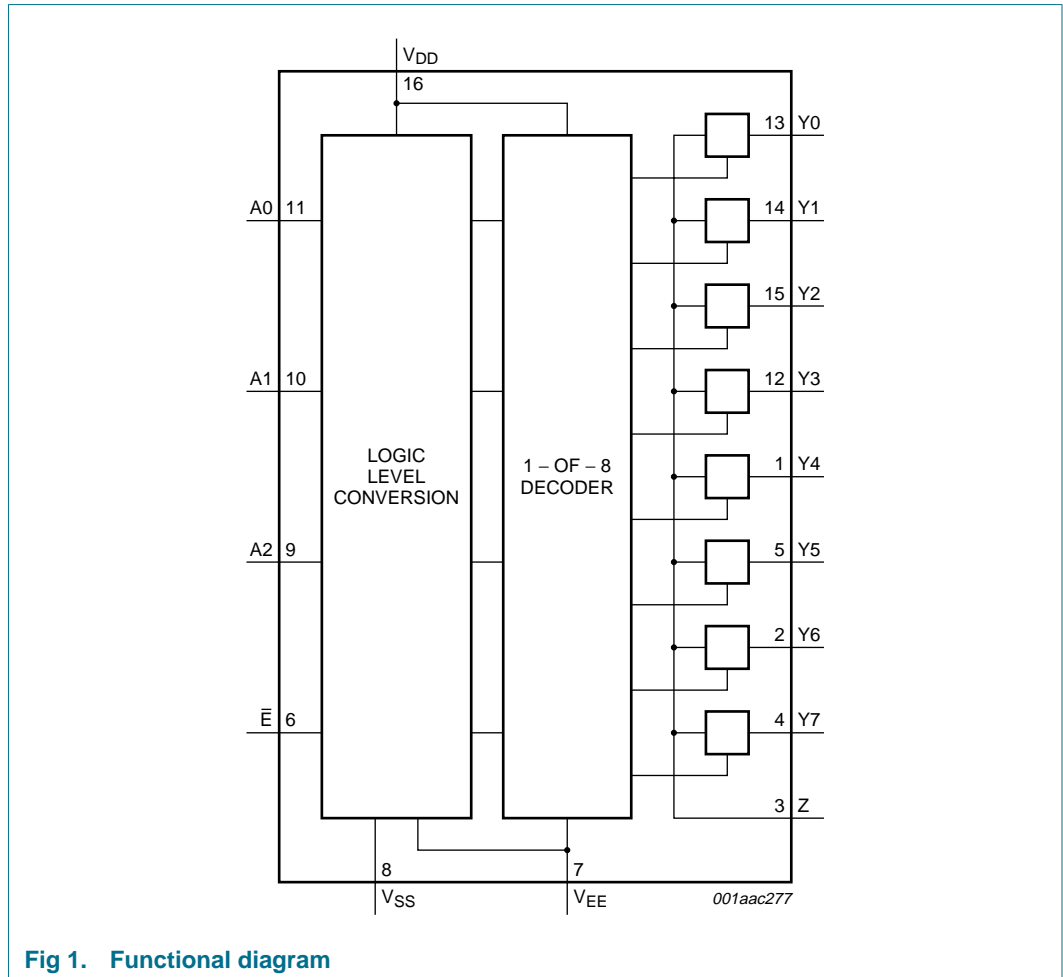


Fig 1. Functional diagram

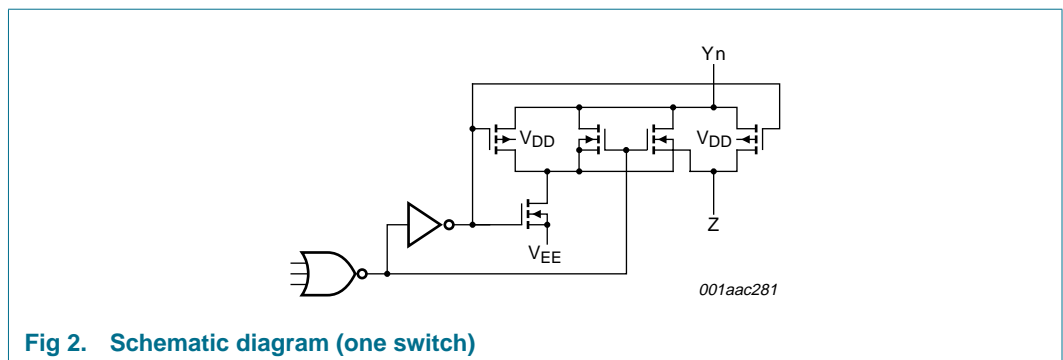


Fig 2. Schematic diagram (one switch)

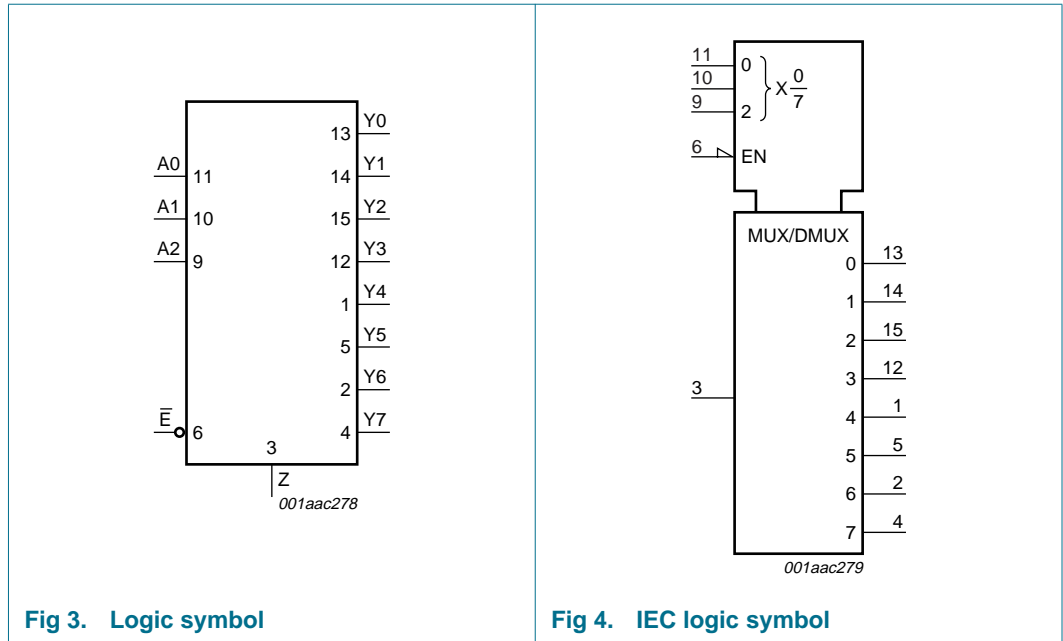


Fig 3. Logic symbol

Fig 4. IEC logic symbol

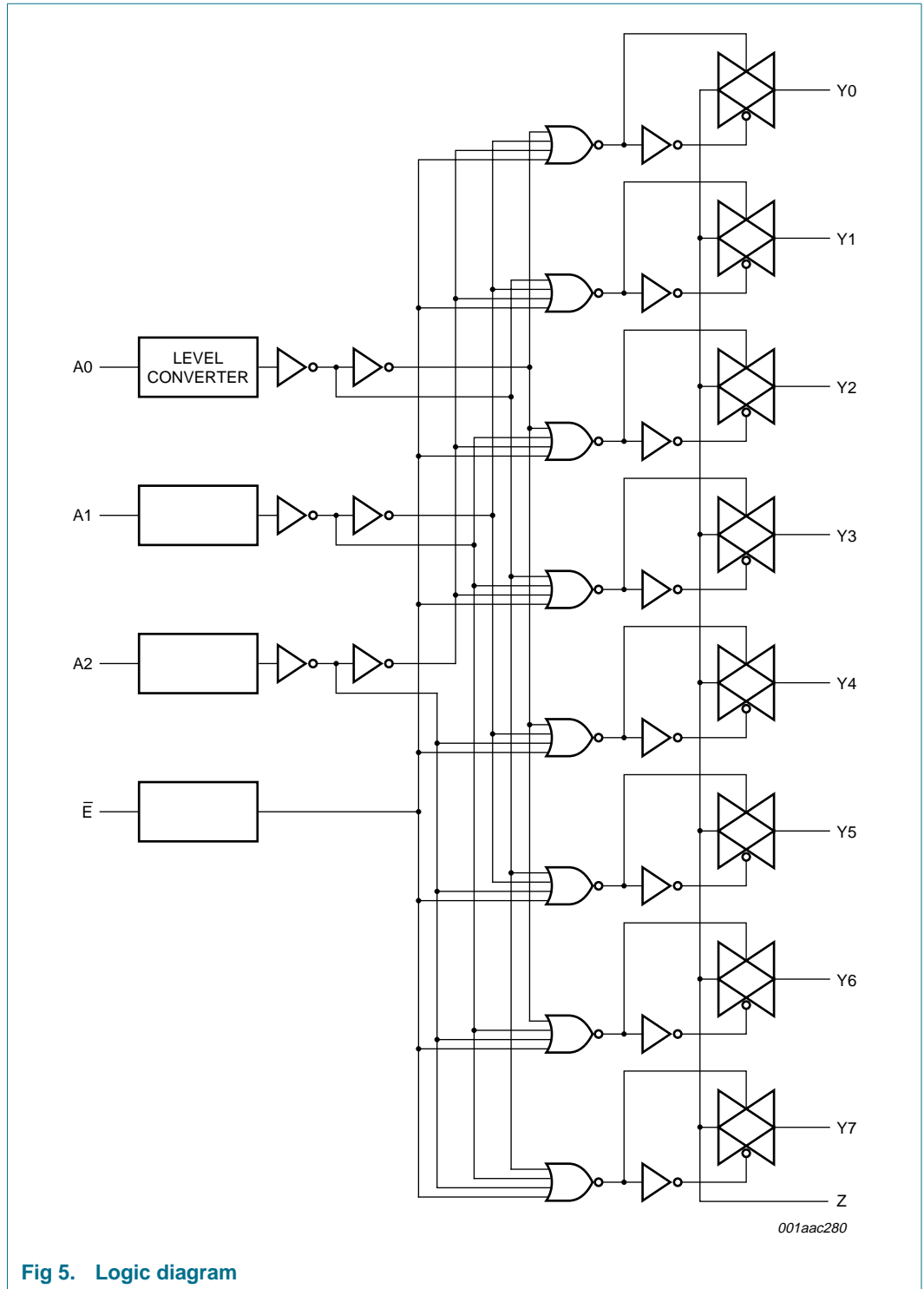
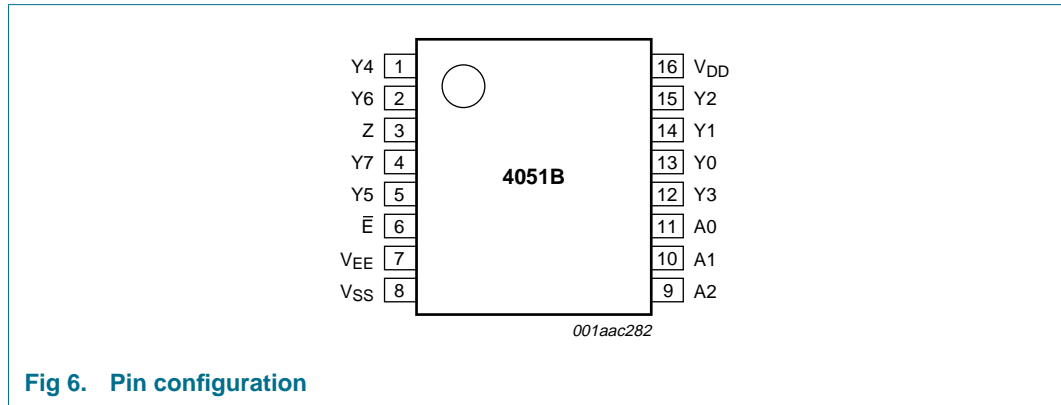


Fig 5. Logic diagram

6. Pinning information

6.1 Pinning



6.2 Pin description

Table 3: Pin description

Symbol	Pin	Description
Y4	1	independent input/output
Y6	2	independent input/output
Z	3	common input/output
Y7	4	independent input/output
Y5	5	independent input/output
\bar{E}	6	enable input (active LOW)
V_{EE}	7	supply voltage of switches
V_{SS}	8	ground (0 V)
A2	9	address input
A1	10	address input
A0	11	address input
Y3	12	independent input/output
Y0	13	independent input/output
Y1	14	independent input/output
Y2	15	independent input/output
V_{DD}	16	supply voltage

7. Functional description

Table 4: Function table [\[1\]](#)

Inputs				Channel ON
\bar{E}	A2	A1	A0	
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	-

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

8. Limiting values

Table 5: Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134).

Symbol	Parameter	Conditions	Min	Max	Unit
V_{DD}	supply voltage		[1] -0.5	+18	V
V_{EE}	supply voltage of switches	referenced to V_{DD}	[1] -18	+0.5	V
V_I	voltage on any input		-0.5	$V_{DD} + 0.5$	V
I	DC current into any input or output		-	± 10	mA
T_{stg}	storage temperature		-65	+150	°C
T_{amb}	ambient temperature		-40	+85	°C
P_{tot}	power dissipation	$T_{amb} = -40\text{ °C to }+85\text{ °C}$			
	DIP16		[2] -	700	mW
	SO16, SSOP16 and TSSOP16		[2] -	500	mW
P_o	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, 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 DIP16 packages: above 70 °C, derate linearly with 12 mW/K.
For SO16 packages: above 70 °C, derate linearly with 8 mW/K.
For SSOP16 and TSSOP16 packages: above 60 °C, derate linearly with 5.5 mW/K.

9. Static characteristics

Table 6: Static characteristics

$V_{SS} = 0\text{ V}$; unless otherwise specified

Symbol	Parameter	Conditions	$T_{\text{amb}} = -40\text{ °C}$		$T_{\text{amb}} = 25\text{ °C}$		$T_{\text{amb}} = 85\text{ °C}$		Unit
			Min	Max	Min	Max	Min	Max	
I_{DD}	quiescent device current	all valid input combinations; $V_I = V_{SS}$ or V_{DD} ; $I_O = 0\text{ A}$							
		$V_{DD} = 5\text{ V}$	-	20	-	20	-	150	μA
		$V_{DD} = 10\text{ V}$	-	40	-	40	-	300	μA
		$V_{DD} = 15\text{ V}$	-	80	-	80	-	600	μA
V_{IL}	LOW-level input voltage	$ I_O < 1\text{ }\mu\text{A}$							
		$V_O = 0.5\text{ V}$ or 4.5 V ; $V_{DD} = 5\text{ V}$	-	1.5	-	1.5	-	1.5	V
		$V_O = 1.0\text{ V}$ or 9.0 V ; $V_{DD} = 10\text{ V}$	-	3.0	-	3.0	-	3.0	V
		$V_O = 1.5\text{ V}$ or 13.5 V ; $V_{DD} = 15\text{ V}$	-	4.0	-	4.0	-	4.0	V
V_{IH}	HIGH-level input voltage	$ I_O < 1\text{ }\mu\text{A}$							
		$V_O = 0.5\text{ V}$ or 4.5 V ; $V_{DD} = 5\text{ V}$	3.5	-	3.5	-	3.5	-	V
		$V_O = 1.0\text{ V}$ or 9.0 V ; $V_{DD} = 10\text{ V}$	7.0	-	7.0	-	7.0	-	V
		$V_O = 1.5\text{ V}$ or 13.5 V ; $V_{DD} = 15\text{ V}$	11.0	-	11.0	-	11.0	-	V
I_{LI}	Input leakage current	$V_I = 0\text{ V}$ or 15 V ; $V_{DD} = 15\text{ V}$	-	0.3	-	0.3	-	1.0	μA
I_{OZ}	3-state output leakage current	$V_{DD} = 15\text{ V}$							
		output returned to V_{DD}	-	1.6	-	1.6	-	12.0	μA
		output returned to V_{SS}	-	-1.6	-	-1.6	-	-12.0	μA
C_i	input capacitance digital inputs		-	-	-	7.5	-	-	pF

Table 7: Static characteristics for R_{ON}
 $T_{amb} = 25^{\circ}C$; R_{ON} test conditions see [Figure 8](#)

Symbol	Parameter	Conditions	Min	Typ	Max	Unit	
R_{ON}	ON resistance	$V_{is} = 0\text{ V to }V_{DD} - V_{EE}$					
		$V_{DD} - V_{EE} = 5\text{ V}$	-	350	2500	Ω	
		$V_{DD} - V_{EE} = 10\text{ V}$	-	80	245	Ω	
		$V_{DD} - V_{EE} = 15\text{ V}$	-	60	175	Ω	
		$V_{is} = 0\text{ V}$					
		$V_{DD} - V_{EE} = 5\text{ V}$	-	115	340	Ω	
		$V_{DD} - V_{EE} = 10\text{ V}$	-	50	160	Ω	
		$V_{DD} - V_{EE} = 15\text{ V}$	-	40	115	Ω	
		$V_{is} = V_{DD} - V_{EE}$					
		$V_{DD} - V_{EE} = 5\text{ V}$	-	120	365	Ω	
		$V_{DD} - V_{EE} = 10\text{ V}$	-	65	200	Ω	
		$V_{DD} - V_{EE} = 15\text{ V}$	-	50	155	Ω	
ΔR_{ON}	ON resistance difference between any two channels	$V_{is} = 0\text{ V to }V_{DD} - V_{EE}$					
		$V_{DD} - V_{EE} = 5\text{ V}$	-	25	-	Ω	
		$V_{DD} - V_{EE} = 10\text{ V}$	-	10	-	Ω	
		$V_{DD} - V_{EE} = 15\text{ V}$	-	5	-	Ω	
$I_{L(OFF)}$	OFF-state leakage current	$V_{SS} = V_{EE}$; $V_{DD} - V_{EE} = 15\text{ V}$					
		all channels OFF; \bar{E} at V_{DD}	-	-	1000	nA	
		any channel; \bar{E} at V_{SS}	-	-	200	nA	

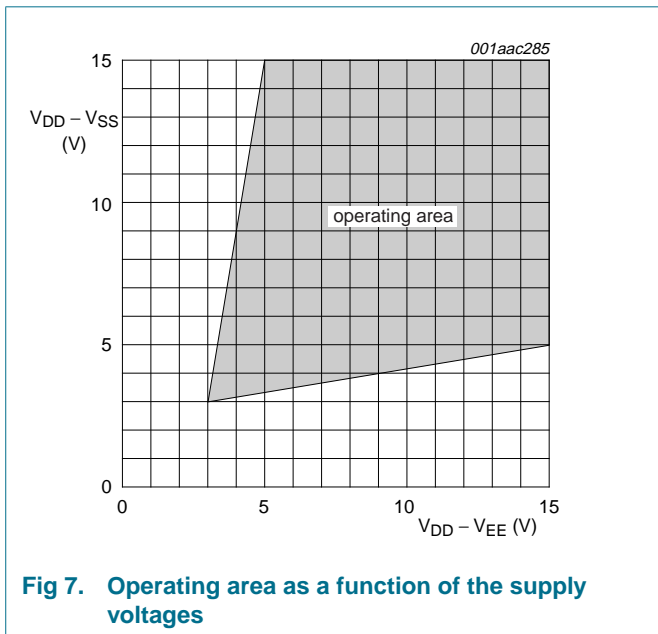


Fig 7. Operating area as a function of the supply voltages

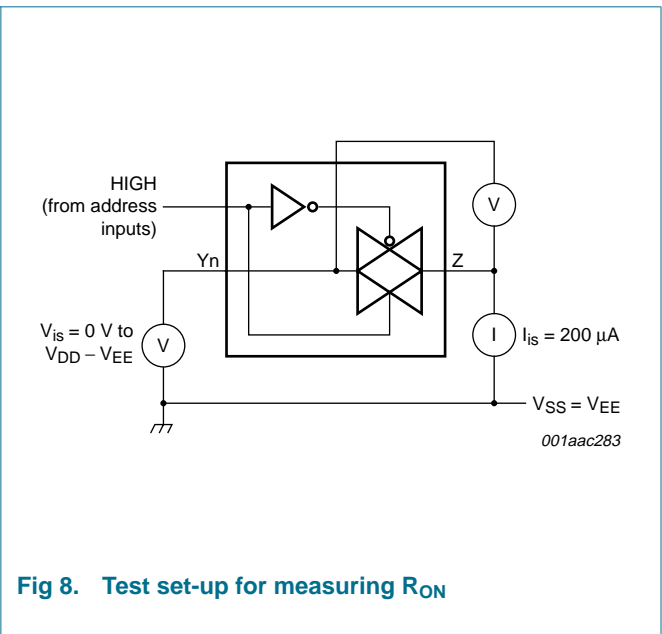
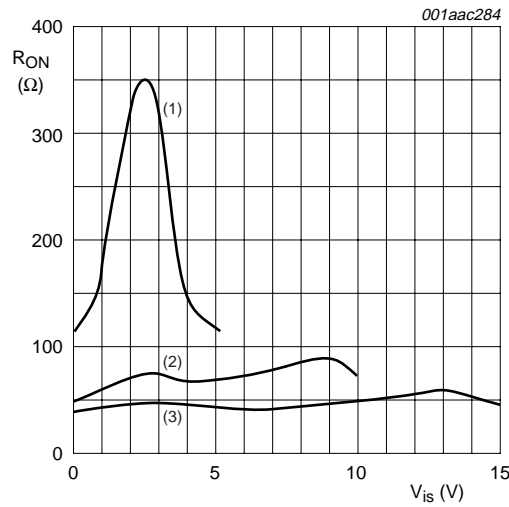


Fig 8. Test set-up for measuring R_{ON}



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

- (1) $V_{DD} = 5 V.$
- (2) $V_{DD} = 10 V.$
- (3) $V_{DD} = 15 V.$

Fig 9. Typical R_{ON} as a function of input voltage

10. Dynamic characteristics

Table 8: Dynamic characteristics

$V_{EE} = V_{SS} = 0 V; R_L = 10 k\Omega; C_L = 50 pF; T_{amb} = 25 ^\circ C; input transition times \le 20 ns; test circuit see Figure 13.$

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
t_{PHL}, t_{PLH}	propagation delay Z to Y_n or Y_n to Z	$\bar{E} = V_{SS}; V_{is} = V_{DD}$ (square-wave); see Figure 10	[1]			
		$V_{DD} = 5 V$	-	15	30	ns
		$V_{DD} = 10 V$	-	5	10	ns
		$V_{DD} = 15 V$	-	5	10	ns
t_{PHL}	HIGH to LOW propagation delay An to Z or An to Y_n	$\bar{E} = V_{SS}; A_n = V_{DD}$ (square-wave); $V_{is} = V_{EE}$; see Figure 11	[1] [2]			
		$V_{DD} = 5 V$	-	150	300	ns
		$V_{DD} = 10 V$	-	60	120	ns
		$V_{DD} = 15 V$	-	45	90	ns
t_{PLH}	LOW to HIGH propagation delay An to Z or An to Y_n	$\bar{E} = V_{SS}; A_n = V_{DD}$ (square-wave); $V_{is} = V_{DD}$; see Figure 11	[1] [2]			
		$V_{DD} = 5 V$	-	150	300	ns
		$V_{DD} = 10 V$	-	65	130	ns
		$V_{DD} = 15 V$	-	45	90	ns

Table 8: Dynamic characteristics ...continued $V_{EE} = V_{SS} = 0$ V; $R_L = 10$ k Ω ; $C_L = 50$ pF; $T_{amb} = 25$ °C; input transition times ≤ 20 ns; test circuit see [Figure 13](#).

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
t_{PHZ}	output disable time HIGH to OFF for \bar{E} to Z or \bar{E} to Yn	$\bar{E} = V_{DD}$ (square wave); $V_{is} = V_{DD}$; see Figure 12 ^[1]				
		$V_{DD} = 5$ V	-	120	240	ns
		$V_{DD} = 10$ V	-	90	180	ns
		$V_{DD} = 15$ V	-	85	170	ns
t_{PLZ}	output disable time LOW to OFF for \bar{E} to Z or \bar{E} to Yn	$\bar{E} = V_{DD}$ (square wave); $V_{is} = V_{EE}$; see Figure 12 ^[1]				
		$V_{DD} = 5$ V	-	145	290	ns
		$V_{DD} = 10$ V	-	120	240	ns
		$V_{DD} = 15$ V	-	115	230	ns
t_{PZH}	output enable times OFF to HIGH or LOW for \bar{E} to Z or \bar{E} to Yn	$\bar{E} = V_{DD}$ (square wave); $V_{is} = V_{DD}$; see Figure 12 ^[1]				
		$V_{DD} = 5$ V	-	140	280	ns
		$V_{DD} = 10$ V	-	55	110	ns
		$V_{DD} = 15$ V	-	40	80	ns
t_{PZL}	output enable times OFF to HIGH or LOW for \bar{E} to Z or \bar{E} to Yn	$\bar{E} = V_{DD}$ (square wave); $V_{is} = V_{EE}$; see Figure 12 ^[1]				
		$V_{DD} = 5$ V	-	140	280	ns
		$V_{DD} = 10$ V	-	55	110	ns
		$V_{DD} = 15$ V	-	40	80	ns
P_D	dynamic power dissipation		^[3]	-	-	-

[1] V_{is} is the input voltage at a Yn or Z terminal, whichever is assigned as input. V_{os} is the output voltage at a Yn or Z terminal, whichever is assigned as output.

[2] The temperature coefficient for propagation delays is 0.35 %/°C.

[3] Dynamic power dissipation P_D can be calculated with the following formulae (P_D in μ W):

for $V_{DD} = 5$ V, $P_D = 1000 \times f_i + \Sigma (f_o \times C_L) \times V_{DD}^2$;

for $V_{DD} = 10$ V, $P_D = 5500 \times f_i + \Sigma (f_o \times C_L) \times V_{DD}^2$;

for $V_{DD} = 15$ V, $P_D = 15000 \times f_i + \Sigma (f_o \times C_L) \times V_{DD}^2$, where:

f_i = input frequency in MHz;

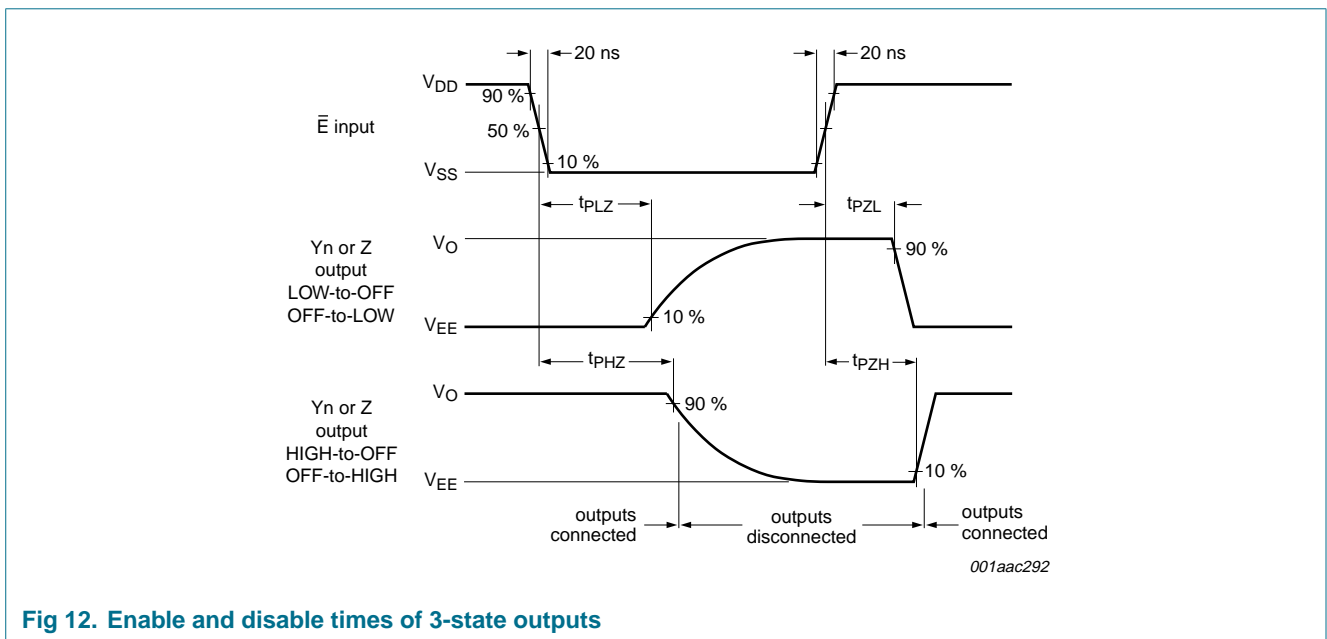
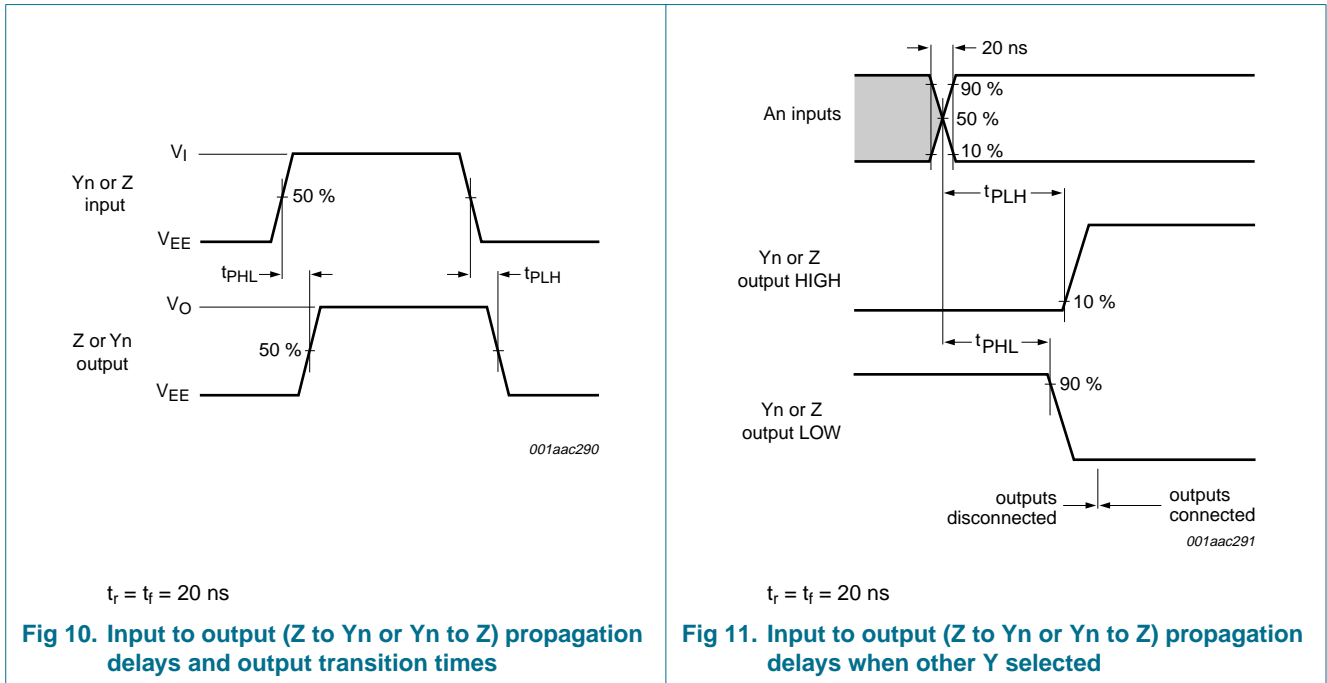
f_o = output frequency in MHz;

C_L = output load capacitance in pF;

V_{DD} = supply voltage in V;

$\Sigma(C_L \times f_o)$ = sum of the outputs.

11. Waveforms



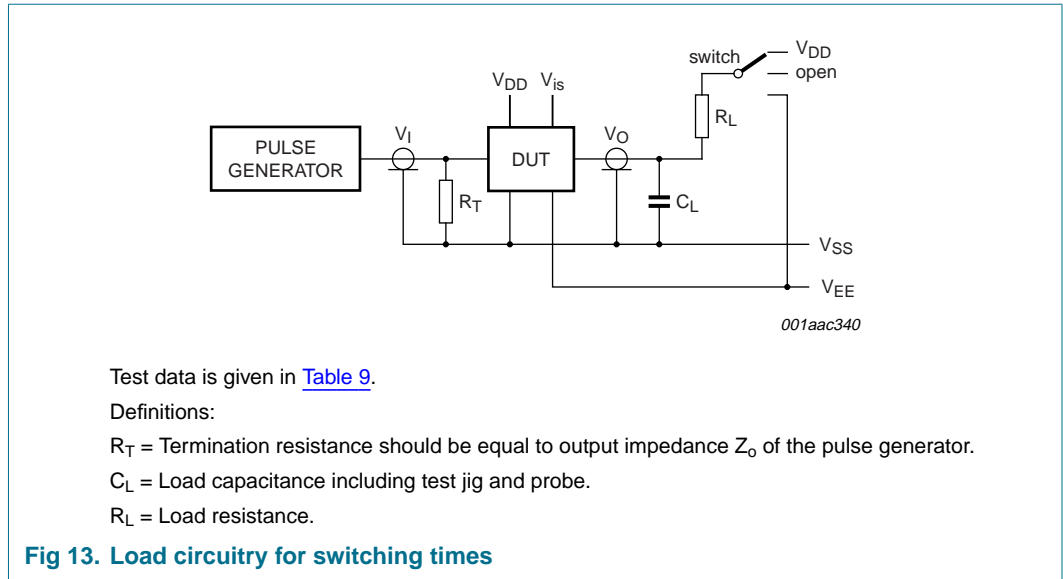


Table 9: Test data

Test	Input		Load		Switch
	V_{is}	t_r, t_f	C_L	R_L	
t_{PHL}	V_{EE}	20 ns	50 pF	10 k Ω	V_{DD}
t_{PLH}	V_{DD}	20 ns	50 pF	10 k Ω	V_{EE}
t_{PZH}, t_{PHZ}	V_{DD}	20 ns	50 pF	10 k Ω	V_{EE}
t_{PZL}, t_{PLZ}	V_{EE}	20 ns	50 pF	10 k Ω	V_{DD}
other	pulse	20 ns	50 pF	10 k Ω	open

12. Additional dynamic characteristics

Table 10: Additional dynamic characteristics

$V_{is} = 0.5V_{DD}(p-p)$ sine-wave and symmetrical.

Symbol	Parameter	Conditions	Min	Typ	Max	Unit
d_{sin}	distortion, sine-wave response	channel ON; $R_L = 10\text{ k}\Omega$; $C_L = 15\text{ pF}$; $f_{is} = 1\text{ kHz}$; see Figure 14				
		$V_{DD} = 5\text{ V}$	-	0.25	-	%
		$V_{DD} = 10\text{ V}$	-	0.04	-	%
		$V_{DD} = 15\text{ V}$	-	0.04	-	%
f_{ct}	crosstalk between any two channels	$V_{DD} = 10\text{ V}$	[1] -	1	-	MHz
V_{ct}	crosstalk \bar{E} or An to Yn or Z	$R_L = 10\text{ k}\Omega$; $C_L = 15\text{ pF}$; \bar{E} or An = V_{DD} (square-wave); crosstalk is $ V_{OS} $ (peak value); $V_{DD} = 10\text{ V}$; see Figure 15	-	50	-	mV
f_{OFF}	OFF-state feed-through	$V_{DD} = 10\text{ V}$	[2] -	1	-	MHz

Table 10: Additional dynamic characteristics ...continued

$V_{is} = 0.5V_{DD}(p-p)$ sine-wave and symmetrical.

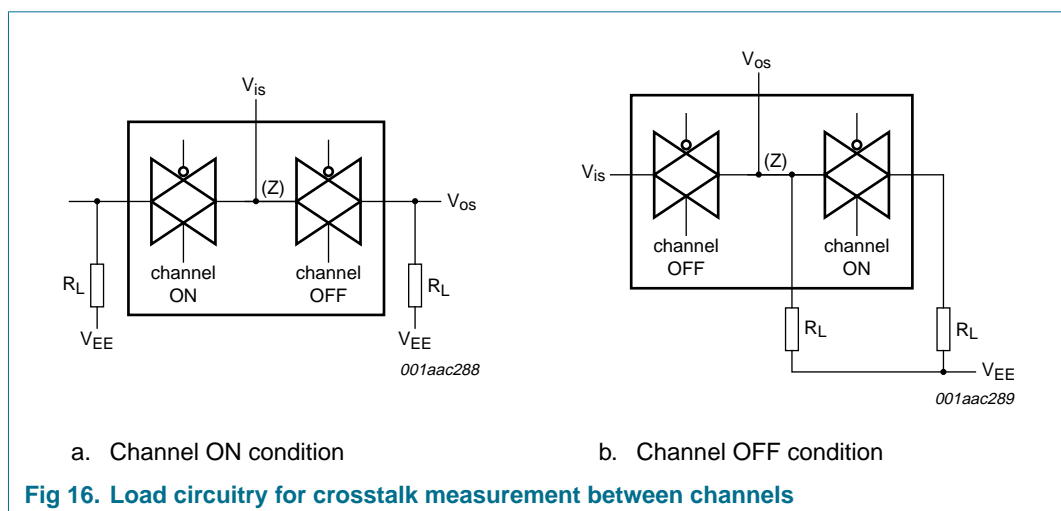
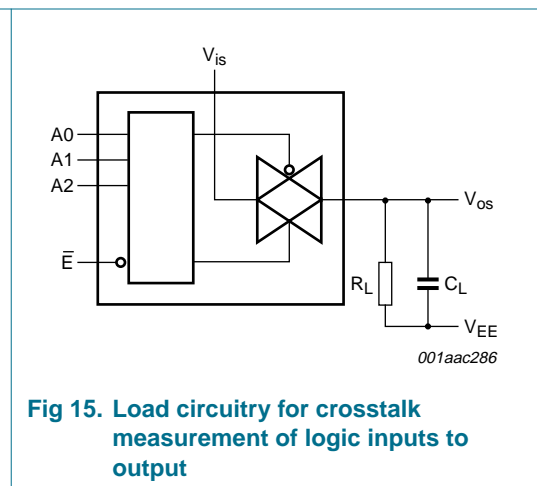
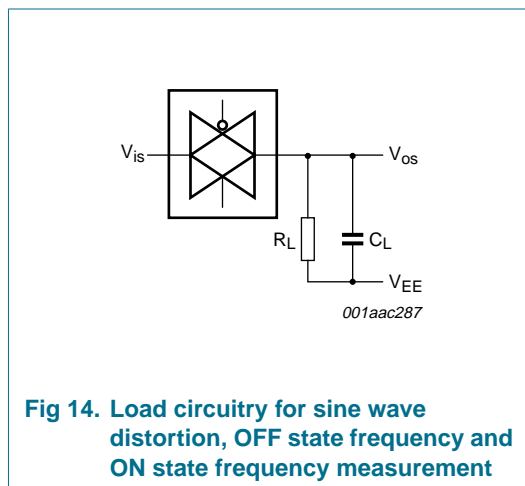
Symbol	Parameter	Conditions	Min	Typ	Max	Unit
f_{ON}	ON-state frequency response	$V_{DD} = 5\text{ V}$	[3] -	13	-	MHz
		$V_{DD} = 10\text{ V}$	[3] -	40	-	MHz
		$V_{DD} = 15\text{ V}$	[3] -	70	-	MHz

[1] $R_L = 1\text{ k}\Omega$; $20\log \frac{V_{os}}{V_{is}} = -50\text{ dB}$; see Figure 16.

[2] $R_L = 1\text{ k}\Omega$; $C_L = 5\text{ pF}$; channel OFF; $20\log \frac{V_{os}}{V_{is}} = -50\text{ dB}$; see Figure 14.

[3] $R_L = 1\text{ k}\Omega$; $C_L = 5\text{ pF}$; channel ON; $20\log \frac{V_{os}}{V_{is}} = -3\text{ dB}$; see Figure 14.

13. Test circuits additional dynamic characteristics



14. Package outline

DIP16: plastic dual in-line package; 16 leads (300 mil); long body

SOT38-1

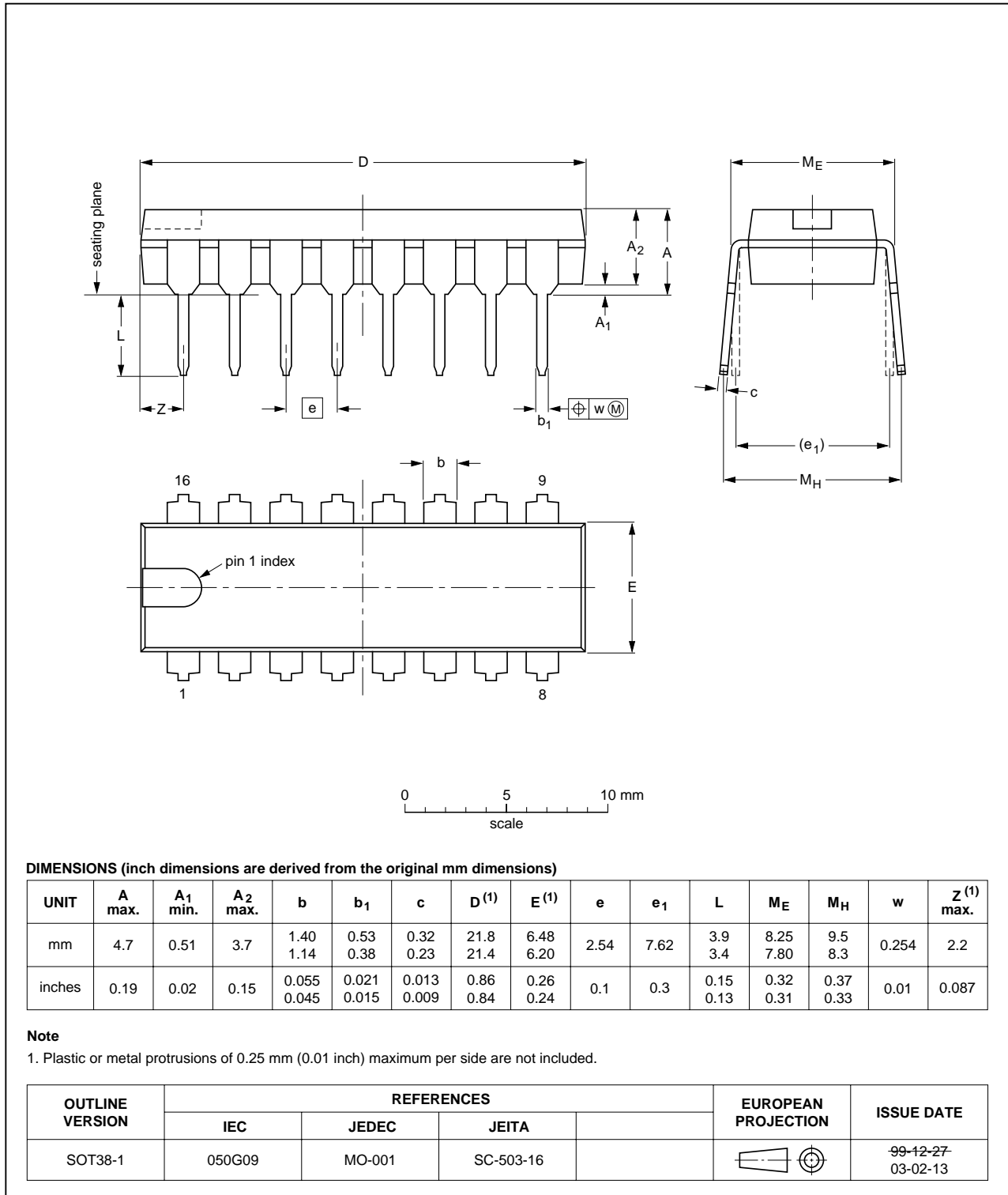


Fig 17. Package outline SOT38-1 (DIP16)

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

SOT109-1

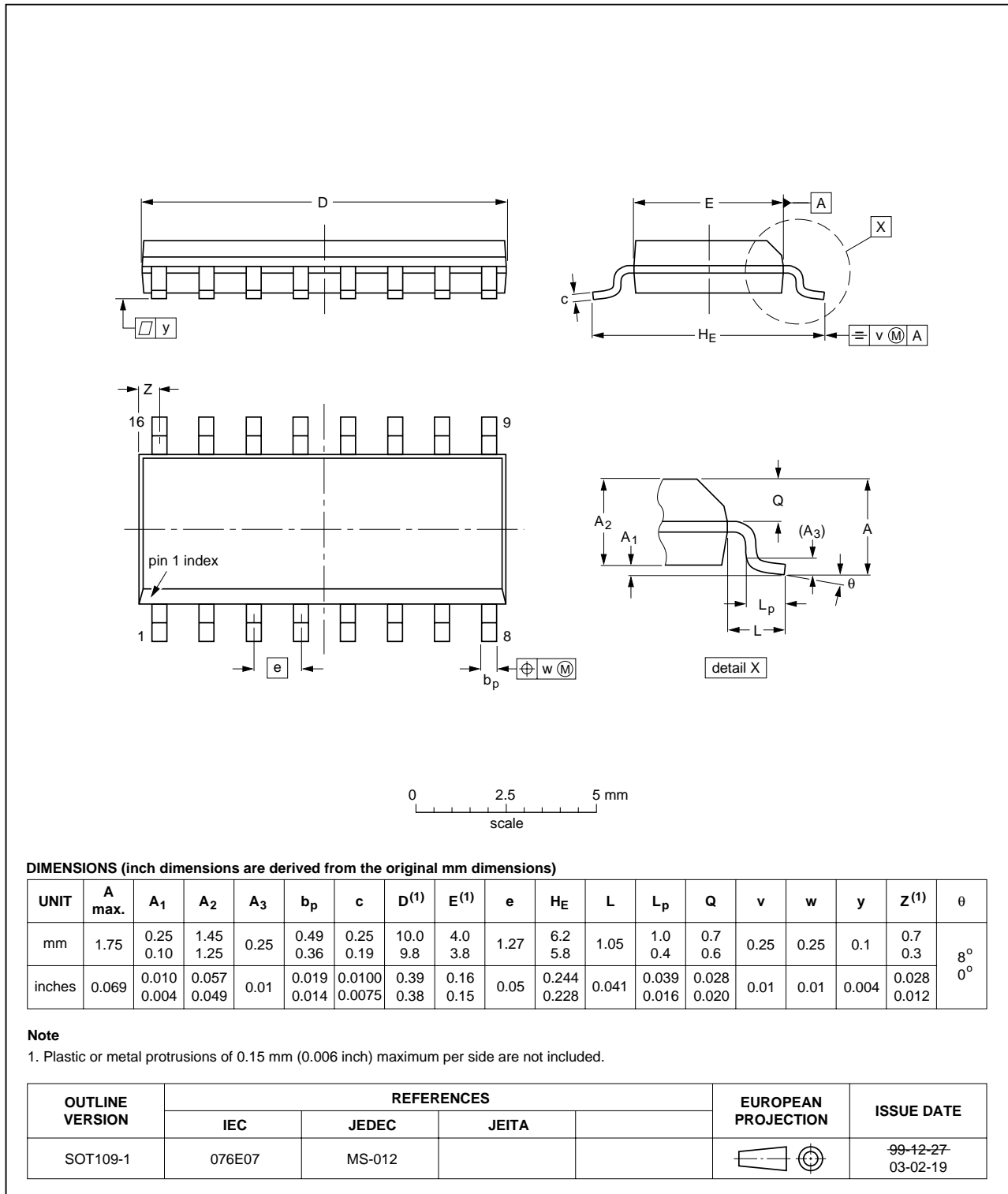


Fig 18. Package outline SOT109-1 (SO16)

SSOP16: plastic shrink small outline package; 16 leads; body width 5.3 mm

SOT338-1

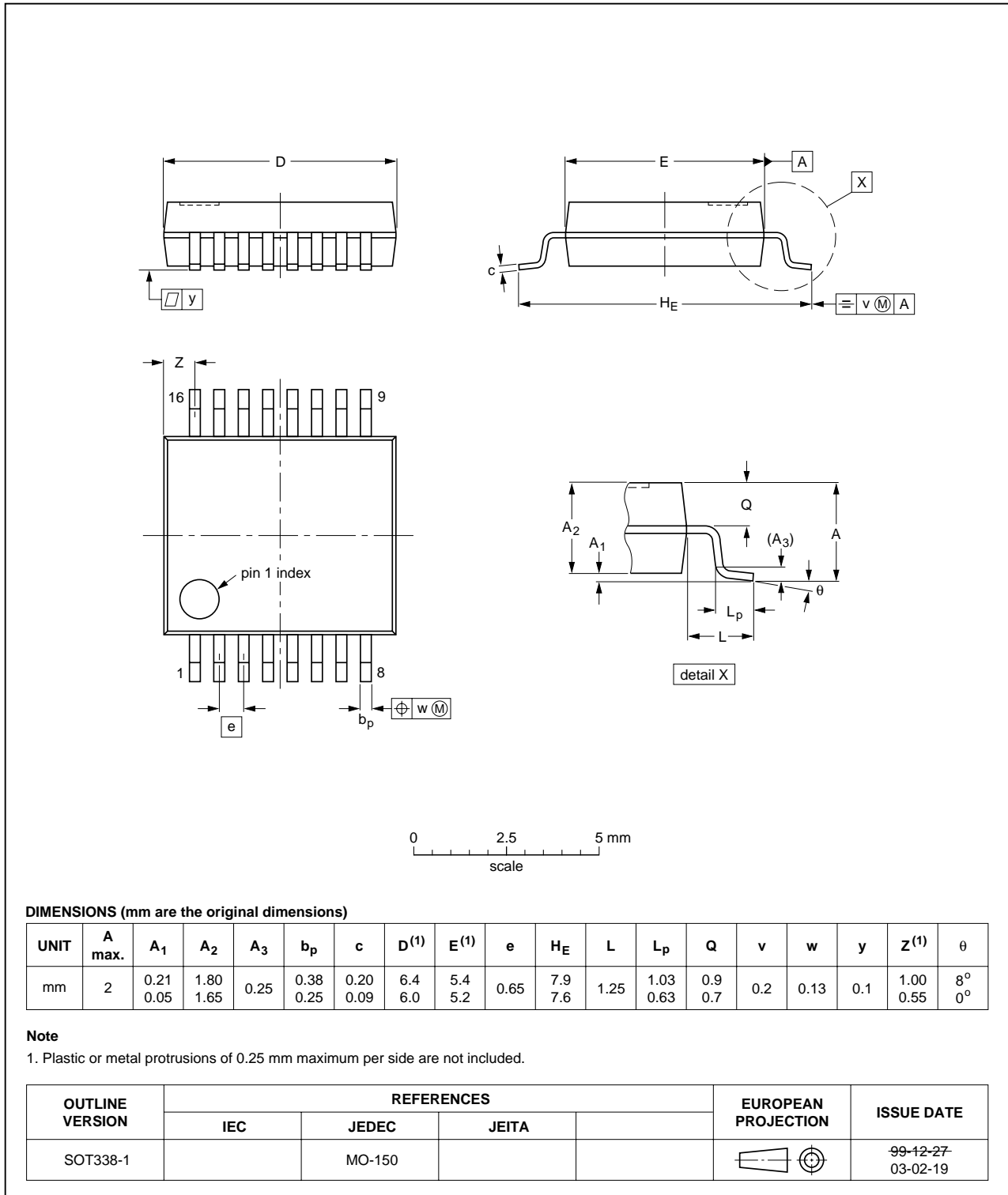


Fig 19. Package outline SOT338-1 (SSOP16)

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

SOT403-1

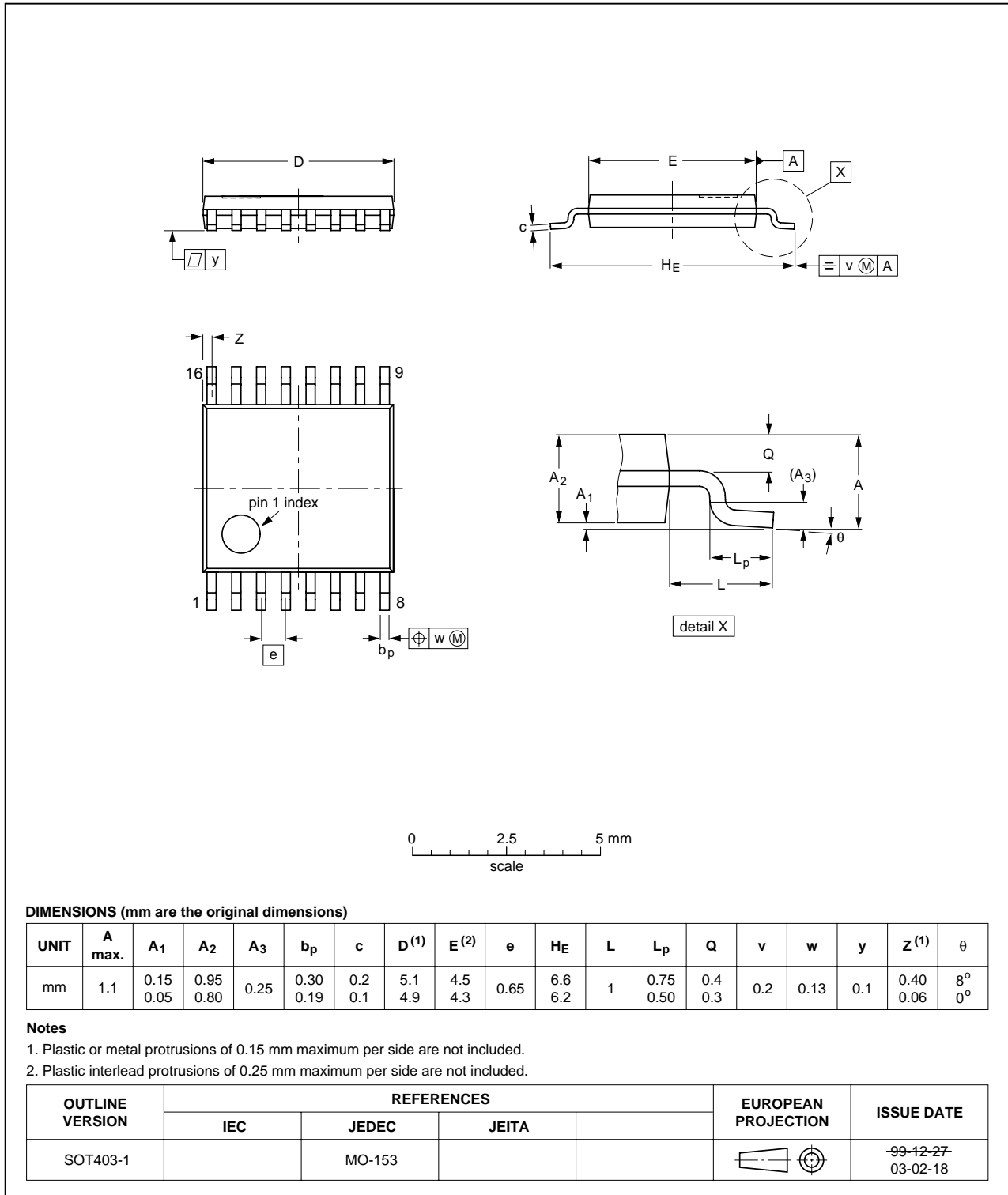


Fig 20. Package outline SOT403-1 (TSSOP16)

15. Revision history

Table 11: Revision history

Document ID	Release date	Data sheet status	Change notice	Doc. number	Supersedes
HEF4051B_4	20050112	Product data sheet	-	9397 750 14377	HEF4051B_CNV_3
Modifications:	<ul style="list-style-type: none"> The format of this data sheet has been redesigned to comply with the new presentation and information standard of Philips Semiconductors. Section 4 "Ordering information", and Section 14 "Package outline": Modified to include the SOT338-1 (SSOP16) and SOT403-1 (TSSOP16) packages and to remove the SOT74 (CDIP16) package 				
HEF4051B_CNV_3	19950101	Product specification	-	-	-

16. Data sheet status

Level	Data sheet status ^[1]	Product status ^[2] ^[3]	Definition
I	Objective data	Development	This data sheet contains data from the objective specification for product development. Philips Semiconductors reserves the right to change the specification in any manner without notice.
II	Preliminary data	Qualification	This data sheet contains data from the preliminary specification. Supplementary data will be published at a later date. Philips Semiconductors reserves the right to change the specification without notice, in order to improve the design and supply the best possible product.
III	Product data	Production	This data sheet contains data from the product specification. Philips Semiconductors reserves the right to make changes at any time in order to improve the design, manufacturing and supply. Relevant changes will be communicated via a Customer Product/Process Change Notification (CPCN).

[1] Please consult the most recently issued data sheet before initiating or completing a design.

[2] The product status of the device(s) described in this data sheet may have changed since this data sheet was published. The latest information is available on the Internet at URL <http://www.semiconductors.philips.com>.

[3] For data sheets describing multiple type numbers, the highest-level product status determines the data sheet status.

17. Definitions

Short-form specification — The data in a short-form specification is extracted from a full data sheet with the same type number and title. For detailed information see the relevant data sheet or data handbook.

Limiting values definition — Limiting values given are in accordance with the Absolute Maximum Rating System (IEC 60134). Stress above one or more of the limiting values may cause permanent damage to the device. These are stress ratings only and operation of the device at these or at any other conditions above those given in the Characteristics sections of the specification is not implied. Exposure to limiting values for extended periods may affect device reliability.

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

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