HEF40175B

Quad D-type flip-flop

Rev. 6 — 14 December 2010 **Product data sheet**

1. General description

The HEF40175B is a quad edge-triggered D-type flip-flop with four data inputs (D0 to D3), a clock input (CP), an overriding asynchronous master reset input ($\overline{MR}$), four buffered outputs (Q0 to Q3), and four complementary buffered outputs ($\overline{Q0}$ to $\overline{Q3}$). Information on D0 to D3 is transferred to Q0 to Q3 on the LOW-to-HIGH transition of CP if $\overline{MR}$ is HIGH. When LOW, $\overline{MR}$ resets all flip-flops (Q0 to Q3 = LOW; $\overline{Q0}$ to $\overline{Q3}$ = HIGH), independent of CP and D0 to D3.

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. It is also suitable for use over the full industrial (−40 °C to +85 °C) temperature range.

2. Features and benefits

- Fully static operation
- 5 V, 10 V, and 15 V parametric ratings
- Standardized symmetrical output characteristics
- Operates across the full industrial temperature range from −40 °C to +85 °C
- Complies with JEDEC standard JESD 13-B

3. Applications

- Industrial
- Shift registers
- Buffer/storage register
- Pattern generator

4. Ordering information

Table 1. Ordering information

All types operate from −40 °C to +85 °C.

Type number	Package		
	Name	Description	Version
HEF40175BP	DIP16	plastic dual in-line package; 16 leads (300 mil)	SOT38-4
HEF40175BT	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
HEF40175BTT	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1

5. Functional diagram

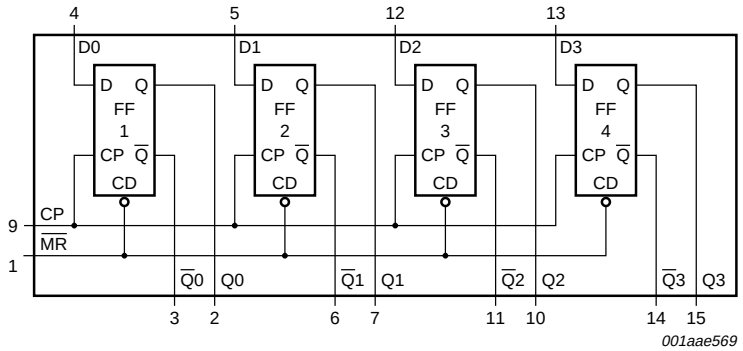


Fig 1. Functional diagram

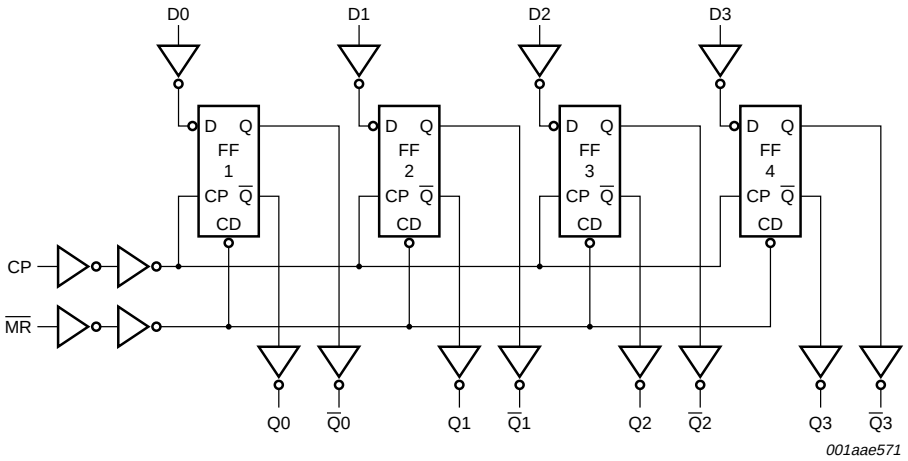


Fig 2. Logic diagram

6. Pinning information

6.1 Pinning

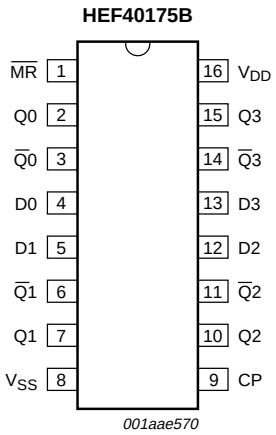


Fig 3. Pin configuration SOT38-4 and SOT109-1

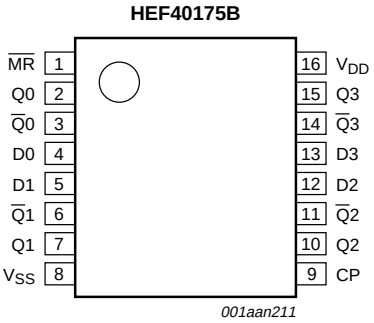


Fig 4. Pin configuration SOT403-1

6.2 Pin description

Table 2. Pin description

Symbol	Pin	Description
$\overline{MR}$	1	master reset input (active LOW)
Q0 to Q3	2, 7, 10, 15	buffered output
$\overline{Q0}$ to $\overline{Q3}$	3, 6, 11, 14	complementary buffered output
D0 to D3	4, 5, 12, 13	data input
V_{SS}	8	ground supply voltage
CP	9	clock input (LOW-to-HIGH edge-triggered)
V_{DD}	16	supply voltage

7. Functional description

Table 3. Function table [1]

Input			Output	
CP	Dn	$\overline{MR}$	Qn	Qn
↑	H	H	H	L
↑	L	H	L	H
↓	X	H	no change	no change
X	X	L	L	H

[1] H = HIGH voltage level; L = LOW voltage level; X = don't care; ↑ = positive-going transition; ↓ = negative-going transition.

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 or $V_I > V_{DD} + 0.5$ V		-	±10	mA
V_I	input voltage			–0.5	$V_{DD} + 0.5$	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	DIP16 package	[1]	-	750	mW
		SO16 package	[2]	-	500	mW
		TSSOP16 package	[3]	-	500	mW
P	power dissipation	per output		-	100	mW

[1] For DIP16 package: P_{tot} derates linearly with 12 mW/K above 70 °C.

[2] For SO16 package: P_{tot} derates linearly with 8 mW/K above 70 °C.

[3] 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		3	-	15	V
V_I	input voltage		0	-	V_{DD}	V
T_{amb}	ambient temperature	in free air	–40	-	+85	°C
$\Delta t/\Delta V$	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	5 V	0.52	-	0.44	-	0.36	-	mA
		V_O = 0.5 V	10 V	1.3	-	1.1	-	0.9	-	mA
		V_O = 1.5 V	15 V	3.6	-	3.0	-	2.4	-	mA
I_I	input leakage current		15 V	-	±0.3	-	±0.3	-	±1.0	μA
I_{DD}	supply current	all valid input combinations; $\|I_O\|$ < 1 μA	5 V	-	20	-	20	-	150	μA
			10 V	-	40	-	40	-	300	μA
			15 V	-	80	-	80	-	600	μA
C_I	input capacitance		-	-	-	-	7.5	-	-	pF

11. Dynamic characteristics

Table 7. Dynamic characteristics

V_{SS} = 0 V; T_{amb} = 25 °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	CP to Qn or $\overline{Qn}$; see Figure 5	5 V	53 ns + (0.55 ns/pF) C_L	-	80	160	ns
			10 V	24 ns + (0.23 ns/pF) C_L	-	35	70	ns
			15 V	17 ns + (0.16 ns/pF) C_L	-	25	50	ns
		$\overline{MR}$ to Qn; see Figure 5	5 V	48 ns + (0.55 ns/pF) C_L	-	75	155	ns
			10 V	19 ns + (0.23 ns/pF) C_L	-	30	65	ns
			15 V	17 ns + (0.16 ns/pF) C_L	-	25	50	ns

Table 7. Dynamic characteristics *...continued*

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

Symbol	Parameter	Conditions	V_{DD}		Extrapolation formula	Min	Typ	Max	Unit
t_{PLH}	LOW to HIGH propagation delay	CP to Qn or $\overline{Qn}$; see Figure 5	5 V	[1]	43 ns + (0.55 ns/pF) C_L	-	70	140	ns
			10 V		19 ns + (0.23 ns/pF) C_L	-	30	65	ns
			15 V		17 ns + (0.16 ns/pF) C_L	-	25	45	ns
		$\overline{MR}$ to $\overline{Qn}$; see Figure 5	5 V		43 ns + (0.55 ns/pF) C_L	-	70	140	ns
			10 V		19 ns + (0.23 ns/pF) C_L	-	30	65	ns
			15 V		17 ns + (0.16 ns/pF) C_L	-	25	50	ns
t_t	transition time	see Figure 5	5 V	[1]	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
t_{su}	set-up time	Dn to CP; see Figure 5	5 V			60	30	-	ns
			10 V			20	10	-	ns
			15 V			15	5	-	ns
t_h	hold time	Dn to CP; see Figure 5	5 V			+25	−5	-	ns
			10 V			10	0	-	ns
			15 V			10	0	-	ns
t_W	pulse width;	CP input LOW; minimum pulse width see Figure 5	5 V			90	45	-	ns
			10 V			35	15	-	ns
			15 V			25	10	-	ns
		$\overline{MR}$ input LOW; minimum pulse width see Figure 5	5 V			80	40	-	ns
			10 V			30	15	-	ns
			15 V			20	10	-	ns
t_{rec}	recovery time	$\overline{MR}$ input; see Figure 5	5 V			0	−30	-	ns
			10 V			0	−20	-	ns
			15 V			0	−15	-	ns
f_{max}	maximum frequency		5 V			5	11	-	MHz
			10 V			15	30	-	MHz
			15 V			20	45	-	MHz

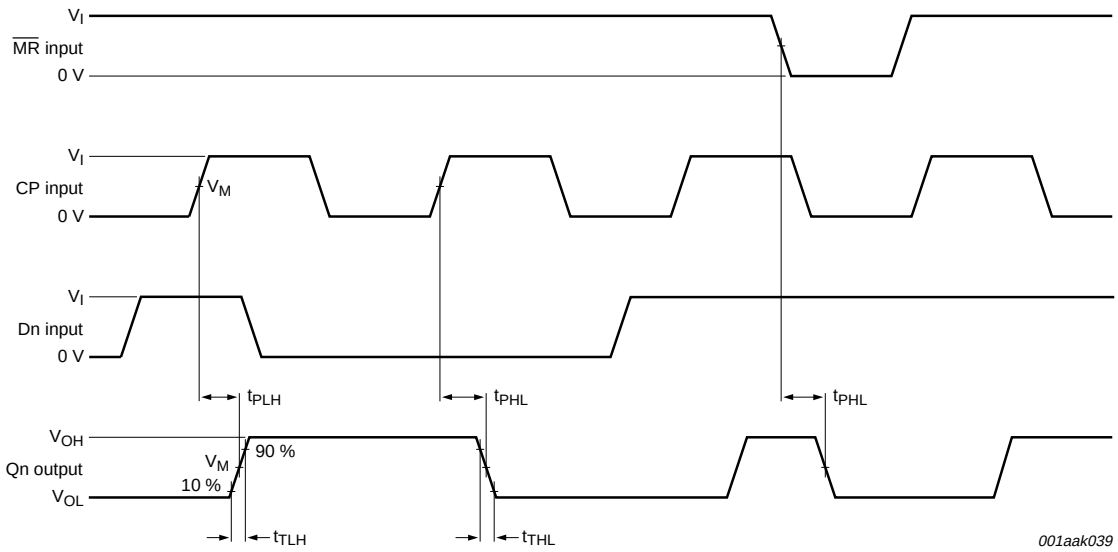
[1] The typical values of the propagation delay and transition times are calculated from the extrapolation formula shown (C_L in pF).

Table 8. Dynamic power dissipation P_D

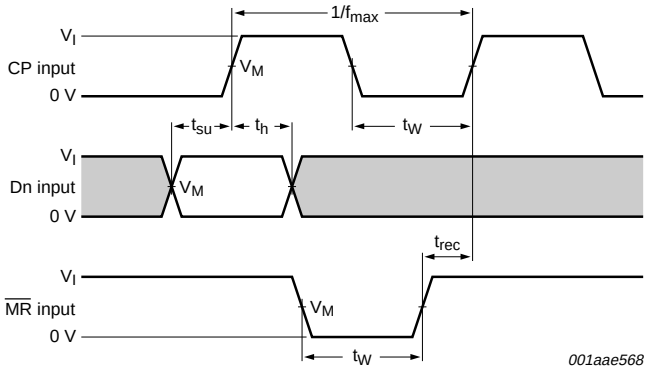
P_D can be calculated from the formulas shown. V_{SS} = 0 V; $t_r = t_f \leq 20$ ns; T_{amb} = 25 °C.

Symbol	Parameter	V_{DD}	Typical formula for P_D (μW)	where:
P_D	dynamic power dissipation	5 V	$P_D = 2000 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	f_i = input frequency in MHz,
		10 V	$P_D = 8400 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	f_o = output frequency in MHz,
		15 V	$P_D = 22500 \times f_i + \Sigma(f_o \times C_L) \times V_{DD}^2$	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



a. CP and $\overline{MR}$ to Qn Propagation delays and Qn transition times



b. Minimum pulse widths for CP and $\overline{MR}$, $\overline{MR}$ to CP recovery time, and set-up and hold time for Dn to CP

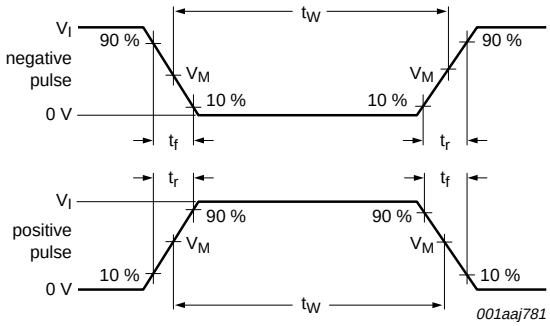
V_{OH} and V_{OL} are typical output voltage levels that occur with the output load.

Set-up and hold times are shown as positive values but may be specified as negative values.

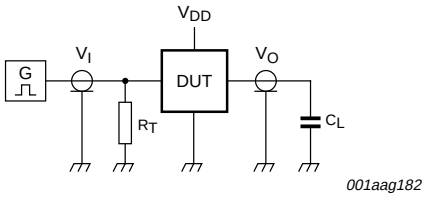
The shaded area are where input changes result in predicable output performance.

Measurement points are given in Table 9.

Fig 5. Waveforms showing switching times



a. Input waveforms



b. Test circuit

Test and measurement data is given in Table 9

Definitions test circuit:

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 jig and probe capacitance.

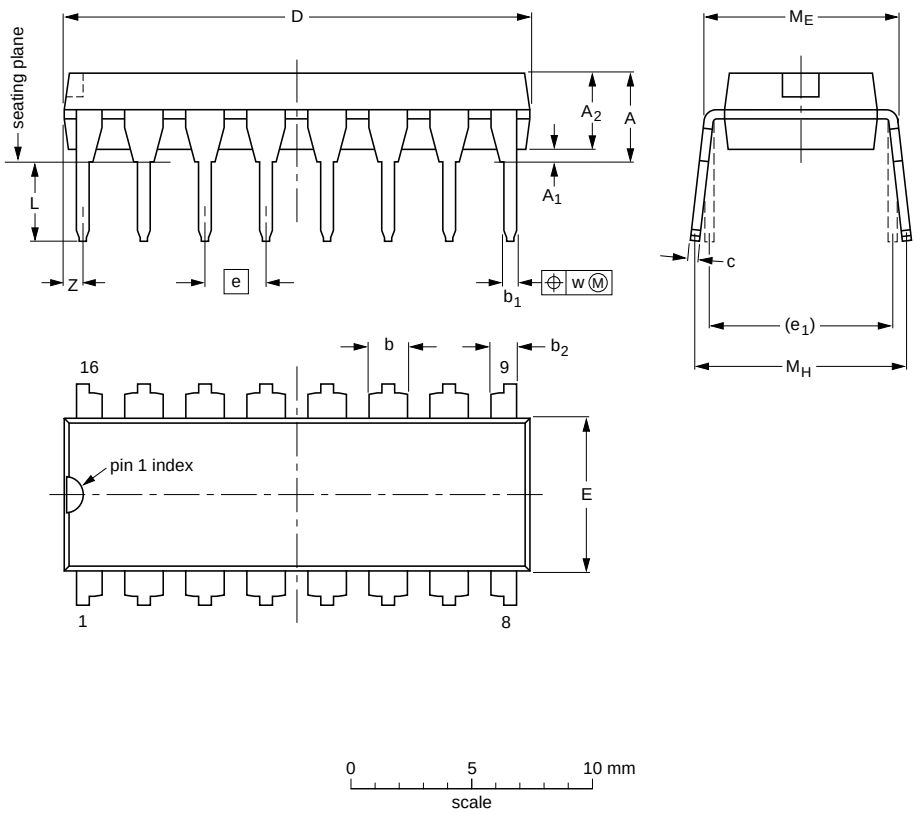
Fig 6. Test circuit for measuring switching times

Table 9. Measurement points and test data

Supply voltage	Input		Load
V_{DD}	V_I	t_r, t_f	C_L
5 V to 15 V	V_{SS} or V_{DD}	≤ 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_1 min.	A_2 max.	b	b_1	b_2	c	D (1)	E (1)	e	e_1	L	M_E	M_H	w	Z (1) 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

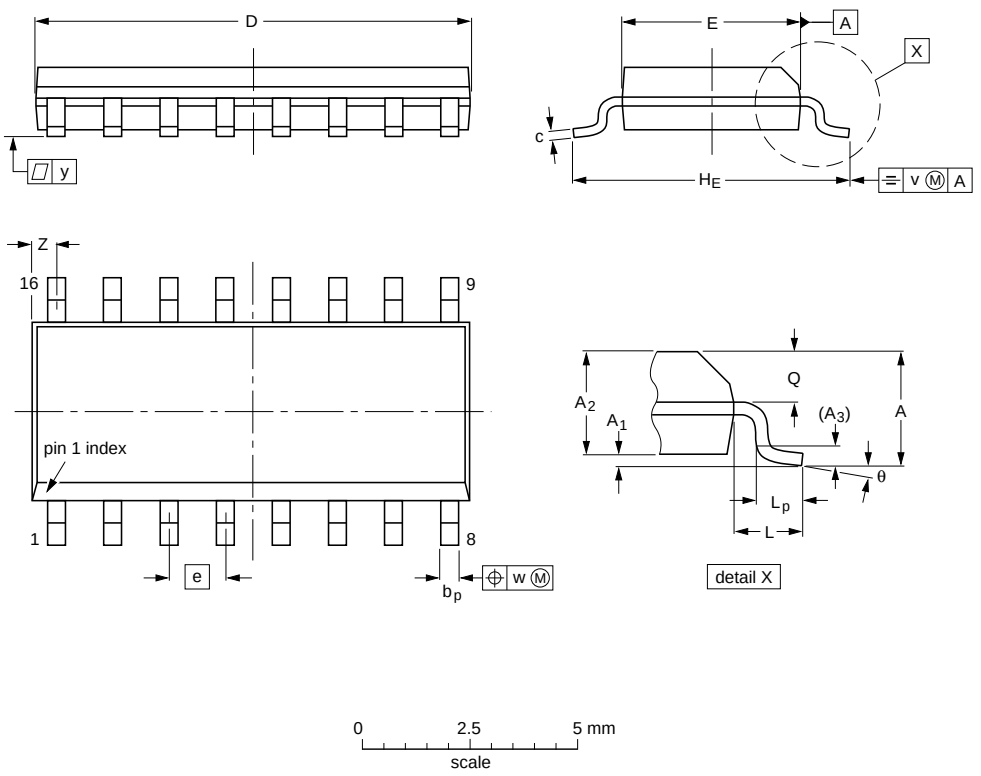
Note

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_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(1)}$	e	H_E	L	L_p	Q	v	w	y	$Z^{(1)}$	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^o 0^o
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	

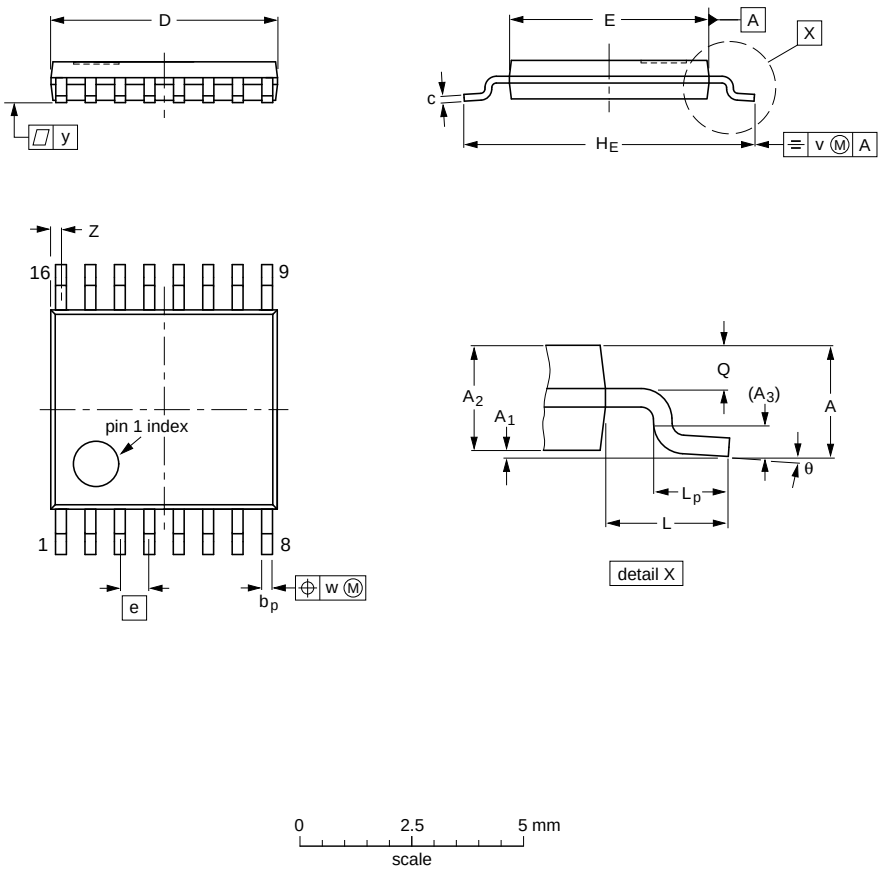
Note

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)

TSSOP16: plastic thin shrink small outline package; 16 leads; body width 4.4 mm **SOT403-1**



DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A_1	A_2	A_3	b_p	c	D (1)	E (2)	e	H_E	L	L_p	Q	v	w	y	Z (1)	θ
mm	1.1	0.15 0.05	0.95 0.80	0.25	0.30 0.19	0.2 0.1	5.1 4.9	4.5 4.3	0.65	6.6 6.2	1	0.75 0.50	0.4 0.3	0.2	0.13	0.1	0.40 0.06	8^o 0^o

Notes

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic interlead protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	JEITA			
SOT403-1		MO-153				~~99-12-27~~ 03-02-18

Fig 9. Package outline SOT403-1 (TSSOP16)

14. Revision history

Table 10. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
HEF40175B v.6	20101214	Product data sheet	-	HEF40175B v.5
Modifications:	• Added type number HEF40175BTT (SOT403-1 package).			
HEF40175B v.5	20100105	Product data sheet	-	HEF40175B v.4
Modifications:	• Section 2 “Features and benefits” $\Delta t/\Delta V$ values updated.			
HEF40175B v.4	20090813	Product data sheet	-	HEF40175B_CNV v.3
HEF40175B_CNV v.3	19950101	Product specification	-	HEF40175B_CNV v.2
HEF40175B_CNV v.2	19950101	Product specification	-	-

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.nxp.com.

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