

74HC85; 74HCT85

4-bit magnitude comparator

Rev. 4 — 4 August 2021

Product data sheet

1. General description

The 74HC85; 74HCT85 is a 4-bit magnitude comparator that can be expanded to almost any length. They perform comparison of two 4-bit binary, BCD or other monotonic codes and present the three possible magnitude results at the outputs ($Q_{A>B}$, $Q_{A=B}$ and $Q_{A<B}$). The 4-bit inputs are weighted (A0 to A3 and B0 to B3), where A3 and B3 are the most significant bits. For proper compare operation the expander inputs ($I_{A>B}$, $I_{A=B}$ and $I_{A<B}$) to the least significant position must be connected as follows: $I_{A<B} = I_{A>B} = \text{LOW}$ and $I_{A=B} = \text{HIGH}$. For words greater than 4-bits, units can be cascaded by connecting outputs $Q_{A>B}$, $Q_{A=B}$ and $Q_{A<B}$ to the corresponding inputs of the significant comparator. 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 2.0 to 6.0 V
- CMOS low power dissipation
- High noise immunity
- Latch-up performance exceeds 100 mA per JESD 78 Class II Level B
- Input levels:
 - For 74HC85: CMOS level
 - For 74HCT85: TTL level
- Complies with JEDEC standards:
 - JESD8C (2.7 V to 3.6 V)
 - JESD7A (2.0 V to 6.0 V)
- ESD protection:
 - HBM JESD22-A114-A exceeds 2000 V
 - MM JESD22-A115-A exceeds 200 V
- Specified from -40 °C to +85 °C and from -40 °C to +125 °C

3. Applications

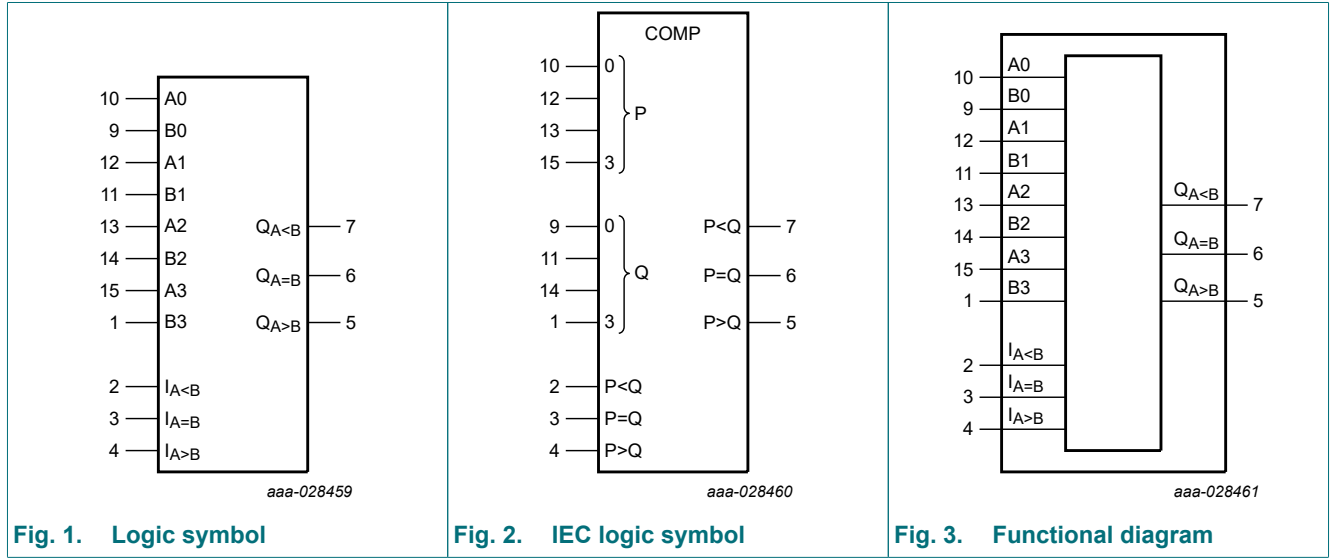
- Process controllers
- Servo-motor control

4. Ordering information

Table 1. Ordering information

Type number	Package			Version
	Temperature range	Name	Description	
74HC85D	-40 °C to +125 °C	SO16	plastic small outline package; 16 leads; body width 3.9 mm	SOT109-1
74HCT85D				
74HC85PW	-40 °C to +125 °C	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm	SOT403-1
74HCT85PW				

5. Functional diagram



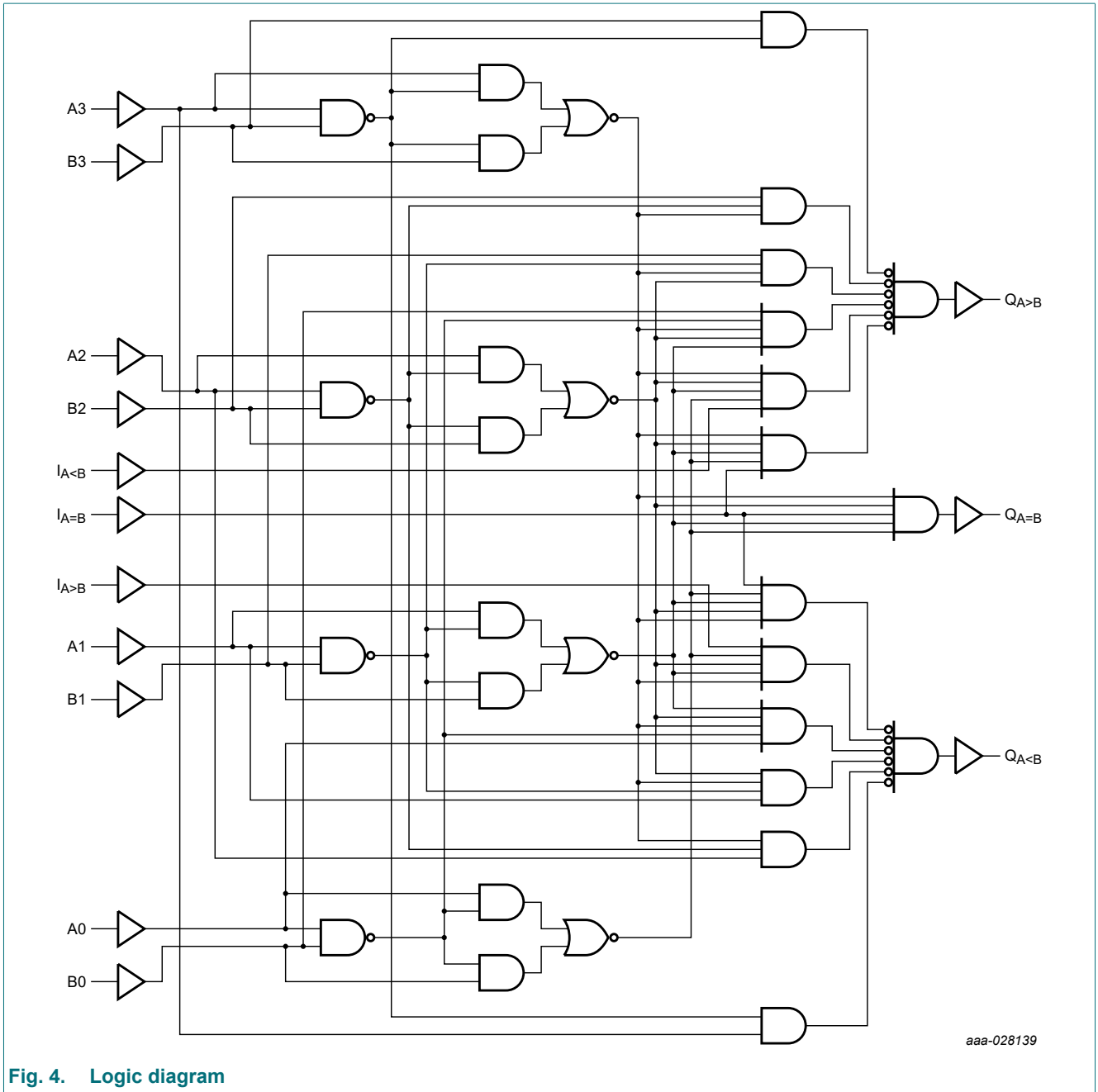


Fig. 4. Logic diagram

6. Pinning information

6.1. Pinning

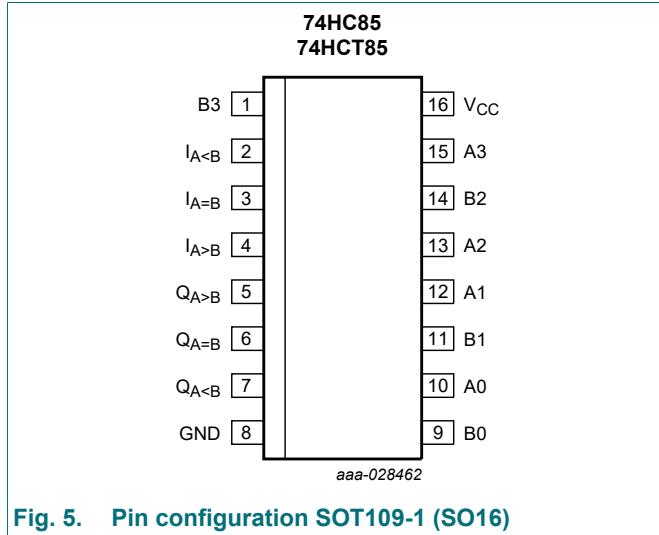


Fig. 5. Pin configuration SOT109-1 (SO16)

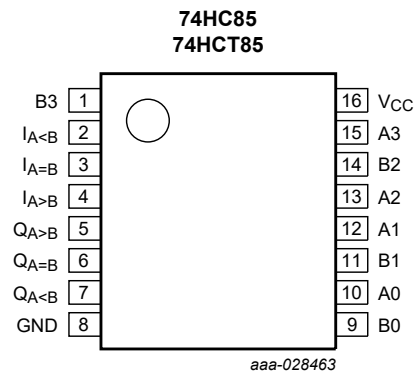


Fig. 6. Pin configuration SOT403-1 (TSSOP16)

6.2. Pin description

Table 2. Pin description

Symbol	Pin	Description
$I_{A<B}$	2	A<B expansion input
$I_{A=B}$	3	A=B expansion input
$I_{A>B}$	4	A>B expansion input
$Q_{A>B}$	5	A>B output
$Q_{A=B}$	6	A=B output
$Q_{A<B}$	7	A<B output
A0, A1, A2, A3	10, 12, 13, 15	word A inputs
B0, B1, B2, B3	9, 11, 14, 1	word B inputs
GND	8	ground (0 V)
V_{CC}	16	supply voltage

7. Functional description

Table 3. Function table

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

Comparing inputs				Cascading inputs			Outputs		
A3, B3	A2, B2	A1, B1	A0, B0	I _{A>B}	I _{A<B}	I _{A=B}	Q _{A>B}	Q _{A<B}	Q _{A=B}
A3 > B3	X	X	X	X	X	X	H	L	L
A3 < B3	X	X	X	X	X	X	L	H	L
A3 = B3	A2 > B2	X	X	X	X	X	H	L	L
A3 = B3	A2 < B2	X	X	X	X	X	L	H	L
A3 = B3	A2 = B2	A1 > B1	X	X	X	X	H	L	L
A3 = B3	A2 = B2	A1 < B1	X	X	X	X	L	H	L
A3 = B3	A2 = B2	A1 = B1	A0 > B0	X	X	X	H	L	L
A3 = B3	A2 = B2	A1 = B1	A0 < B0	X	X	X	L	H	L
A3 = B3	A2 = B2	A1 = B1	A0 = B0	H	L	L	H	L	L
A3 = B3	A2 = B2	A1 = B1	A0 = B0	L	H	L	L	H	L
A3 = B3	A2 = B2	A1 = B1	A0 = B0	L	L	H	L	L	H
A3 = B3	A2 = B2	A1 = B1	A0 = B0	X	X	H	L	L	H
A3 = B3	A2 = B2	A1 = B1	A0 = B0	H	H	L	L	L	L
A3 = B3	A2 = B2	A1 = B1	A0 = B0	L	L	L	H	H	L

8. Limiting values

Table 4. Limiting values

In accordance with the Absolute Maximum Rating System (IEC 60134). Voltages are referenced to GND (ground = 0 V)

Symbol	Parameter	Conditions	Min	Max	Unit
V _{CC}	supply voltage		-0.5	+7	V
I _{IK}	input clamping current	V _I < -0.5 V or V _I > V _{CC} + 0.5 V [1]	-	±20	mA
I _{OK}	output clamping current	V _O < -0.5 V or V _O > V _{CC} + 0.5 V [1]	-	±20	mA
I _O	output current	-0.5 V < V _O < V _{CC} + 0.5 V	-	±25	mA
I _{CC}	supply current		-	50	mA
I _{GND}	ground current		-50	-	mA
T _{stg}	storage temperature		-65	+150	°C
P _{tot}	total power dissipation	T _{amb} = -40 °C to +125 °C [2]	-	500	mW

[1] The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

[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

Voltages are referenced to GND (ground = 0 V)

Symbol	Parameter	Conditions	74HC85			74HCT85			Unit
			Min	Typ	Max	Min	Typ	Max	
V_{CC}	supply voltage		2.0	5.0	6.0	4.5	5.0	5.5	V
V_I	input voltage		0	-	V_{CC}	0	-	V_{CC}	V
V_O	output voltage		0	-	V_{CC}	0	-	V_{CC}	V
T_{amb}	ambient temperature		-40	-	+125	-40	-	+125	°C
$\Delta t/\Delta V$	input transition rise and fall rate	$V_{CC} = 2.0$ V	-	-	625	-	-	-	ns/V
		$V_{CC} = 4.5$ V	-	1.67	139	-	1.67	139	ns/V
		$V_{CC} = 6.0$ V	-	-	83	-	-	-	ns/V

10. Static characteristics

Table 6. Static characteristics

At recommended operating conditions; voltages are referenced to GND (ground = 0 V).

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
74HC85										
V_{IH}	HIGH-level input voltage	$V_{CC} = 2.0$ V	1.5	1.2	-	1.5	-	1.5	-	V
		$V_{CC} = 4.5$ V	3.15	2.4	-	3.15	-	3.15	-	V
		$V_{CC} = 6.0$ V	4.2	3.2	-	4.2	-	4.2	-	V
V_{IL}	LOW-level input voltage	$V_{CC} = 2.0$ V	-	0.8	0.5	-	0.5	-	0.5	V
		$V_{CC} = 4.5$ V	-	2.1	1.35	-	1.35	-	1.35	V
		$V_{CC} = 6.0$ V	-	2.8	1.8	-	1.8	-	1.8	V
V_{OH}	HIGH-level output voltage	$V_I = V_{IH}$ or V_{IL}								
		$I_O = -20$ μ A; $V_{CC} = 2.0$ V	1.9	2.0	-	1.9	-	1.9	-	V
		$I_O = -20$ μ A; $V_{CC} = 4.5$ V	4.4	4.5	-	4.4	-	4.4	-	V
		$I_O = -20$ μ A; $V_{CC} = 6.0$ V	5.9	6.0	-	5.9	-	5.9	-	V
		$I_O = -4.0$ mA; $V_{CC} = 4.5$ V	3.98	4.32	-	3.84	-	3.7	-	V
V_{OL}	LOW-level output voltage	$V_I = V_{IH}$ or V_{IL}								
		$I_O = 20$ μ A; $V_{CC} = 2.0$ V	-	0	0.1	-	0.1	-	0.1	V
		$I_O = 20$ μ A; $V_{CC} = 4.5$ V	-	0	0.1	-	0.1	-	0.1	V
		$I_O = 20$ μ A; $V_{CC} = 6.0$ V	-	0	0.1	-	0.1	-	0.1	V
		$I_O = 4.0$ mA; $V_{CC} = 4.5$ V	-	0.15	0.26	-	0.33	-	0.4	V
I_I	input leakage current	$V_I = V_{CC}$ or GND; $V_{CC} = 6.0$ V	-	-	± 0.1	-	± 1	-	± 1	μ A
		$V_I = V_{CC}$ or GND; $I_O = 0$ A; $V_{CC} = 6.0$ V	-	-	8.0	-	80	-	160	μ A
C_I	input capacitance		-	3.5	-	-	-	-	-	pF

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
74HCT85										
V _{IH}	HIGH-level input voltage	V _{CC} = 4.5 V to 5.5 V	2.0	1.6	-	2.0	-	2.0	-	V
V _{IL}	LOW-level input voltage	V _{CC} = 4.5 V to 5.5 V	-	1.2	0.8	-	0.8	-	0.8	V
V _{OH}	HIGH-level output voltage	V _I = V _{IH} or V _{IL} ; V _{CC} = 4.5 V								
		I _O = -20 µA	4.4	4.5	-	4.4	-	4.4	-	V
		I _O = -4.0 mA	3.98	4.32	-	3.84	-	3.7	-	V
V _{OL}	LOW-level output voltage	V _I = V _{IH} or V _{IL} ; V _{CC} = 4.5 V								
		I _O = 20 µA	-	0	0.1	-	0.1	-	0.1	V
		I _O = 4.0 mA	-	0.15	0.26	-	0.33	-	0.4	V
I _I	input leakage current	V _I = V _{CC} or GND; V _{CC} = 5.5 V	-	-	±0.1	-	±1	-	±1	µA
I _{CC}	supply current	V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 5.5 V	-	-	8.0	-	80	-	160	µA
ΔI _{CC}	additional supply current	per input pin; V _I = V _{CC} - 2.1 V; other inputs at V _{CC} or GND; V _{CC} = 4.5 V to 5.5 V; I _O = 0 A								
		I _{A<B} and I _{A>B} inputs	-	100	360	-	450	-	490	µA
		A _n , B _n and I _{A=B} inputs	-	150	540	-	675	-	735	µA
C _I	input capacitance		-	3.5	-	-	-	-	-	pF

11. Dynamic characteristics

Table 7. Dynamic characteristics

At recommended operating conditions; voltages are referenced to GND (ground = 0 V);
 $C_L = 50$ pF unless otherwise specified; for test circuit, see Fig. 8

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
74HC85										
t_{pd}	propagation delay	An, Bn to $Q_{A>B}$; [1]								
		$V_{CC} = 2.0$ V	-	63	195	-	245	-	295	ns
		$V_{CC} = 4.5$ V	-	23	39	-	49	-	59	ns
		$V_{CC} = 6.0$ V	-	18	33	-	42	-	50	ns
		$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	20	-	-	-	-	-	ns
		An, Bn to $Q_{A=B}$; see Fig. 7								
		$V_{CC} = 2.0$ V	-	58	175	-	220	-	265	ns
		$V_{CC} = 4.5$ V	-	21	35	-	44	-	53	ns
		$V_{CC} = 6.0$ V	-	17	30	-	37	-	45	ns
		$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	18	-	-	-	-	-	ns
		$I_{A=B}$ or $I_{A>B}$ to $Q_{A<B}$; $I_{A<B}$ or $I_{A=B}$ to $Q_{A>B}$; see Fig. 7								
		$V_{CC} = 2.0$ V	-	50	140	-	175	-	210	ns
		$V_{CC} = 4.5$ V	-	18	28	-	35	-	42	ns
		$V_{CC} = 6.0$ V	-	14	24	-	30	-	36	ns
		$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	15	-	-	-	-	-	ns
		$I_{A=B}$ to $Q_{A=B}$; see Fig. 7								
$V_{CC} = 2.0$ V	-	39	120	-	150	-	180	ns		
$V_{CC} = 4.5$ V	-	14	24	-	30	-	36	ns		
$V_{CC} = 6.0$ V	-	11	20	-	26	-	31	ns		
$V_{CC} = 5.0$ V; $C_L = 15$ pF	-	11	-	-	-	-	-	ns		
t_t	transition time	see Fig. 7 [2]								
		$V_{CC} = 2.0$ V	-	19	75	-	95	-	110	ns
		$V_{CC} = 4.5$ V	-	7	15	-	19	-	22	ns
		$V_{CC} = 6.0$ V	-	6	13	-	16	-	19	ns
C_{PD}	power dissipation capacitance	per package; $V_I = \text{GND to } V_{CC}$ [3]	-	18	-	-	-	-	pF	

Symbol	Parameter	Conditions	25 °C			-40 °C to +85 °C		-40 °C to +125 °C		Unit
			Min	Typ	Max	Min	Max	Min	Max	
74HCT85										
t_{pd}	propagation delay	An, Bn to $Q_{A>B}$; see Fig. 7 [1]								
		$V_{CC} = 4.5\text{ V}$	-	26	44	-	55	-	66	ns
		$V_{CC} = 5.0\text{ V}; C_L = 15\text{ pF}$	-	22	-	-	-	-	-	ns
		An, Bn to $Q_{A=B}$; see Fig. 7								
		$V_{CC} = 4.5\text{ V}$	-	24	40	-	50	-	60	ns
		$V_{CC} = 5.0\text{ V}; C_L = 15\text{ pF}$	-	20	-	-	-	-	-	ns
		$I_{A=B}$ or $I_{A>B}$ to $Q_{A<B}$; $I_{A<B}$ or $I_{A=B}$ to $Q_{A>B}$; see Fig. 7								
		$V_{CC} = 4.5\text{ V}$	-	18	31	-	39	-	47	ns
		$V_{CC} = 5.0\text{ V}; C_L = 15\text{ pF}$	-	15	-	-	-	-	-	ns
		$I_{A=B}$ to $Q_{A=B}$; see Fig. 7								
$V_{CC} = 4.5\text{ V}$	-	18	31	-	39	-	47	ns		
$V_{CC} = 5.0\text{ V}; C_L = 15\text{ pF}$	-	15	-	-	-	-	-	ns		
t_t	transition time	$V_{CC} = 4.5\text{ V}$; see Fig. 7 [2]	-	7	15	-	19	-	22	ns
C_{PD}	power dissipation capacitance	per package; $V_I = \text{GND to } V_{CC} - 1.5\text{ V}$ [3]	-	20	-	-	-	-	-	pF

[1] t_{pd} is the same as t_{PHL} and t_{PLH} .

[2] t_t is the same as t_{THL} and t_{TLH} .

[3] C_{PD} is used to determine the dynamic power dissipation (P_D in μW).

$$P_D = C_{PD} \times V_{CC}^2 \times f_i + \sum (C_L \times V_{CC}^2 \times f_o) \text{ where:}$$

f_i = input frequency in MHz;

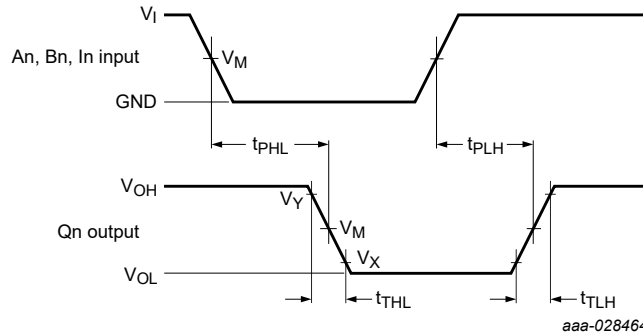
f_o = output frequency in MHz;

$\sum (C_L \times V_{CC}^2 \times f_o)$ = sum of outputs;

C_L = output load capacitance in pF;

V_{CC} = supply voltage in V.

11.1. Waveforms and test circuit



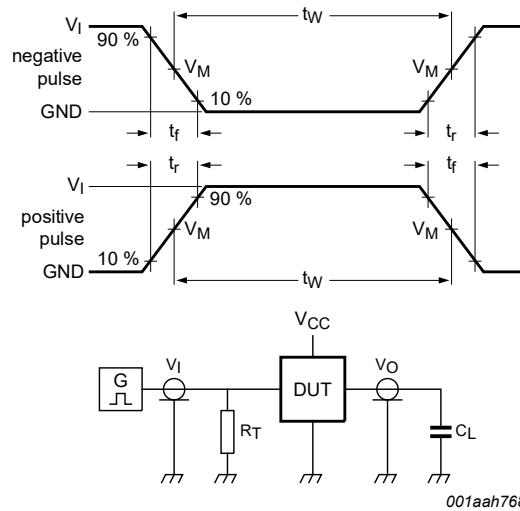
Measurement points are given in [Table 8](#).

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

Fig. 7. Word A inputs (An), word B inputs (Bn) and expansion inputs (In) to the outputs (Qn) propagation delays and the output transition times

Table 8. Measurement points

Type	Input		Output		
	V_I	V_M	V_M	V_X	V_Y
74HC85	V_{CC}	$0.5V_{CC}$	$0.5V_{CC}$	$0.1 V_{CC}$	$0.9 V_{CC}$
74HCT85	3 V	1.3 V	1.3 V	$0.1 V_{CC}$	$0.9 V_{CC}$



Test data is given in [Table 9](#).

Definitions test circuit:

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. 8. Test circuit for measuring switching times

Table 9. Test data

Type	Input		Load	Test
	V_I	t_r, t_f	C_L	
74HC85	V_{CC}	6.0 ns	15 pF, 50 pF	t_{PLH}, t_{PHL}
74HCT85	3.0 V	6.0 ns	15 pF, 50 pF	t_{PLH}, t_{PHL}

12. Application information

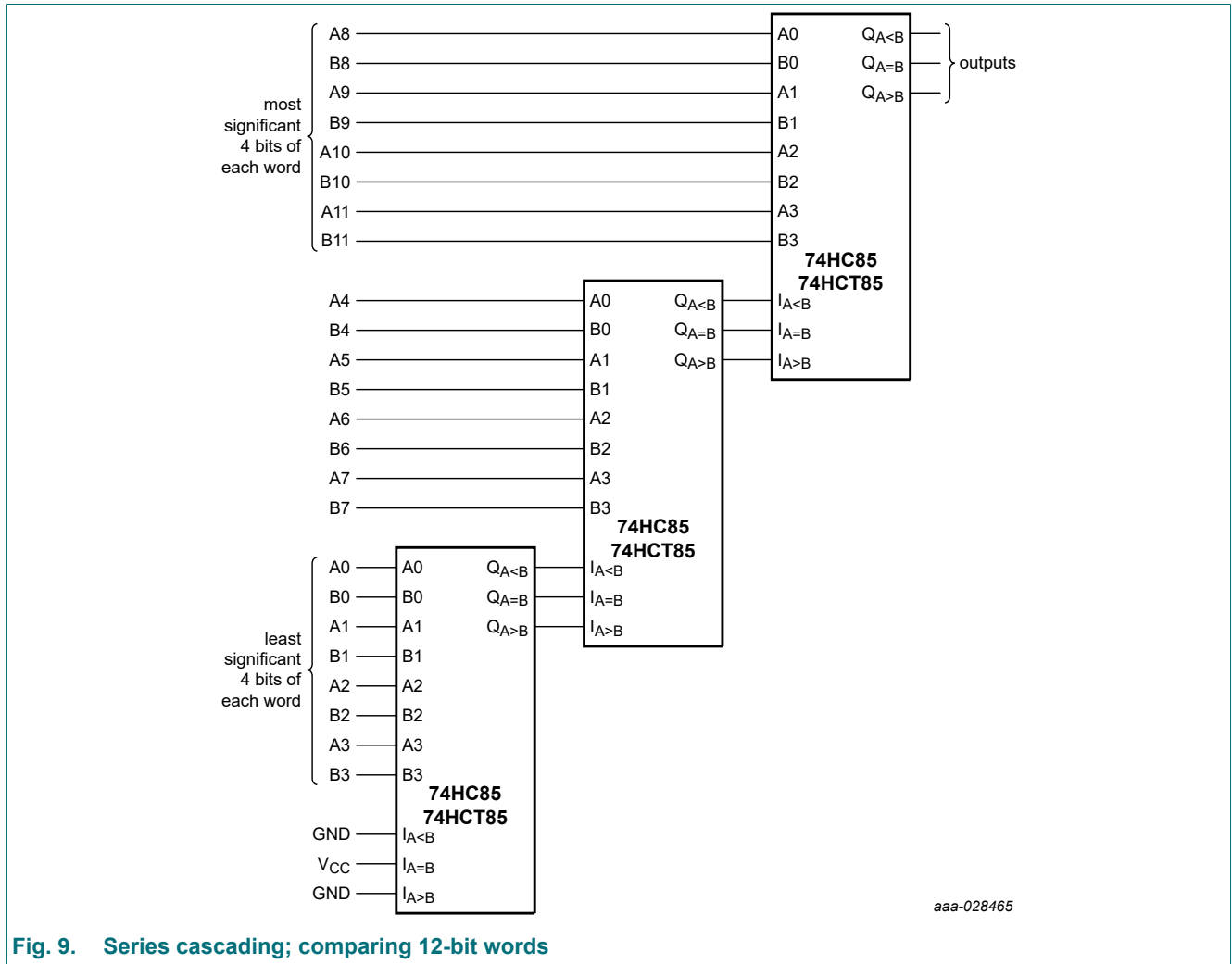


Fig. 9. Series cascading; comparing 12-bit words

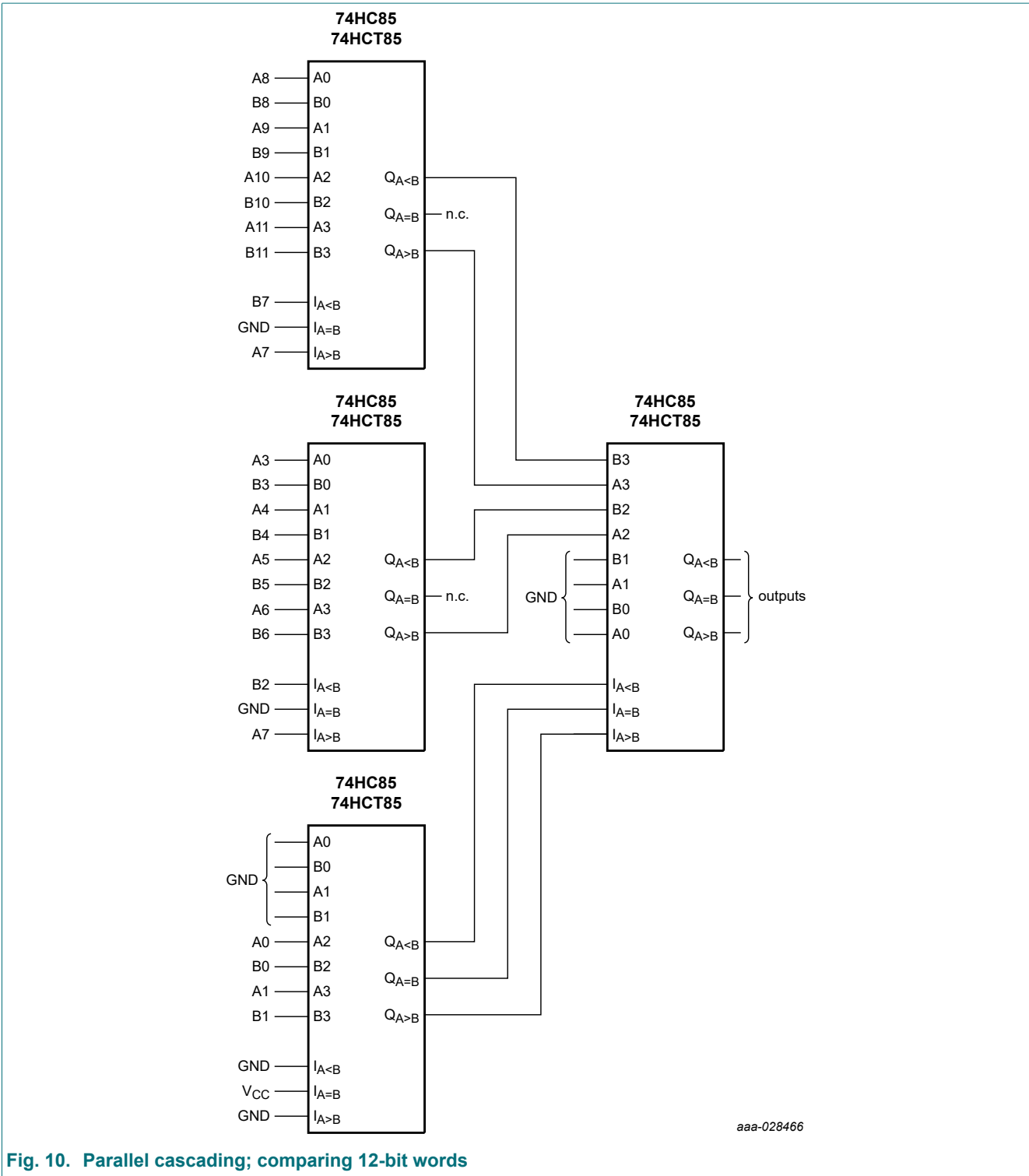


Fig. 10. Parallel cascading; comparing 12-bit words

13. Package outline

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

SOT109-1

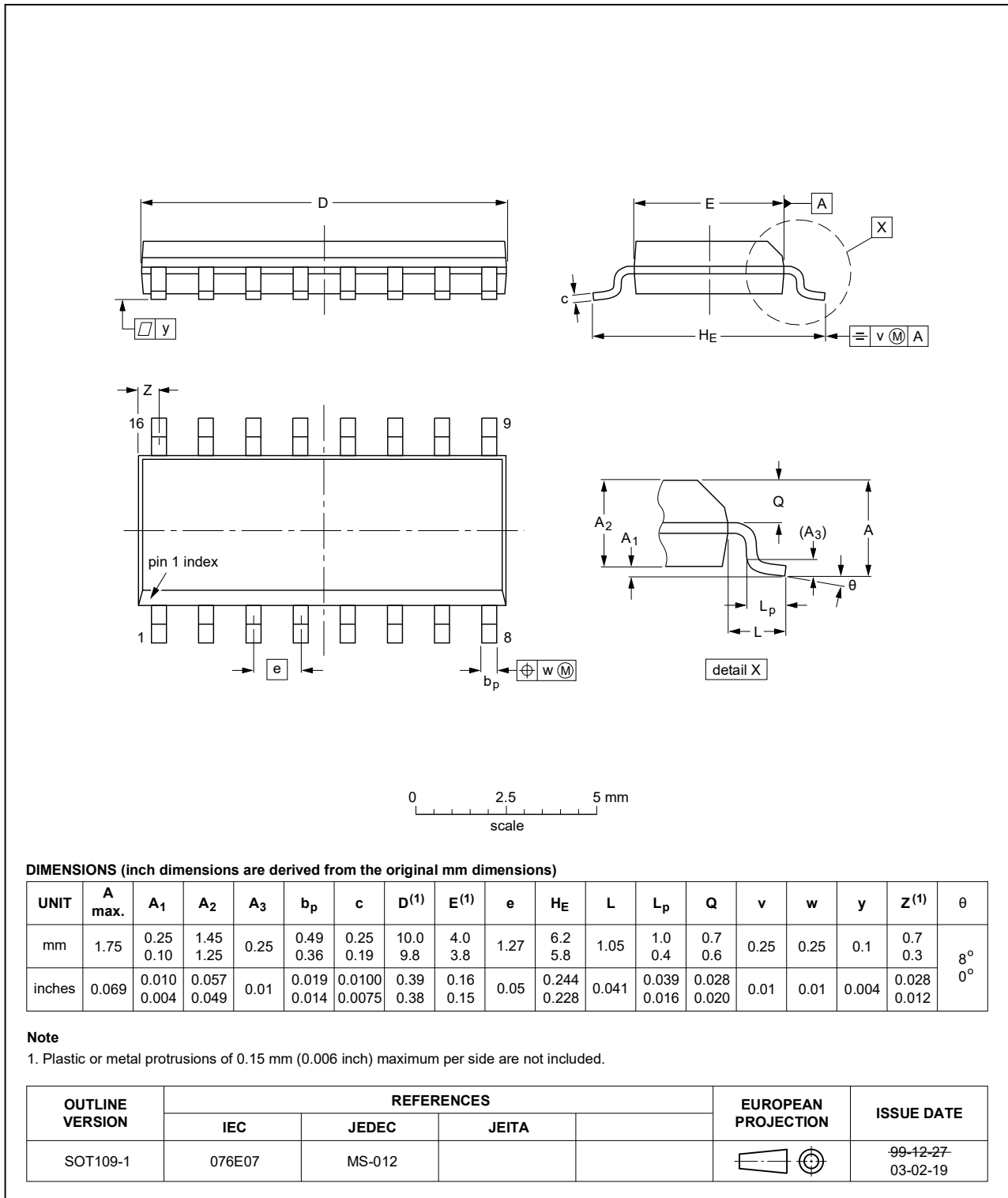


Fig. 11. Package outline SOT109-1 (SO16)

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

SOT403-1

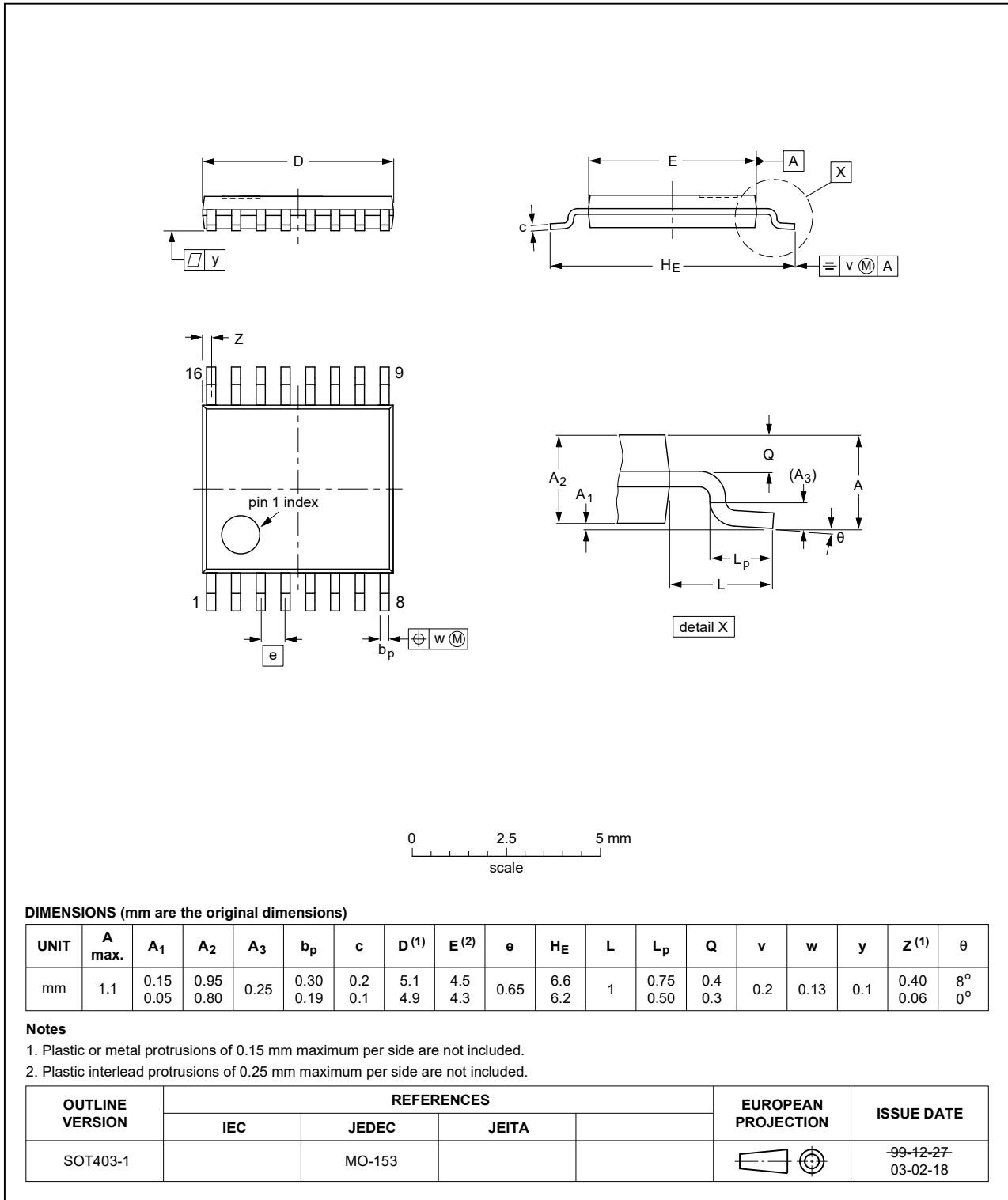


Fig. 12. Package outline SOT403-1 (TSSOP16)

14. Abbreviations

Table 10. Abbreviations

Acronym	Description
CMOS	Complementary Metal-Oxide Semiconductor
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body Model
MM	Machine Model
TTL	Transistor-Transistor Logic

15. Revision history

Table 11. Revision history

Document ID	Release date	Data sheet status	Change notice	Supersedes
74HC_HCT85 v.4	20210804	Product data sheet	-	74HC_HCT85 v.3
Modifications:	<ul style="list-style-type: none"> Type number 74HCT85PW (SOT403-1/TSSOP16) added. Type numbers 74HC85DB and 74HCT85DB (SOT338-1/SSOP16) removed. Section 8: Derating values for P_{tot} total power dissipation updated. 			
74HC_HCT85 v.3	20180420	Product data sheet	-	74HC_HCT85 v.2
Modifications:	<ul style="list-style-type: none"> 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. 			
74HC_HCT85 v.2	19901201	Product specification	-	74HC_HCT85 v.1
74HC_HCT85 v.1	19901201	Product specification	-	-

16. 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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