

74HC85; 74HCT85

4-bit magnitude comparator

Rev. 5 — 2 April 2024

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: 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 and from -40 °C to +125 °C

3. Applications

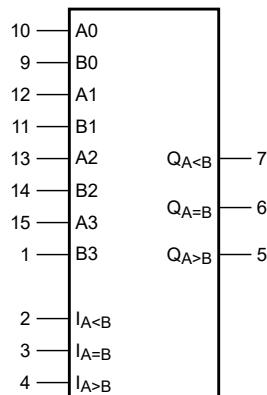
- Process controllers
- Servo-motor control

4. Ordering information

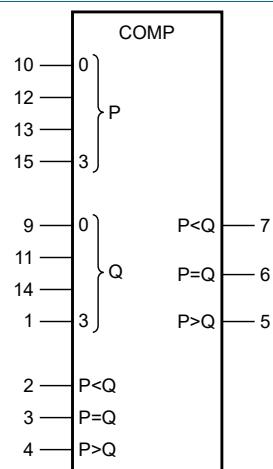
Table 1. Ordering information

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	-40 °C to +125 °C	TSSOP16	plastic thin shrink small outline package; 16 leads; body width 4.4 mm		SOT403-1
74HC85PW					
74HCT85PW					

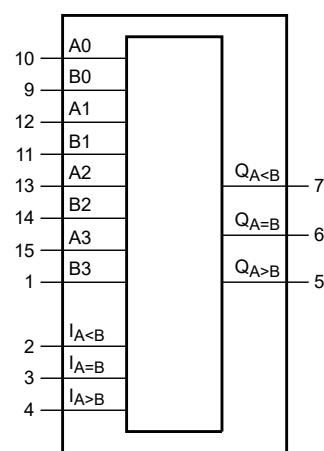
5. Functional diagram



aaa-028459

Fig. 1. Logic symbol

aaa-028460

Fig. 2. IEC logic symbol

aaa-028461

Fig. 3. Functional diagram

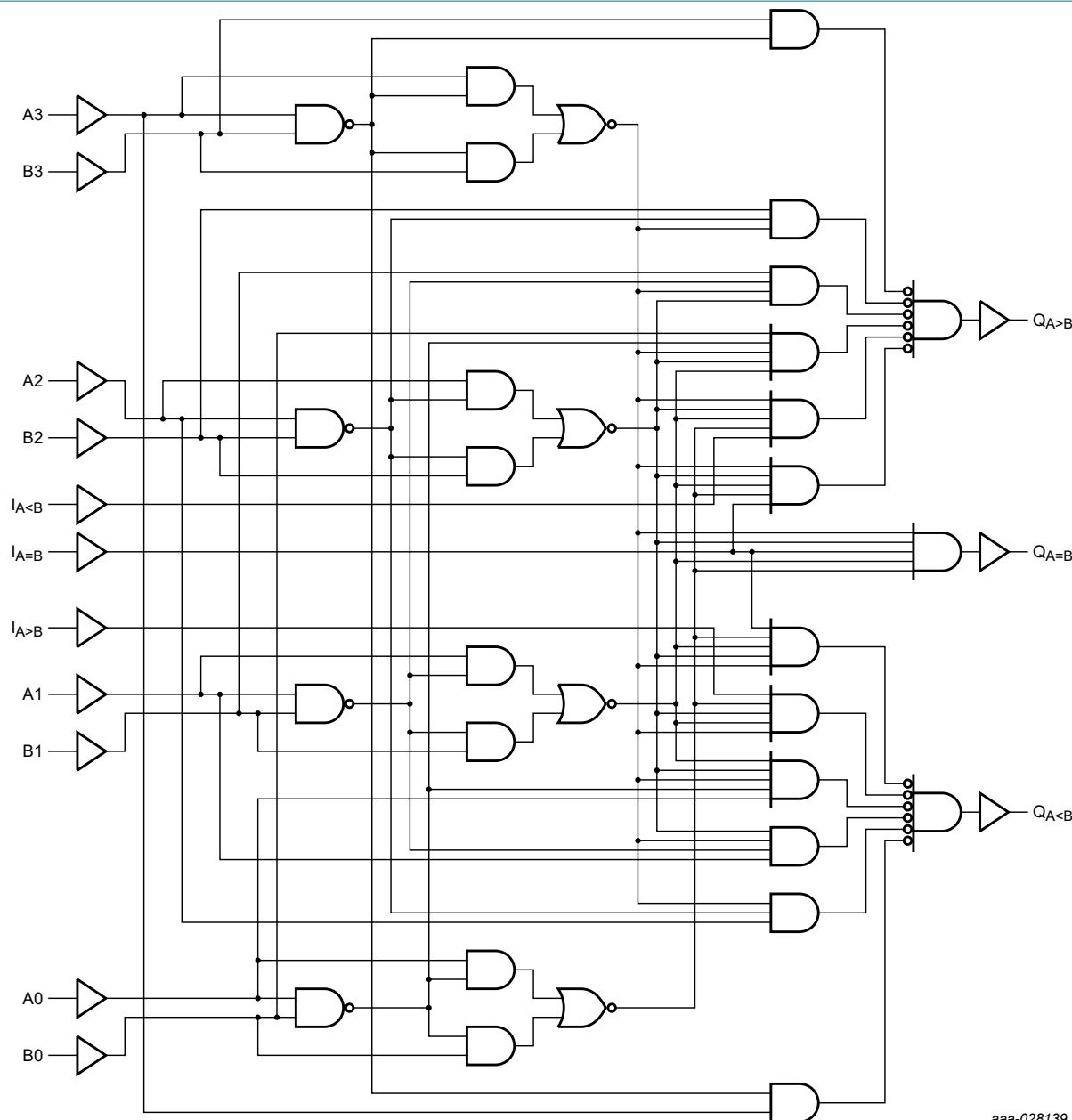


Fig. 4. Logic diagram

6. Pinning information

6.1. Pinning

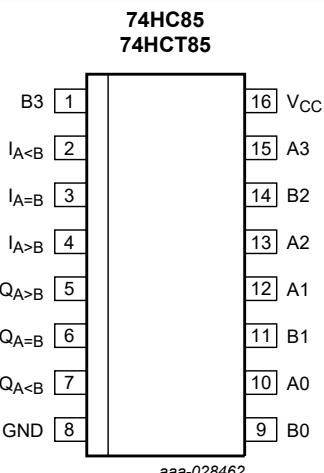


Fig. 5. Pin configuration SOT109-1 (SO16)

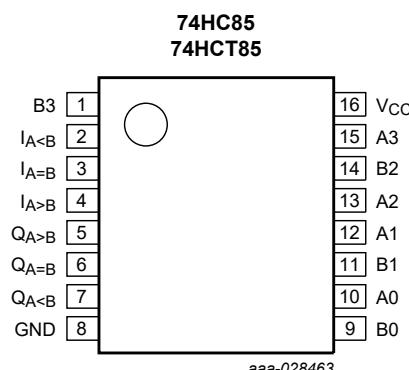


Fig. 6. Pin configuration SOT403-1 (TSSOP16)

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	H	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 µA; V _{CC} = 2.0 V	1.9	2.0	-	1.9	-	1.9	-	V
		I _O = -20 µA; V _{CC} = 4.5 V	4.4	4.5	-	4.4	-	4.4	-	V
		I _O = -20 µA; 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
		I _O = -5.2 mA; V _{CC} = 6.0 V	5.48	5.81	-	5.34	-	5.2	-	V
V _{OL}	LOW-level output voltage	V _I = V _{IH} or V _{IL}								
		I _O = 20 µA; V _{CC} = 2.0 V	-	0	0.1	-	0.1	-	0.1	V
		I _O = 20 µA; V _{CC} = 4.5 V	-	0	0.1	-	0.1	-	0.1	V
		I _O = 20 µA; 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 _O = 5.2 mA; V _{CC} = 6.0 V	-	0.16	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	µA
I _{CC}	supply current	V _I = V _{CC} or GND; I _O = 0 A; V _{CC} = 6.0 V	-	-	8.0	-	80	-	160	µA
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	$V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$	2.0	1.6	-	2.0	-	2.0	-	V
V_{IL}	LOW-level input voltage	$V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$	-	1.2	0.8	-	0.8	-	0.8	V
V_{OH}	HIGH-level output voltage	$V_I = V_{IH}$ or V_{IL} ; $V_{CC} = 4.5 \text{ V}$								
		$I_O = -20 \mu\text{A}$	4.4	4.5	-	4.4	-	4.4	-	V
		$I_O = -4.0 \text{ mA}$	3.98	4.32	-	3.84	-	3.7	-	V
V_{OL}	LOW-level output voltage	$V_I = V_{IH}$ or V_{IL} ; $V_{CC} = 4.5 \text{ V}$								
		$I_O = 20 \mu\text{A}$	-	0	0.1	-	0.1	-	0.1	V
		$I_O = 4.0 \text{ mA}$	-	0.15	0.26	-	0.33	-	0.4	V
I_I	input leakage current	$V_I = V_{CC}$ or GND; $V_{CC} = 5.5 \text{ V}$	-	-	± 0.1	-	± 1	-	± 1	μA
I_{CC}	supply current	$V_I = V_{CC}$ or GND; $I_O = 0 \text{ A}$; $V_{CC} = 5.5 \text{ V}$	-	-	8.0	-	80	-	160	μA
ΔI_{CC}	additional supply current	per input pin; $V_I = V_{CC} - 2.1 \text{ V}$; other inputs at V_{CC} or GND; $V_{CC} = 4.5 \text{ V to } 5.5 \text{ V}$; $I_O = 0 \text{ A}$								
		$I_{A < B}$ and $I_{A > B}$ inputs	-	100	360	-	450	-	490	μA
		An, Bn 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);
 $C_L = 50 \text{ pF}$ 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] An, Bn to $Q_{A<B}$; see Fig. 7								
		$V_{CC} = 2.0 \text{ V}$	-	63	195	-	245	-	295	ns
		$V_{CC} = 4.5 \text{ V}$	-	23	39	-	49	-	59	ns
		$V_{CC} = 6.0 \text{ V}$	-	18	33	-	42	-	50	ns
		$V_{CC} = 5.0 \text{ V}; C_L = 15 \text{ pF}$	-	20	-	-	-	-	-	ns
		An, Bn to $Q_{A=B}$; see Fig. 7								
		$V_{CC} = 2.0 \text{ V}$	-	58	175	-	220	-	265	ns
		$V_{CC} = 4.5 \text{ V}$	-	21	35	-	44	-	53	ns
		$V_{CC} = 6.0 \text{ V}$	-	17	30	-	37	-	45	ns
		$V_{CC} = 5.0 \text{ V}; C_L = 15 \text{ pF}$	-	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								
		$V_{CC} = 2.0 \text{ V}$	-	50	140	-	175	-	210	ns
		$V_{CC} = 4.5 \text{ V}$	-	18	28	-	35	-	42	ns
		$V_{CC} = 6.0 \text{ V}$	-	14	24	-	30	-	36	ns
		$V_{CC} = 5.0 \text{ V}; C_L = 15 \text{ pF}$	-	15	-	-	-	-	-	ns
		$I_{A=B}$ to $Q_{A=B}$; see Fig. 7								
		$V_{CC} = 2.0 \text{ V}$	-	39	120	-	150	-	180	ns
		$V_{CC} = 4.5 \text{ V}$	-	14	24	-	30	-	36	ns
		$V_{CC} = 6.0 \text{ V}$	-	11	20	-	26	-	31	ns
		$V_{CC} = 5.0 \text{ V}; C_L = 15 \text{ pF}$	-	11	-	-	-	-	-	ns
t_t	transition time	see Fig. 7 [2]								
		$V_{CC} = 2.0 \text{ V}$	-	19	75	-	95	-	110	ns
		$V_{CC} = 4.5 \text{ V}$	-	7	15	-	19	-	22	ns
		$V_{CC} = 6.0 \text{ V}$	-	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 $Q_{A>B}$: [1] An, Bn to $Q_{A<B}$; see Fig. 7								
		$V_{CC} = 4.5 \text{ V}$	-	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;

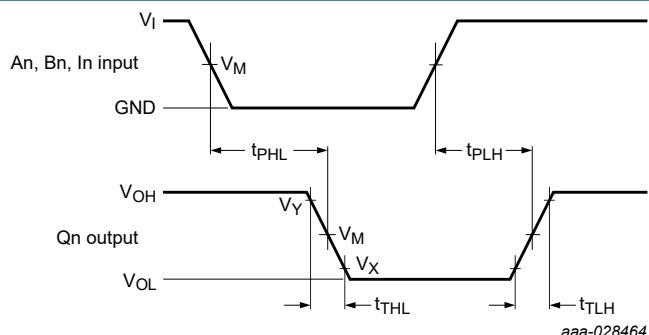
f_o = output frequency in MHz;

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

C_L = output load capacitance in pF;

V_{CC} = supply voltage in V.

11.1. Waveforms and test circuit



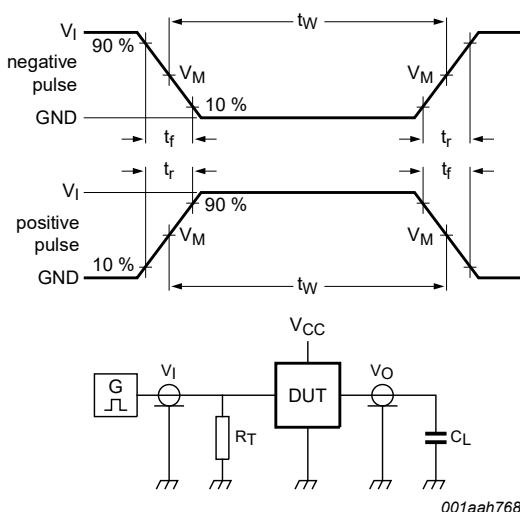
Measurement points are given in [Table 8](#).

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}	$0.5V_{CC}$	$0.5V_{CC}$	$0.1V_{CC}$	$0.9V_{CC}$
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		C_L	Test
	V_I	t_r, t_f		
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

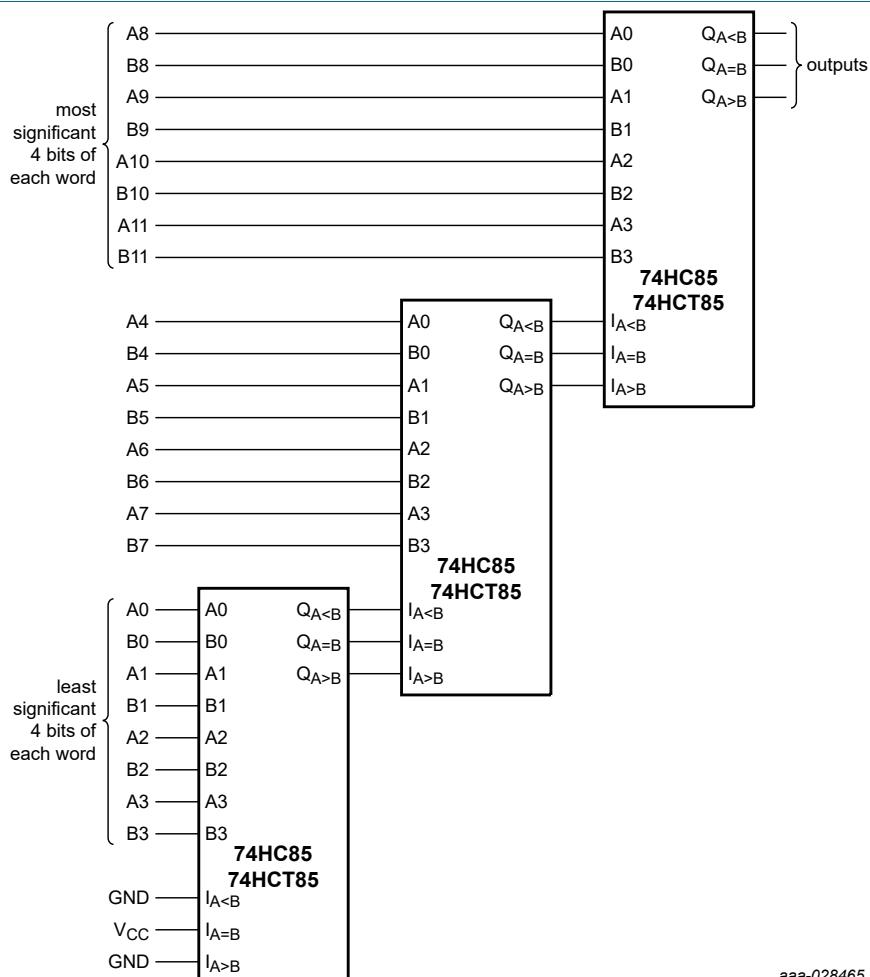


Fig. 9. Series cascading; comparing 12-bit words

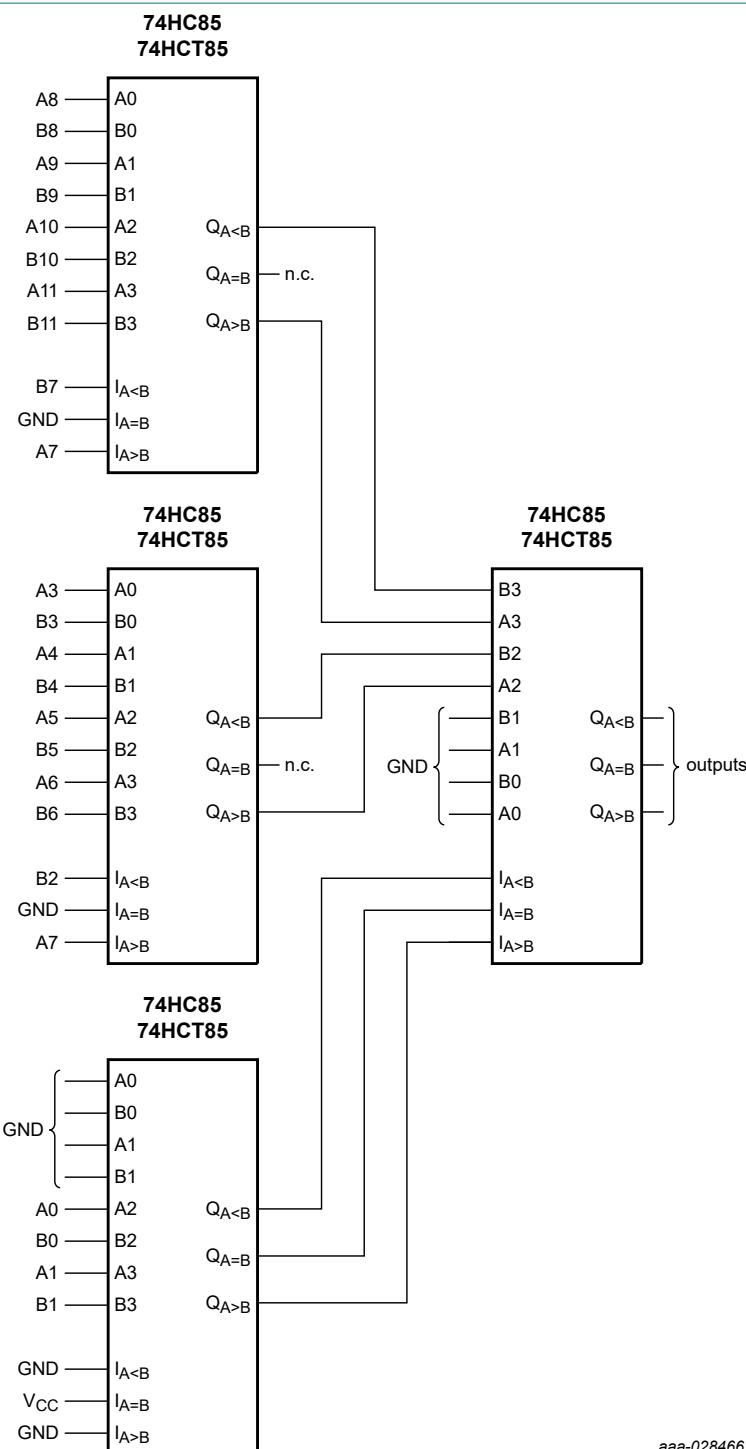


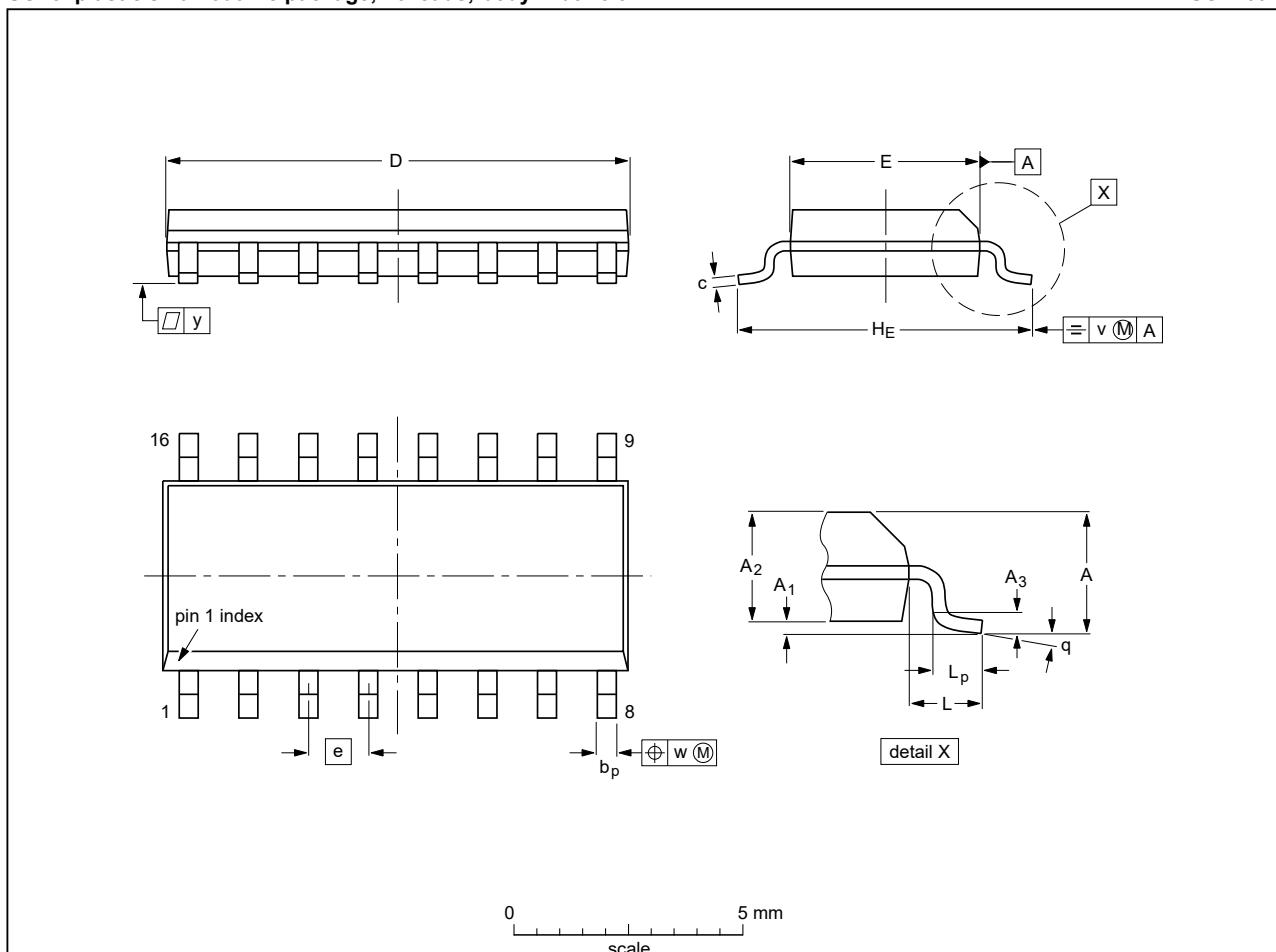
Fig. 10. Parallel cascading; comparing 12-bit words

aaa-028466

13. 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	0.2	0.25	0.1	8°	
mm	nom			0.25					1.27		1.05					0°	
mm	min 0.10	1.25		0.31	0.10	9.8	3.8		5.8		0.4						
inches	max 0.069	0.010			0.020	0.010	0.394	0.16		0.244		0.05		0.008	0.01	0.004	8°
inches	nom			0.01					0.05		0.041						0°
inches	min 0.004	0.049		0.012	0.004	0.386	0.15		0.228		0.016						

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. 11. Package outline SOT109-1 (SO16)

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

SOT403-1

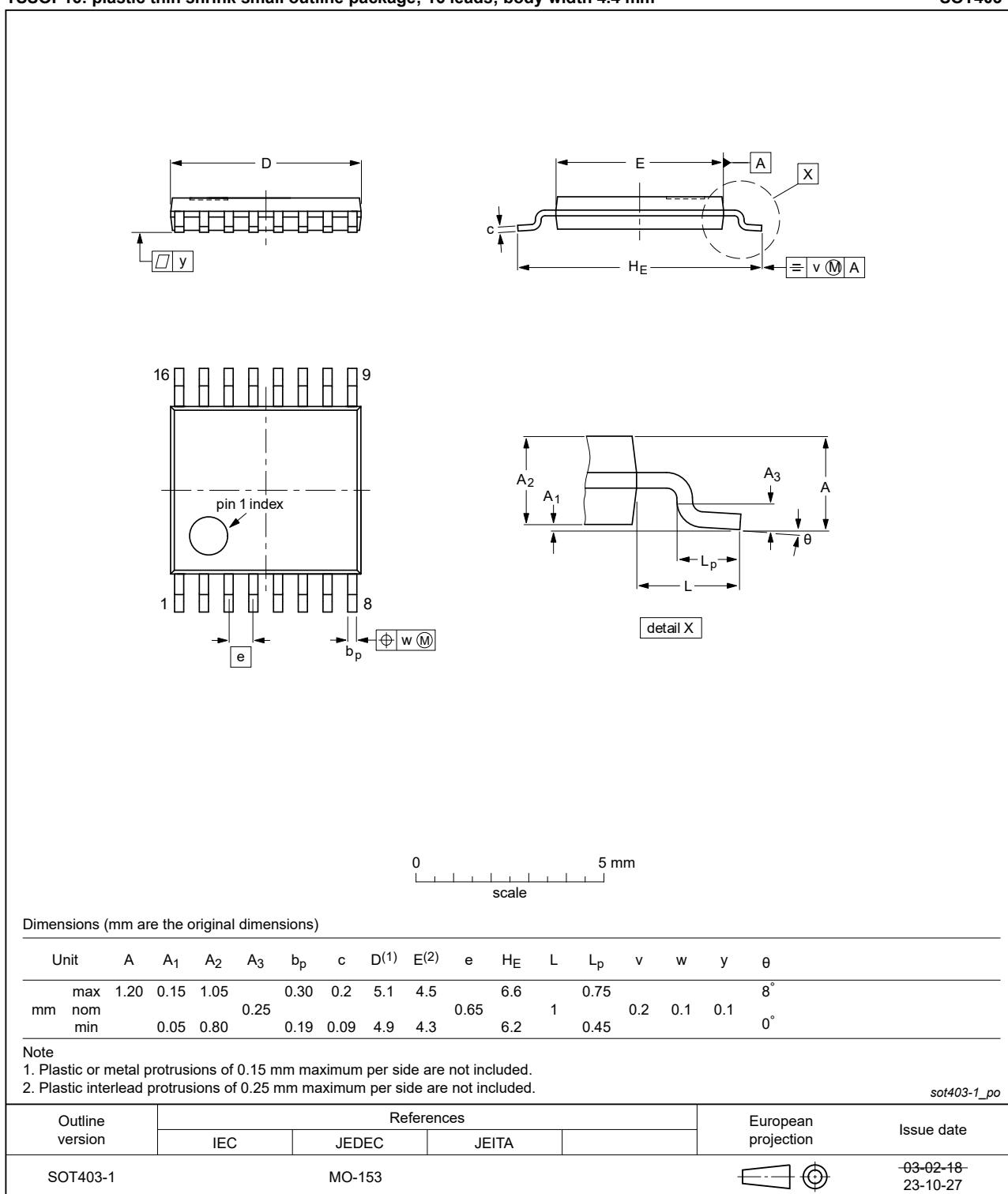


Fig. 12. Package outline SOT403-1 (TSSOP16)

14. Abbreviations

Table 10. Abbreviations

Acronym	Description
CDM	Charged Device Model
CMOS	Complementary Metal-Oxide Semiconductor
DUT	Device Under Test
ESD	ElectroStatic Discharge
HBM	Human Body 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.5	20240402	Product data sheet	-	74HC_HCT85 v.4
Modifications:			<ul style="list-style-type: none"> Fig. 11, Fig. 12: Aligned SO and TSSOP package outline drawings to JEDEC MS-012 and MO-153. Section 2: ESD specification updated according to the latest JEDEC standard. 	
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".
- [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 <https://www.nexperia.com>.

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