

TOSHIBA CMOS Digital Integrated Circuit Silicon Monolithic

TC74HC85AP, TC74HC85AF

4-Bit Magnitude Comparator

The TC74HC85A is a high speed CMOS 4 BIT MAGNITUDE COMPARATOR fabricated with silicon gate C²MOS technology.

It achieves the high speed operation similar to equivalent LSTTL while maintaining the CMOS low power dissipation.

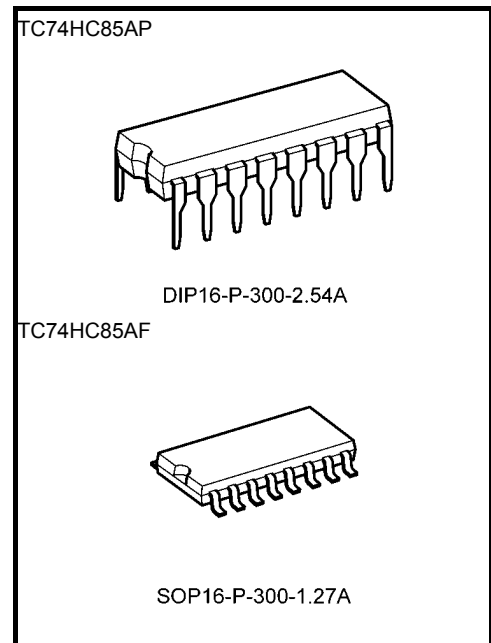
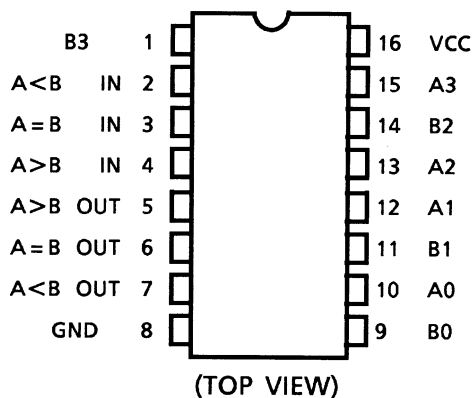
The TC74HC85A compares two 4-bit words applied to inputs A0-A3 and B0-B3, and provides a high voltage level on one of three outputs: A > B, A < B, or A = B.

All inputs are equipped with protection circuits against static discharge or transient excess voltage.

Features

- High speed: $t_{pd} = 22 \text{ ns}$ (typ.) at $V_{CC} = 5 \text{ V}$
- Low power dissipation: $I_{CC} = 4 \mu\text{A}$ (max) at $T_a = 25^\circ\text{C}$
- High noise immunity: $V_{NIH} = V_{NIL} = 28\% V_{CC}$ (min)
- Output drive capability: 10 LSTTL loads
- Symmetrical output impedance: $|I_{OH}| = I_{OL} = 4 \text{ mA}$ (min)
- Balanced propagation delays: $t_{pLH} \approx t_{pHL}$
- Wide operating voltage range: $V_{CC} \text{ (opr)} = 2 \sim 6 \text{ V}$
- Pin and function compatible with 74LS85

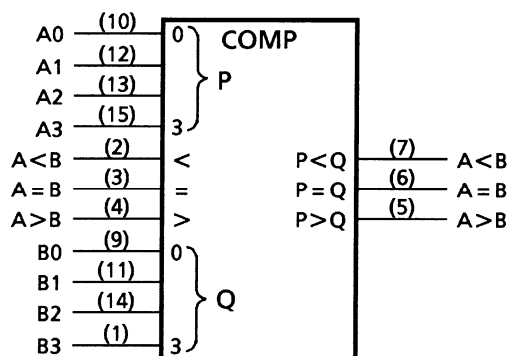
Pin Assignment



Weight

DIP16-P-300-2.54A : 1.00 g (typ.)
SOP16-P-300-1.27A : 0.18 g (typ.)

IEC Logic Symbol

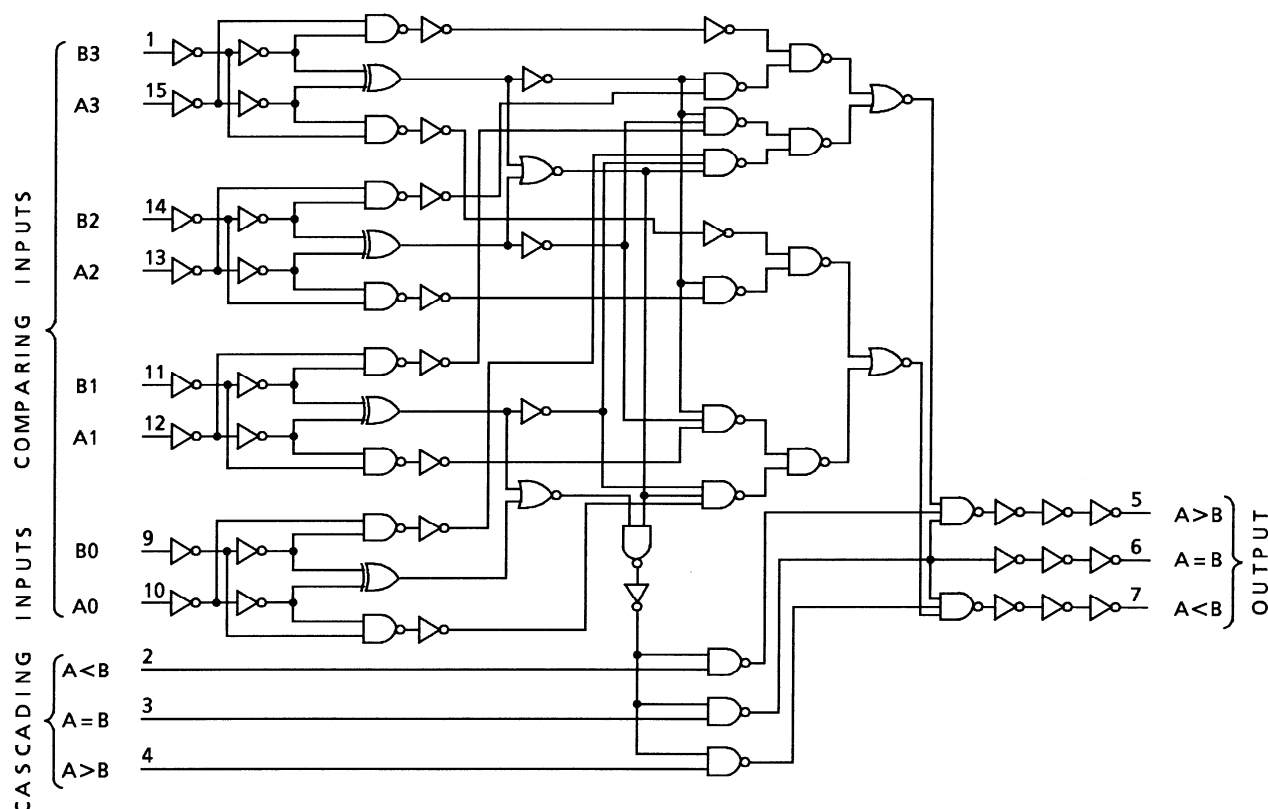


Truth Table

Comparing Inputs				Cascading Inputs			Outputs		
				A > B	A < B	A = B	A > B	A < B	A = B
A3 > B3	X	X	X	X	X	X	H	L	L
A3 = B3	A2 > B2	X	X	X	X	X	H	L	L
A3 = B3	A2 = B2	A1 > B1	X	X	X	X	H	L	L
A3 = B3	A2 = B2	A1 = B1	A0 > B0	X	X	X	H	L	L
A3 = B3, A2 = B2, A1 = B1, A0 = B0				L	L	L	H	H	L
				X	X	H	L	L	H
				L	H	L	L	H	L
				H	L	L	H	L	L
				H	H	L	L	L	L
A3 = B3	A2 = B2	A1 = B1	A0 < B0	X	X	X	L	H	L
A3 = B3	A2 = B2	A1 < B1	X	X	X	X	L	H	L
A3 = B3	A2 < B2	X	X	X	X	X	L	H	L
A3 < B3	X	X	X	X	X	X	L	H	L

X: Don't care

System Diagram



Absolute Maximum Ratings (Note 1)

Characteristics	Symbol	Rating	Unit
Supply voltage range	V_{CC}	-0.5~7	V
DC input voltage	V_{IN}	-0.5~ $V_{CC} + 0.5$	V
DC output voltage	V_{OUT}	-0.5~ $V_{CC} + 0.5$	V
Input diode current	I_{IK}	±20	mA
Output diode current	I_{OK}	±20	mA
DC output current	I_{OUT}	±25	mA
DC V_{CC} /ground current	I_{CC}	±50	mA
Power dissipation	P_D	500 (DIP) (Note 2)/180 (SOP)	mW
Storage temperature	T_{stg}	-65~150	°C

Note 1: Exceeding any of the absolute maximum ratings, even briefly, lead to deterioration in IC performance or even destruction.

Using continuously under heavy loads (e.g. the application of high temperature/current/voltage and the significant change in temperature, etc.) may cause this product to decrease in the reliability significantly even if the operating conditions (i.e. operating temperature/current/voltage, etc.) are within the absolute maximum ratings and the operating ranges.

Please design the appropriate reliability upon reviewing the Toshiba Semiconductor Reliability Handbook ("Handling Precautions"/"Derating Concept and Methods") and individual reliability data (i.e. reliability test report and estimated failure rate, etc).

Note 2: 500 mW in the range of $T_a = -40$ to 65°C . From $T_a = 65$ to 85°C a derating factor of $-10 \text{ mW}/^\circ\text{C}$ shall be applied until 300 mW.

Operating Ranges (Note)

Characteristics	Symbol	Rating	Unit
Supply voltage	V_{CC}	2~6	V
Input voltage	V_{IN}	0~ V_{CC}	V
Output voltage	V_{OUT}	0~ V_{CC}	V
Operating temperature	T_{opr}	-40~85	°C
Input rise and fall time	t_r, t_f	0~1000 ($V_{CC} = 2.0$ V) 0~500 ($V_{CC} = 4.5$ V) 0~400 ($V_{CC} = 6.0$ V)	ns

Note: The operating ranges must be maintained to ensure the normal operation of the device.
Unused inputs must be tied to either V_{CC} or GND.

Electrical Characteristics
DC Characteristics

Characteristics	Symbol	Test Condition		$T_a = 25^\circ\text{C}$			$T_a = -40\sim 85^\circ\text{C}$		Unit
				V_{CC} (V)	Min	Typ.	Max	Min	Max
High-level input voltage	V_{IH}	—		2.0 4.5 6.0	1.50 3.15 4.20	— — —	— — —	1.50 3.15 4.20	V
Low-level input voltage	V_{IL}	—		2.0 4.5 6.0	— — —	— — —	0.50 1.35 1.80	— — —	V
High-level output voltage	V_{OH}	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OH} = -20\ \mu\text{A}$	2.0 4.5 6.0	1.9 4.4 5.9	2.0 4.5 6.0	— — —	1.9 4.4 5.9	V
			$I_{OH} = -4\ \text{mA}$	4.5 6.0	4.18 5.68	4.31 5.80	— —	4.13 5.63	
			$I_{OH} = -5.2\ \text{mA}$	6.0	5.68	5.80	—	5.63	
Low-level output voltage	V_{OL}	$V_{IN} = V_{IH}$ or V_{IL}	$I_{OL} = 20\ \mu\text{A}$	2.0 4.5 6.0	— — —	0.0 0.0 0.0	0.1 0.1 0.1	— — —	V
			$I_{OL} = 4\ \text{mA}$	4.5 6.0	— —	0.17 0.18	0.26 0.26	— —	
			$I_{OL} = 5.2\ \text{mA}$	6.0	—	0.18	0.26	—	
Input leakage current	I_{IN}	$V_{IN} = V_{CC}$ or GND		6.0	—	—	± 0.1	—	μA
Quiescent supply current	I_{CC}	$V_{IN} = V_{CC}$ or GND		6.0	—	—	4.0	—	μA

AC Characteristics ($C_L = 15 \text{ pF}$, $V_{CC} = 5 \text{ V}$, $T_a = 25^\circ\text{C}$, input: $t_r = t_f = 6 \text{ ns}$)

Characteristics	Symbol	Test Condition	Min	Typ.	Max	Unit
Output transition time	t_{TLH} t_{THL}	—	—	4	8	ns
Propagation delay time (A, B-OUT)	t_{pLH} t_{pHL}	—	—	22	34	ns
Propagation delay time (CASCADE-OUT)	t_{pLH} t_{pHL}	—	—	10	18	ns

AC Characteristics ($C_L = 50 \text{ pF}$, input: $t_r = t_f = 6 \text{ ns}$)

Characteristics	Symbol	Test Condition	$T_a = 25^\circ\text{C}$			$T_a = -40 \sim 85^\circ\text{C}$		Unit
			V_{CC} (V)	Min	Typ.	Max	Min	Max
Output transition time	t_{TLH} t_{THL}	—	2.0	—	30	75	—	95
			4.5	—	8	15	—	19
			6.0	—	7	13	—	16
Propagation delay time (A, B-OUT)	t_{pLH} t_{pHL}	—	2.0	—	90	195	—	245
			4.5	—	26	39	—	49
			6.0	—	22	33	—	42
Propagation delay time (CASCADE-OUT)	t_{pLH} t_{pHL}	—	2.0	—	40	110	—	140
			4.5	—	13	22	—	28
			6.0	—	11	19	—	24
Input capacitance	C_{IN}	—	—	5	10	—	10	pF
Power dissipation capacitance	C_{PD} (Note)	—	—	25	—	—	—	pF

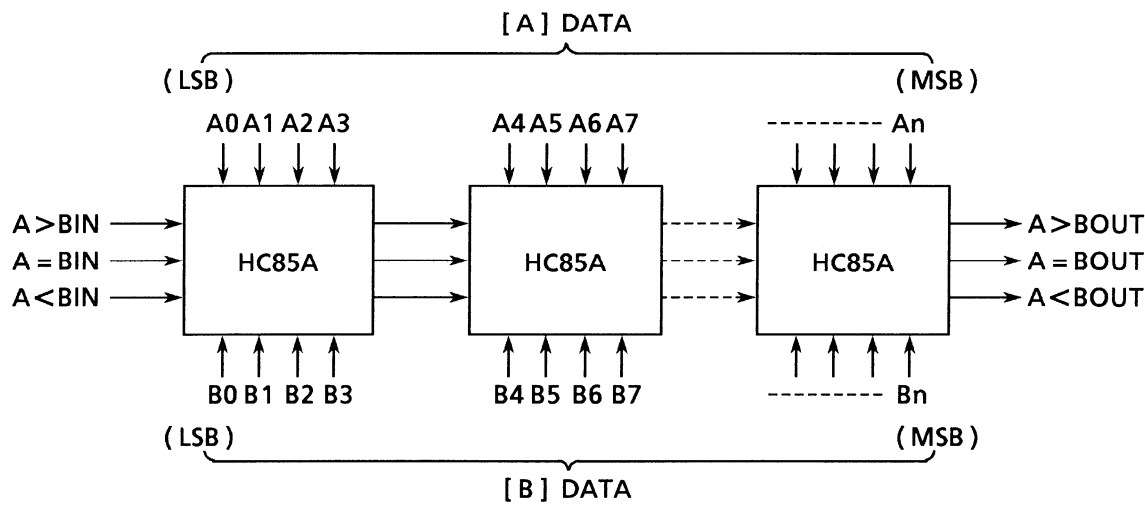
Note: C_{PD} is defined as the value of the internal equivalent capacitance which is calculated from the operating current consumption without load.

Average operating current can be obtained by the equation:

$$I_{CC}(\text{opr}) = C_{PD} \cdot V_{CC} \cdot f_{IN} + I_{CC}$$

Typical Application

N – BIT CASCADING CONNECTION



Comparing Input	Cascading Inputs			Outputs		
	A > B	A = B	A < B	A > B	A = B	A < B
[A] > [B]	X	X	X	H	L	L
[A] = [B]	H	L	L	H	L	L
	X	H	X	L	H	L
	L	L	H	L	L	H
[A] < [B]	X	X	X	L	L	H

X: Don't care

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