

# HEF4050B

## Hex non-inverting buffers

Rev. 8 — 18 November 2011

Product data sheet

### 1. General description

The HEF4050B provides six non-inverting buffers with high current output capability suitable for driving TTL or high capacitive loads. Since input voltages in excess of the buffers' supply voltage are permitted, the buffers may also be used to convert logic levels of up to 15 V to standard TTL levels. Their guaranteed fan-out into common bipolar logic elements is shown in [Table 3](#).

It operates over a recommended  $V_{DD}$  power supply range of 3 V to 15 V referenced to  $V_{SS}$  (usually ground). Unused inputs must be connected to  $V_{DD}$ ,  $V_{SS}$ , or another input.

### 2. Features and benefits

- Accepts input voltages in excess of the supply voltage
- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Specified from  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$
- Complies with JEDEC standard JESD 13-B

### 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

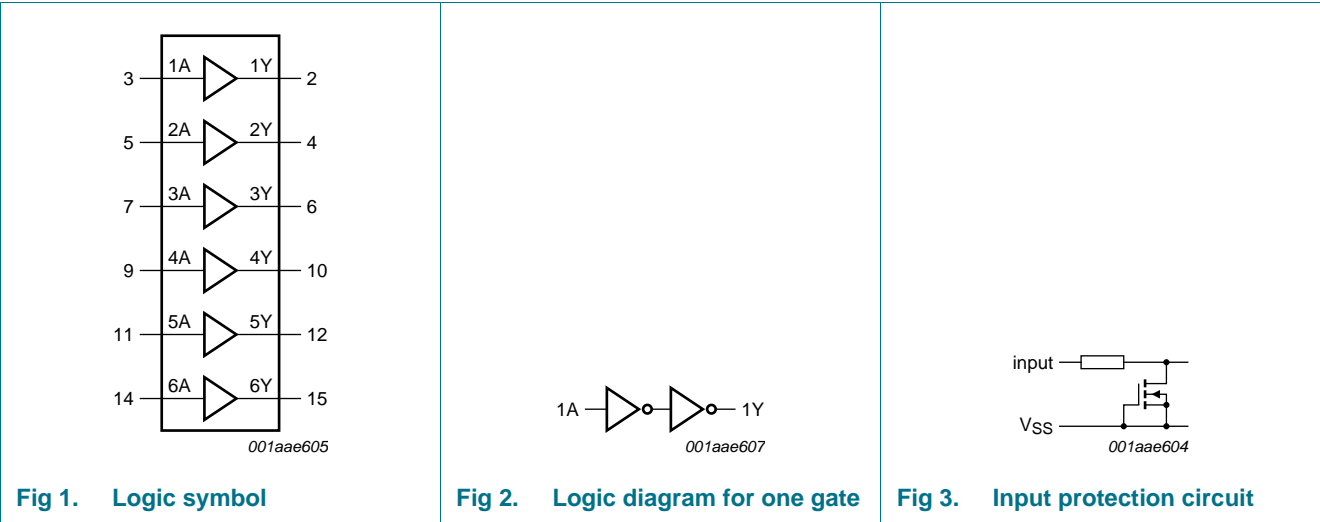
**Table 1. Ordering information**

All types operate from  $-40^{\circ}\text{C}$  to  $+85^{\circ}\text{C}$ .

Type number	Package		
	Name	Description	Version
HEF4050BP	DIP16	plastic dual in-line package; 16 leads (300 mil)	SOT38-4
HEF4050BT	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1

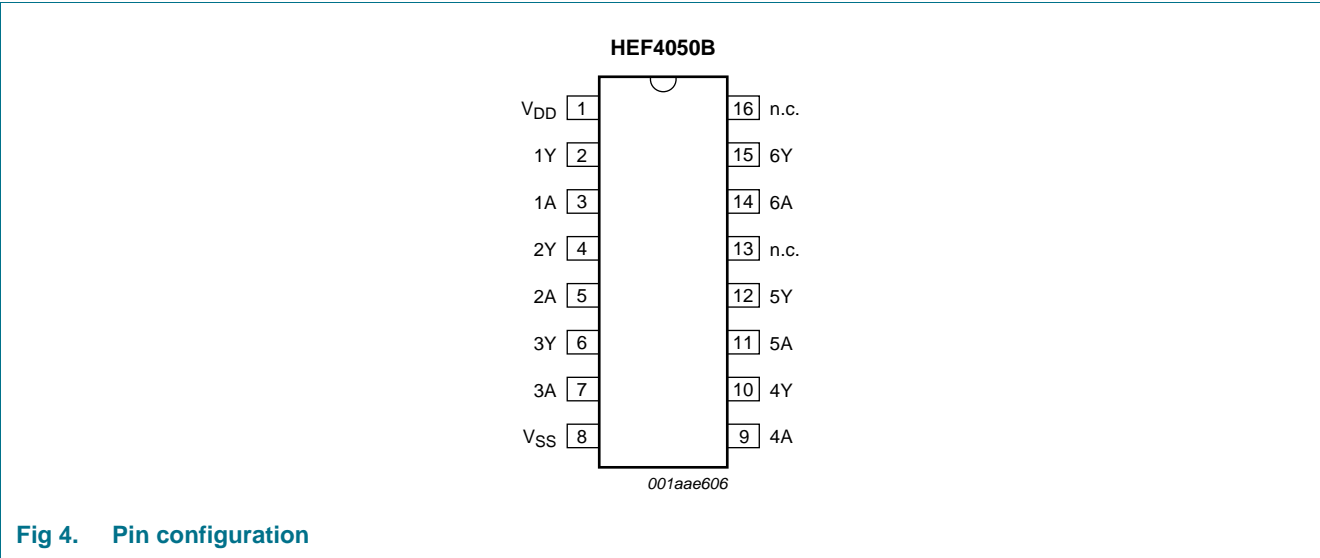


5. Functional diagram



6. Pinning information

6.1 Pinning



6.2 Pin description

Symbol	Pin	Description
V <sub>DD</sub>	1	supply voltage
1Y to 6Y	2, 4, 6, 10, 12, 15	output

Table 2. Pin description ...continued

Symbol	Pin	Description
1A to 6A	3, 5, 7, 9, 11, 14,	input
V <sub>SS</sub>	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 <sub>DD</sub>	supply voltage		-0.5	+18	V
I <sub>IK</sub>	input clamping current	V <sub>I</sub> < -0.5 V or V <sub>I</sub> > V <sub>DD</sub> + 0.5 V	-	±10	mA
V <sub>I</sub>	input voltage		-0.5	V <sub>DD</sub> + 0.5	V
I <sub>OK</sub>	output clamping current	V <sub>O</sub> < -0.5 V or V <sub>O</sub> > V <sub>DD</sub> + 0.5 V	-	±10	mA
I <sub>I/O</sub>	input/output current		-	10	mA
I <sub>DD</sub>	supply current		-	50	mA
T <sub>stg</sub>	storage temperature		-65	+150	°C
T <sub>amb</sub>	ambient temperature		-40	+85	°C
P <sub>tot</sub>	total power dissipation	T <sub>amb</sub> -40 °C to +85 °C			
		DIP16 package	[1] -	750	mW
		SO16 package	[2] -	500	mW
P	power dissipation	per output	-	100	mW

[1] For DIP16 package: P<sub>tot</sub> derates linearly with 12 mW/K above 70 °C.

[2] For SO16 package: P<sub>tot</sub> derates linearly with 8 mW/K above 70 °C.

## 9. Recommended operating conditions

Table 5. Recommended operating conditions

Symbol	Parameter	Conditions	Min	Max	Unit
V <sub>DD</sub>	supply voltage		3	15	V
V <sub>I</sub>	input voltage		0	V <sub>DD</sub>	V
T <sub>amb</sub>	ambient temperature	in free air	-40	+85	°C

Table 5. Recommended operating conditions ...continued

Symbol	Parameter	Conditions	Min	Max	Unit
$\Delta t/\Delta V$	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	$\mu\text{s/V}$

## 10. Static characteristics

Table 6. Static characteristics

$V_{SS} = 0\text{ V}$ ;  $V_I = V_{SS}$  or  $V_{DD}$  unless otherwise specified.

Symbol	Parameter	Conditions	$V_{DD}$	$T_{\text{amb}} = -40\text{ }^{\circ}\text{C}$		$T_{\text{amb}} = 25\text{ }^{\circ}\text{C}$		$T_{\text{amb}} = 85\text{ }^{\circ}\text{C}$		Unit
				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	-	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\text{ }\mu\text{A}$	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\text{ }\mu\text{A}$	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\text{ }\mu\text{A}$	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	$V_O = 2.5\text{ V}$	5 V	-	-1.7	-	-1.4	-	-1.1	mA
		$V_O = 4.6\text{ V}$	5 V	-	-0.52	-	-0.44	-	-0.36	mA
		$V_O = 9.5\text{ V}$	10 V	-	-1.3	-	-1.1	-	-0.9	mA
		$V_O = 13.5\text{ V}$	15 V	-	-3.6	-	-3.0	-	-2.4	mA
$I_{OL}$	LOW-level output current	$V_O = 0.4\text{ V}$	4.75 V	3.5	-	2.9	-	2.3	-	mA
		$V_O = 0.5\text{ V}$	10 V	12.0	-	10.0	-	8.0	-	mA
		$V_O = 1.5\text{ V}$	15 V	24.0	-	20.0	-	16.0	-	mA
$I_I$	input leakage current		15 V	-	$\pm 0.3$	-	$\pm 0.3$	-	$\pm 1.0$	$\mu\text{A}$
$I_{DD}$	supply current	$I_O = 0\text{ A}$	5 V	-	4.0	-	4.0	-	30	$\mu\text{A}$
			10 V	-	8.0	-	8.0	-	60	$\mu\text{A}$
			15 V	-	16.0	-	16.0	-	120	$\mu\text{A}$
$C_I$	input capacitance			-	-	-	7.5	-	-	pF

## 11. Dynamic characteristics

**Table 7. Dynamic characteristics**

$V_{SS} = 0\text{ V}$ ;  $T_{amb} = 25\text{ °C}$ ; for test circuit see [Figure 6](#); unless otherwise specified.

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

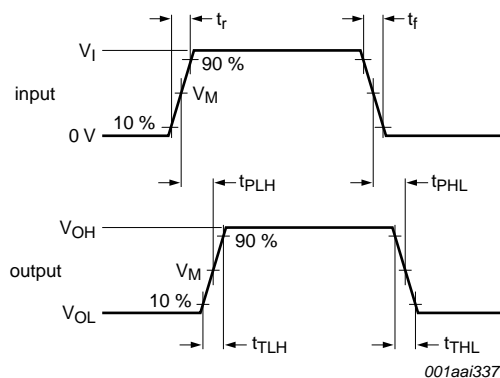
[1] The typical values of the propagation delay and transition times are calculated from the extrapolation formulas shown ( $C_L$  in pF).

**Table 8. Dynamic power dissipation  $P_D$**

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

Symbol	Parameter	$V_{DD}$	Typical formula for $P_D$ ( $\mu\text{W}$ )	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,
		10 V	$P_D = 11600 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	$f_o$ = output frequency in MHz,
		15 V	$P_D = 65900 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	$C_L$ = output load capacitance in pF, $V_{DD}$ = supply voltage in V, $\Sigma(f_o \times C_L)$ = sum of the outputs.

12. Waveforms

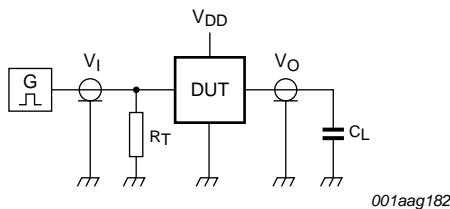


Measurement points are given in [Table 9](#).  
 $V_{OL}$  and  $V_{OH}$  are typical output voltage levels that occur with the output load.

Fig 5. Input to output propagation delays

Table 9. Measurement points

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



Test data is given in [Table 10](#).  
Definitions for 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 switching times

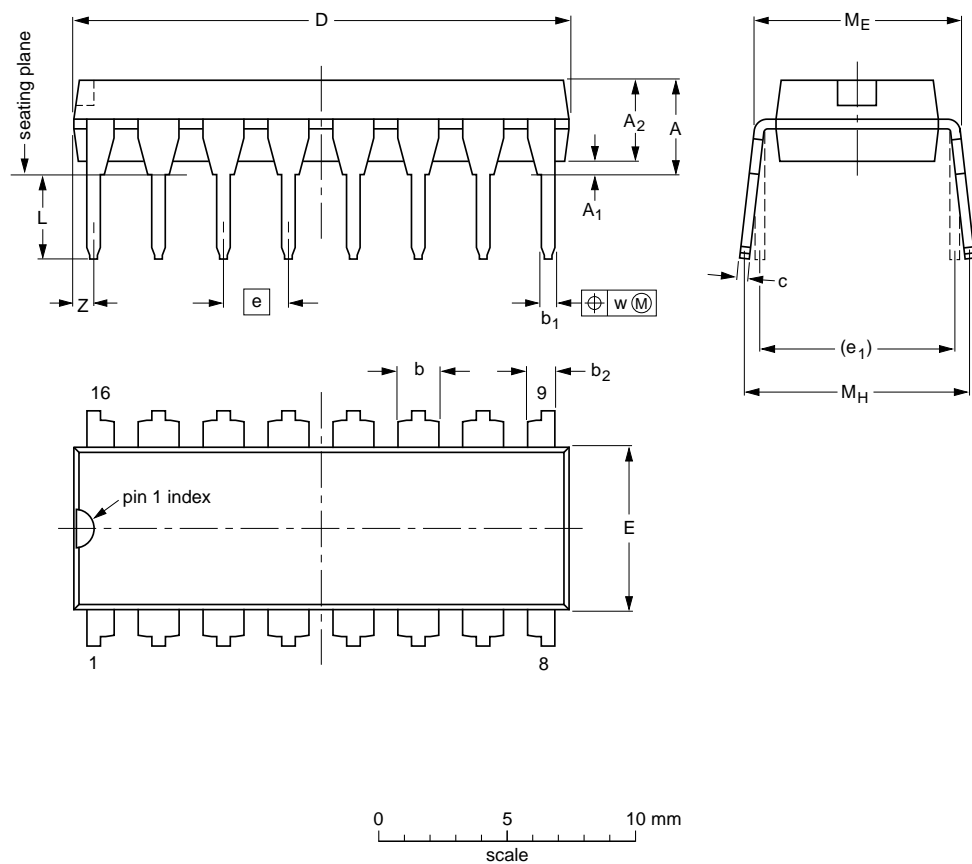
Table 10. Test data

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

13. Package outline

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

SOT38-4



DIMENSIONS (inch dimensions are derived from the original mm dimensions)																
UNIT	A max.	A <sub>1</sub> min.	A <sub>2</sub> max.	b	b <sub>1</sub>	b <sub>2</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	e <sub>1</sub>	L	M <sub>E</sub>	M <sub>H</sub>	w	Z <sup>(1)</sup> max.
mm	4.2	0.51	3.2	1.73 1.30	0.53 0.38	1.25 0.85	0.36 0.23	19.50 18.55	6.48 6.20	2.54	7.62	3.60 3.05	8.25 7.80	10.0 8.3	0.254	0.76
inches	0.17	0.02	0.13	0.068 0.051	0.021 0.015	0.049 0.033	0.014 0.009	0.77 0.73	0.26 0.24	0.1	0.3	0.14 0.12	0.32 0.31	0.39 0.33	0.01	0.03

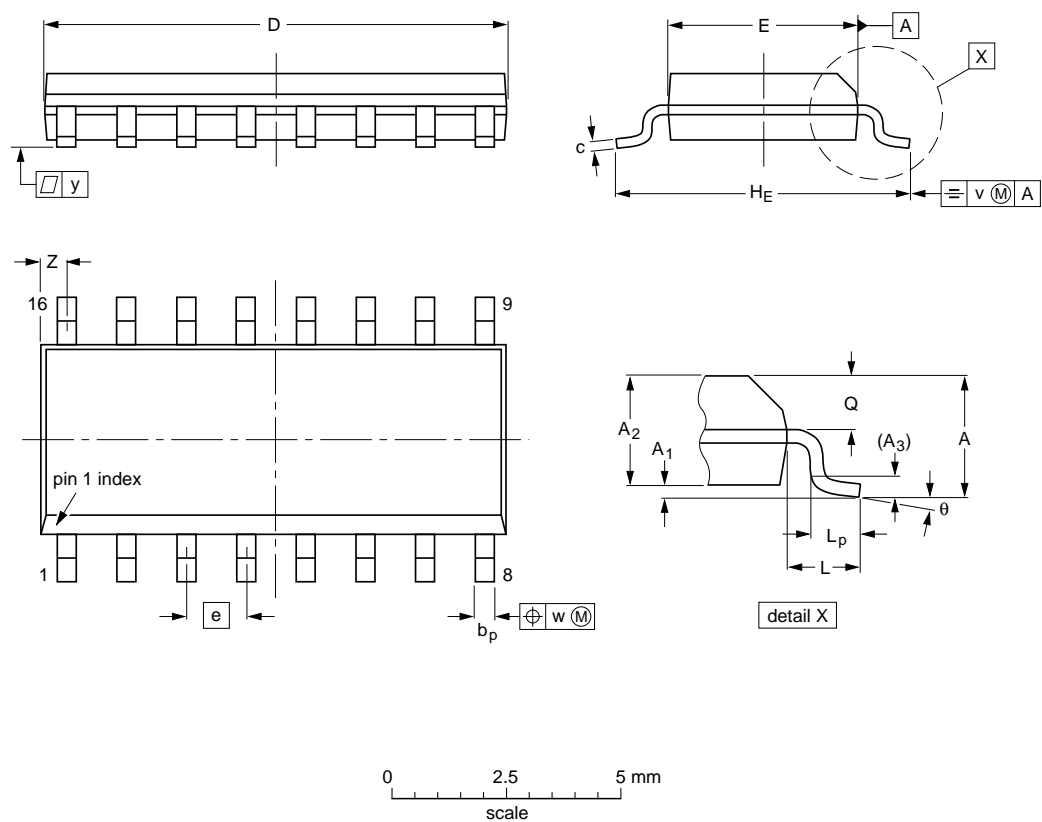
**Note**  
1. Plastic or metal protrusions of 0.25 mm (0.01 inch) maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT38-4						95-01-14 03-02-13

Fig 7. Package outline SOT38-4 (DIP16)

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 max.	A <sub>1</sub>	A <sub>2</sub>	A <sub>3</sub>	b <sub>p</sub>	c	D <sup>(1)</sup>	E <sup>(1)</sup>	e	H <sub>E</sub>	L	L <sub>p</sub>	Q	v	w	y	z <sup>(1)</sup>	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	10.0 9.8	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8° 0°
inches	0.069	0.010 0.004	0.057 0.049	0.01	0.019 0.014	0.0100 0.0075	0.39 0.38	0.16 0.15	0.05	0.244 0.228	0.041	0.039 0.016	0.028 0.020	0.01	0.01	0.004	0.028 0.012	

Note

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

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT109-1	076E07	MS-012				99-12-27 03-02-19

Fig 8. Package outline SOT109-1 (SO16)

## 14. Abbreviations

Table 11. Abbreviations

Acronym	Description
DTL	Diode Transistor Logic
DUT	Device Under Test
LOC MOS	Local Oxidation CMOS
TTL	Transistor-Transistor Logic

## 15. Revision history

Table 12. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF4050B v.8	20111118	Product data sheet	-	HEF4050B v.7
Modifications:	<ul style="list-style-type: none"><li>• <a href="#">Table 6</a>: <math>I_{OH}</math> minimum values changed to maximum</li><li>• <a href="#">Table 11</a>: DUT added</li></ul>			
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	-	-

## 16. Legal information

### 16.1 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".

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