HEF4050B

Hex non-inverting buffers

Rev. 11 — 4 September 2024 Product data sheet

1. General description

The HEF4050B is a hex buffer with overvoltage tolerant inputs. Inputs are overvoltage tolerant to 15.0 V. This enables the device to be used in HIGH-to-LOW level shifiting applications.

2. Features and benefits

- Wide suply voltage range from 3.0 V to 15.0 V
- Overvoltage tolerant inputs 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

3. Applications

- LOCMOS (Local Oxidation CMOS) to DTL/TTL converter
- HIGH sink current for driving two TTL loads
- HIGH-to-LOW level logic conversion

4. Ordering information

Table 1. Ordering information

Type number		Package		
	Temperature range	Name	Description	Version
HEF4050BT	-40 °C to +85 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1

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5. Functional diagram

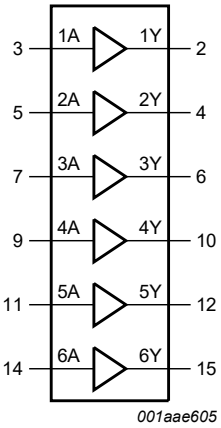


Fig. 1. Logic symbol

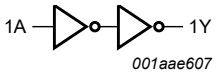


Fig. 2. Logic diagram for one gate

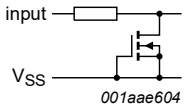


Fig. 3. Input protection circuit

6. Pinning information

6.1. Pinning

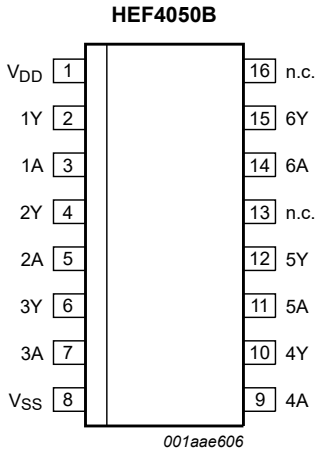


Fig. 4. Pin configuration SOT109-1 (SO16)

6.2. Pin description

Table 2. Pin description

Symbol	Pin	Description
V_{DD}	1	supply voltage
1Y, 2Y, 3Y, 4Y, 5Y, 6Y	2, 4, 6, 10, 12, 15	output
1A, 2A, 3A, 4A, 5A, 6A	3, 5, 7, 9, 11, 14,	input
V_{SS}	8	ground supply voltage
n.c.	13, 16	not connected

7. Functional description

Table 3. Guaranteed fan-out

Driven element	Guaranteed fan-out
Standard TTL	2
74 LS	9
74 L	16

8. Limiting values

Table 4. Limiting values

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

Symbol	Parameter	Conditions	Min	Max	Unit
V_{DD}	supply voltage		-0.5	+18	V
I_{IK}	input clamping current	V_I < -0.5 V	-10	-	mA
V_I	input voltage		-0.5	+18	V
I_{OK}	output clamping current	V_O < -0.5 V or V_O > V_{DD} + 0.5 V	-	±10	mA
$I_{I/O}$	input/output current		-	10	mA
I_{DD}	supply current		-	50	mA
T_{stg}	storage temperature		-65	+150	°C
T_{amb}	ambient temperature		-40	+85	°C
P_{tot}	total power dissipation	T_{amb} -40 °C to +85 °C	-	500	mW
P	power dissipation	per output	-	100	mW

9. Recommended operating conditions

Table 5. Recommended operating conditions

Symbol	Parameter	Conditions	Min	Max	Unit
V_{DD}	supply voltage		3	15	V
V_I	input voltage		0	15	V
T_{amb}	ambient temperature	in free air	-40	+85	°C
Δt/ΔV	input transition rise and fall rate	V_{DD} = 5 V	-	3.75	µs/V
		V_{DD} = 10 V	-	0.5	µs/V
		V_{DD} = 15 V	-	0.08	µs/V

10. Static characteristics

Table 6. Static characteristics

V_{SS} = 0 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		Unit
				Min	Max	Min	Max	Min	Max	
V_{IH}	HIGH-level input voltage	$\|I_O\|$ < 1 µA	5 V	3.5	-	3.5	-	3.5	-	V
			10 V	7.0	-	7.0	-	7.0	-	V
			15 V	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	V
			10 V	-	3.0	-	3.0	-	3.0	V
			15 V	-	4.0	-	4.0	-	4.0	V
V_{OH}	HIGH-level output voltage	$\|I_O\|$ < 1 µA	5 V	4.95	-	4.95	-	4.95	-	V
			10 V	9.95	-	9.95	-	9.95	-	V
			15 V	14.95	-	14.95	-	14.95	-	V
V_{OL}	LOW-level output voltage	$\|I_O\|$ < 1 µA	5 V	-	0.05	-	0.05	-	0.05	V
			10 V	-	0.05	-	0.05	-	0.05	V
			15 V	-	0.05	-	0.05	-	0.05	V
I_{OH}	HIGH-level output current	V_O = 2.5 V	5 V	-	-1.7	-	-1.4	-	-1.1	mA
		V_O = 4.6 V	5 V	-	-0.52	-	-0.44	-	-0.36	mA
		V_O = 9.5 V	10 V	-	-1.3	-	-1.1	-	-0.9	mA
		V_O = 13.5 V	15 V	-	-3.6	-	-3.0	-	-2.4	mA
I_{OL}	LOW-level output current	V_O = 0.4 V	4.75 V	3.5	-	2.9	-	2.3	-	mA
		V_O = 0.5 V	10 V	12.0	-	10.0	-	8.0	-	mA
		V_O = 1.5 V	15 V	24.0	-	20.0	-	16.0	-	mA
I_I	input leakage current		15 V	-	±0.3	-	±0.3	-	±1.0	µA
I_{DD}	supply current	I_O = 0 A	5 V	-	4.0	-	4.0	-	30	µA
			10 V	-	8.0	-	8.0	-	60	µA
			15 V	-	16.0	-	16.0	-	120	µA
C_I	input capacitance			-	-	-	7.5	-	-	pF

11. Dynamic characteristics

Table 7. Dynamic characteristics

V_{SS} = 0 V; T_{amb} = 25 °C unless otherwise specified; for test circuit see Fig. 6

Symbol	Parameter	Conditions	V_{DD}	Extrapolation formula [1]	Min	Typ	Max	Unit
t_{PHL}	HIGH to LOW propagation delay	nA to nY; see Fig. 5	5 V	26 ns + (0.18 ns/pF)C_L	-	35	70	ns
			10 V	16 ns + (0.08 ns/pF)C_L	-	20	35	ns
			15 V	12 ns + (0.05 ns/pF)C_L	-	15	30	ns
t_{PLH}	LOW to HIGH propagation delay	nA to nY; see Fig. 5	5 V	28 ns + (0.55 ns/pF)C_L	-	55	110	ns
			10 V	14 ns + (0.23 ns/pF)C_L	-	25	55	ns
			15 V	12 ns + (0.16 ns/pF)C_L	-	20	40	ns
t_{THL}	HIGH to LOW output transition time	see Fig. 5	5 V	7 ns + (0.35 ns/pF)C_L	-	25	50	ns
			10 V	3 ns + (0.14 ns/pF)C_L	-	10	20	ns
			15 V	2 ns + (0.09 ns/pF)C_L	-	7	14	ns
t_{TLH}	LOW to HIGH output transition time	see Fig. 5	5 V	10 ns + (1.00 ns/pF)C_L	-	60	120	ns
			10 V	9 ns + (0.42 ns/pF)C_L	-	30	60	ns
			15 V	6 ns + (0.28 ns/pF)C_L	-	20	40	ns

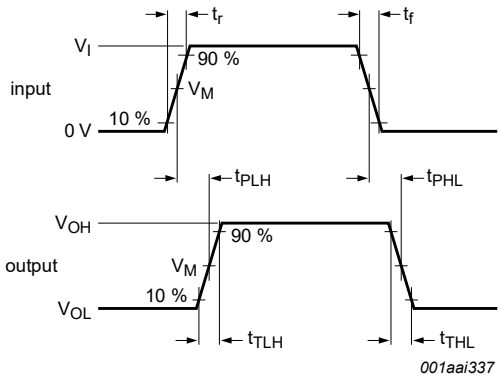
[1] The typical values of the propagation delay and transition times are calculated from the extrapolation formulas shown (C_L in pF).

Table 8. Dynamic power dissipation P_D

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

Symbol	Parameter	V_{DD}	Typical formula for P_D (µW)	where:
P_D	dynamic power dissipation	5 V	$P_D = 3800 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	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; $\Sigma(f_o \times C_L)$ = sum of the outputs.
		10 V	$P_D = 11600 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	
		15 V	$P_D = 65900 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	

11.1. Waveforms and test circuit



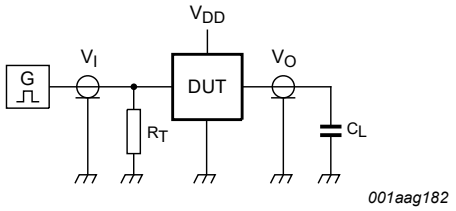
Measurement points are given in Table 9.

V_{OL} and V_{OH} are typical output voltage levels that occur with the output load.

Fig. 5. Input to output propagation delays

Table 9. Measurement points

Input		Output
V_M	V_I	V_M
0.5 × V_{DD}	0 V to V_{DD}	0.5 × V_{DD}



Test data is given in Table 10.

Definitions test circuit:

C_L = Load capacitance including jig and probe capacitance;

R_T = Termination resistance should be equal to output impedance Z_o of the pulse generator.

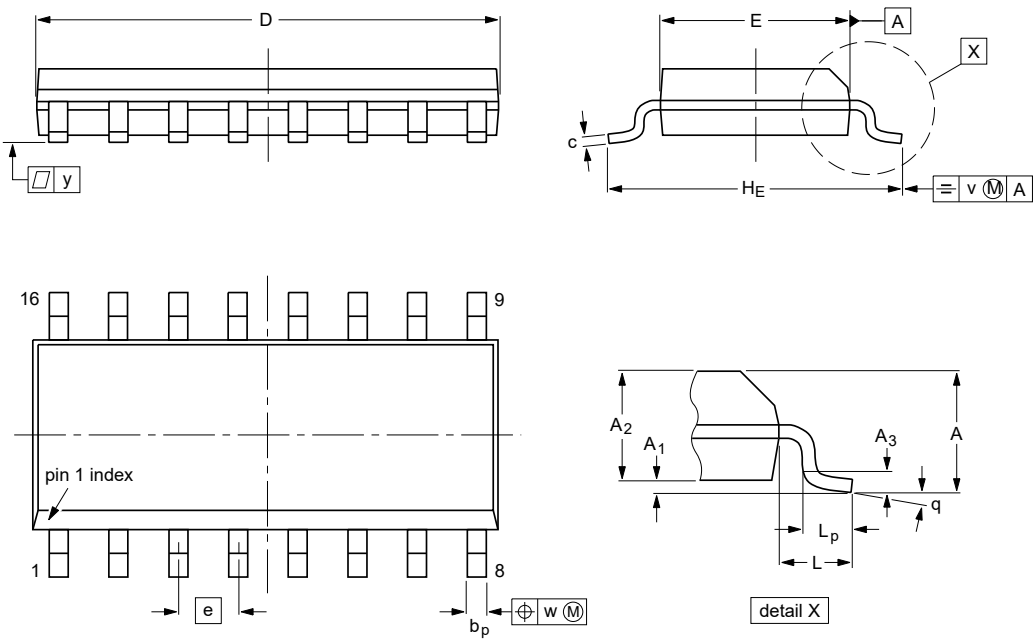
Fig. 6. Test circuit for measuring switching times

Table 10. Test data

Supply voltage	Input			Load
V_{DD}	V_I	V_M	t_r, t_f	C_L
5 V to 15 V	V_{DD}	0.5 × V_I	≤ 20 ns	50 pF

12. Package outline

SO16: plastic small outline package; 16 leads; body width 3.9 mm **SOT109-1**



Dimensions (inch dimensions are derived from the original mm dimensions)

Unit		A	A_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(1)}$	e	H_E	L	L_p	v	w	y	θ
mm	max	1.75	0.25			0.51	0.25	10.0	4.0		6.2		1.27				8°
	nom				0.25					1.27		1.05		0.2	0.25	0.1	
	min		0.10	1.25		0.31	0.10	9.8	3.8		5.8		0.4				0°
inches	max	0.069	0.010			0.020	0.010	0.394	0.16		0.244		0.05				8°
	nom				0.01					0.05		0.041		0.008	0.01	0.004	
	min		0.004	0.049		0.012	0.004	0.386	0.15		0.228		0.016				0°

Note
1. Plastic or metal protrusions of 0.15 mm (0.006 inch) maximum per side are not included.

sot109-1_po

Outline version	References			European projection	Issue date
	IEC	JEDEC	JEITA		
SOT109-1		MS-012			~~03-02-19~~ 23-10-27

Fig. 7. Package outline SOT109-1 (SO16)

13. Abbreviations

Table 11. Abbreviations

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

14. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF4050B v.11	20240904	Product data sheet	-	HEF4050B v.10
Modifications:	• Section 2: ESD specification updated according to the latest JEDEC standard. • Fig. 7: Aligned SO package outline drawing to JEDEC MS-012 • 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. • Section 1 updated.			
HEF4050B v.10	20160623	Product data sheet	-	HEF4050B v.9
Modifications:	• Table 4: condition for input clamping current changed (typo corrected). • Table 5: maximum value for input voltage changed (typo corrected).			
HEF4050B v.9	20160324	Product data sheet	-	HEF4050B v.8
Modifications:	• Type number HEF4050BP (SOT38-4) removed.			
HEF4050B v.8	20111118	Product data sheet	-	HEF4050B v.7
Modifications:	• Table 6: I_{OH} minimum values changed to maximum. • Table 11: DUT added.			
HEF4050B v.7	20091201	Product data sheet	-	HEF4050B v.6
HEF4050B v.6	20090723	Product data sheet	-	HEF4050B v.5
HEF4050B v.5	20081111	Product data sheet	-	HEF4050B v.4
HEF4050B v.4	20080702	Product data sheet	-	HEF4050B_CNV v.3
HEF4050B_CNV v.3	19950101	Product specification	-	HEF4050B_CNV v.2
HEF4050B_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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