4-BIT MAGNITUDE COMPARATOR

FEATURES

- **Serial or parallel expansion without extra gating**
- **Magnitude comparison of any binary words**
- **Output capability: standard**
- **I_{CC} category: MSI**

GENERAL DESCRIPTION

The 74HC/HCT85 are high-speed Si-gate CMOS devices and are pin compatible with low power Schottky TTL (LSTTL). They are specified in compliance with JEDEC standard no. 7A.

The 74HC/HCT85 are 4-bit magnitude comparators 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 (A_0 to A_3 and B_0 to B_3), where A_3 and B_3 are the most significant bits.

The operation of the "85" is described in the function table, showing all possible logic conditions. The upper part of the table describes the normal operation under all conditions that will occur in a single device or in a series expansion scheme. In the upper part of the table the three outputs are mutually exclusive. In the lower part of the table, the outputs reflect the feed forward conditions that exist in the parallel expansion scheme.

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: $I_{A<B} = I_{A>B} =$ = LOW and $I_{A=B}$ = 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.

SYMBOL	PARAMETER	CONDITIONS	TYPICAL		UNIT
			HC	HCT	
t_{PHL}/t_{PLH}	propagation delay A_n, B_n to $Q_{A>B}$, $Q_{A<B}$	C_L = 15 pF; V_{CC} = 5 V	20	22	ns
	A_n, B_n to $Q_{A=B}$		18	20	ns
	$I_{A<B}$, $I_{A=B}$, $I_{A>B}$ to $Q_{A<B}$, $Q_{A>B}$		15	15	ns
	$I_{A=B}$ to $Q_{A=B}$		11	15	ns
C_I	input capacitance		3.5	3.5	pF
C_{PD}	power dissipation capacitance per package	notes 1 and 2	18	20	pF

GND = 0 V; T_{amb} = 25 °C; $t_r = t_f$ = 6 ns

Notes

1. C_{PD} is used to determine the dynamic power dissipation (P_D in μW):
   $P_D = C_{PD} \times V_{CC}^2 \times f_i + \Sigma (C_L \times V_{CC}^2 \times f_o)$ where:
   f_i = input frequency in MHz
   f_o = output frequency in MHz
   $\Sigma (C_L \times V_{CC}^2 \times f_o)$ = sum of outputs
   C_L = output load capacitance in pF
   V_{CC} = supply voltage in V
2. For HC the condition is V_I = GND to V_{CC}
   For HCT the condition is V_I = GND to V_{CC} − 1.5 V

PACKAGE OUTLINES

16-lead DIL; plastic (SOT38Z).
16-lead mini-pack; plastic (SO16; SOT109A).

PIN DESCRIPTION

PIN NO.	SYMBOL	NAME AND FUNCTION
2	$I_{A<B}$	A < B expansion input
3	$I_{A=B}$	A = B expansion input
4	$I_{A>B}$	A > B expansion input
5	$Q_{A>B}$	A > B output
6	$Q_{A=B}$	A = B output
7	$Q_{A<B}$	A < B output
8	GND	ground (0 V)
9, 11, 14, 1,	B_0 to B_3	word B inputs
10, 12, 13, 15	A_0 to A_3	word A inputs
16	V_{CC}	positive supply voltage

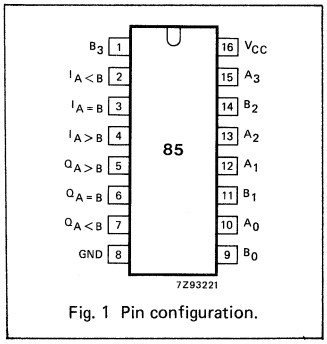

Fig. 1 Pin configuration.

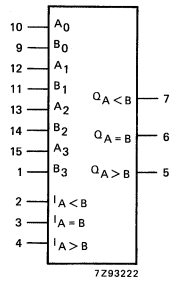

Fig. 2 Logic symbol.

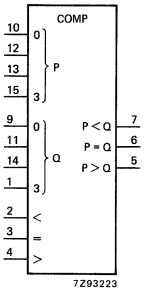

Fig. 3 IEC logic symbol.

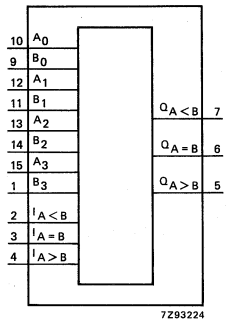

Fig. 4 Functional diagram.

APPLICATIONS

- Process controllers
- Servo-motor control

FUNCTION TABLE

COMPARING INPUTS				CASCADING INPUTS			OUTPUTS		
A_3, B_3	A_2, B_2	A_1, B_1	A_0, B_0	$I_{A>B}$	$I_{A<B}$	$I_{A=B}$	$Q_{A>B}$	$Q_{A<B}$	$Q_{A=B}$
$A_3>B_3$	X	X	X	X	X	X	H	L	L
$A_3<B_3$	X	X	X	X	X	X	L	H	L
$A_3=B_3$	$A_2>B_2$	X	X	X	X	X	H	L	L
$A_3=B_3$	$A_2<B_2$	X	X	X	X	X	L	H	L
$A_3=B_3$	$A_2=B_2$	$A_1>B_1$	X	X	X	X	H	L	L
$A_3=B_3$	$A_2=B_2$	$A_1<B_1$	X	X	X	X	L	H	L
$A_3=B_3$	$A_2=B_2$	$A_1=B_1$	$A_0>B_0$	X	X	X	H	L	L
$A_3=B_3$	$A_2=B_2$	$A_1=B_1$	$A_0<B_0$	X	X	X	L	H	L
$A_3=B_3$	$A_2=B_2$	$A_1=B_1$	$A_0=B_0$	H	L	L	H	L	L
$A_3=B_3$	$A_2=B_2$	$A_1=B_1$	$A_0=B_0$	L	H	L	L	H	L
$A_3=B_3$	$A_2=B_2$	$A_1=B_1$	$A_0=B_0$	L	L	H	L	L	H
$A_3=B_3$	$A_2=B_2$	$A_1=B_1$	$A_0=B_0$	X	X	H	L	L	H
$A_3=B_3$	$A_2=B_2$	$A_1=B_1$	$A_0=B_0$	H	H	L	L	L	L
$A_3=B_3$	$A_2=B_2$	$A_1=B_1$	$A_0=B_0$	L	L	L	H	H	L

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

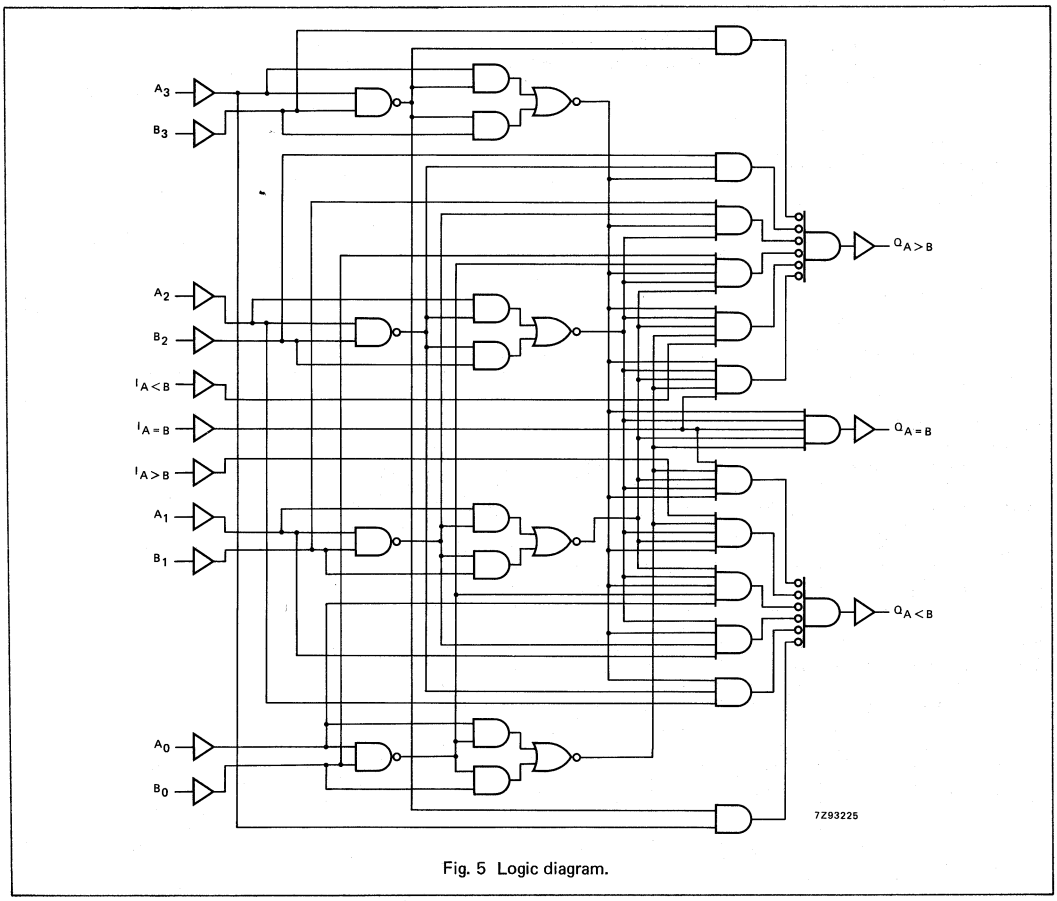

Fig. 5 Logic diagram.

DC CHARACTERISTICS FOR 74HC

For the DC characteristics see chapter "HCMOS family characteristics", section "Family specifications".

Output capability: standard
I_{CC} category: MSI

AC CHARACTERISTICS FOR 74HC

GND = 0 V; $t_r = t_f$ = 6 ns; C_L = 50 pF

SYMBOL	PARAMETER	T_{amb} (°C)							UNIT	TEST CONDITIONS	
		74HC								V_{CC} V	WAVEFORMS
		+25			−40 to +85		−40 to +125				
		min.	typ.	max.	min.	max.	min.	max.			
t_{PHL}/t_{PLH}	propagation delay A_n, B_n to $Q_{A>B}$ or $Q_{A<B}$		63 23 18	195 39 33		245 49 42		295 59 50	ns	2.0 4.5 6.0	Fig. 6
t_{PHL}/t_{PLH}	propagation delay A_n, B_n to $Q_{A=B}$		58 21 17	175 35 30		220 44 37		265 53 45	ns	2.0 4.5 6.0	Fig. 6
t_{PHL}/t_{PLH}	propagation delay $I_{A<B}$, $I_{A=B}$, $I_{A>B}$ to $Q_{A<B}$, $Q_{A>B}$		50 18 14	140 28 24		175 35 30		210 42 36	ns	2.0 4.5 6.0	Fig. 6
t_{PHL}/t_{PLH}	propagation delay $I_{A=B}$ to $Q_{A=B}$		39 14 11	120 24 20		150 30 26		180 36 31	ns	2.0 4.5 6.0	Fig. 6
t_{THL}/t_{TLH}	output transition time		19 7 6	75 15 13		95 19 16		110 22 19	ns	2.0 4.5 6.0	Fig. 6

DC CHARACTERISTICS FOR 74HCT

For the DC characteristics see chapter "HCMOS family characteristics", section "Family specifications".

Output capability: standard
I_{CC} category: MSI

Note to HCT types

The value of additional quiescent supply current (ΔI_{CC}) for a unit load of 1 is given in the family specifications. To determine ΔI_{CC} per input, multiply this value by the unit load coefficient shown in the table below.

INPUT	UNIT LOAD COEFFICIENT
$I_{A<B}$	1.00
$I_{A>B}$	1.00
$I_{A=B}$	1.50
A_n, B_n	1.50

AC CHARACTERISTICS FOR 74HCT

GND = 0 V; $t_r = t_f$ = 6 ns; C_L = 50 pF

SYMBOL	PARAMETER	T_{amb} (°C)							UNIT	TEST CONDITIONS	
		74HCT								V_{CC} V	WAVEFORMS
		+25			−40 to +85		−40 to +125				
		min.	typ.	max.	min.	max.	min.	max.			
t_{PHL}/t_{PLH}	propagation delay A_n, B_n to $Q_{A>B}$ or $Q_{A<B}$		26	44		55		66	ns	4.5	Fig. 6
t_{PHL}/t_{PLH}	propagation delay A_n, B_n to $Q_{A=B}$		24	40		50		60	ns	4.5	Fig. 6
t_{PHL}/t_{PLH}	propagation delay $I_{A<B}$, $I_{A=B}$, $I_{A>B}$ to $Q_{A<B}$, $Q_{A>B}$		18	31		39		47	ns	4.5	Fig. 6
t_{PHL}/t_{PLH}	propagation delay $I_{A=B}$ to $Q_{A=B}$		18	31		39		47	ns	4.5	Fig. 6
t_{THL}/t_{TLH}	output transition time		7	15		19		22	ns	4.5	Fig. 6

AC WAVEFORMS

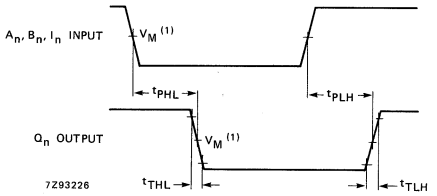

Fig. 6 Waveforms showing the word A inputs (A_n), word B inputs (B_n) and expansion inputs (I_n) to the outputs (Q_n) propagation delays and the output transition times.

Note to AC waveforms

(1) HC : V_M = 50%; V_I = GND to V_{CC}.
HCT: V_M = 1.3 V; V_I = GND to 3 V.

APPLICATION INFORMATION

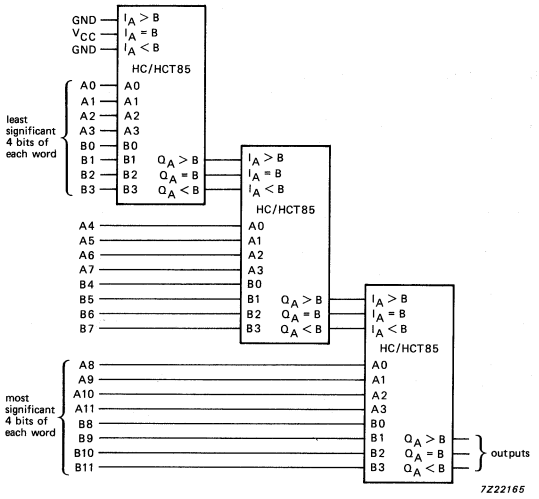

Fig. 7 Series cascading; comparing 12-bit words.

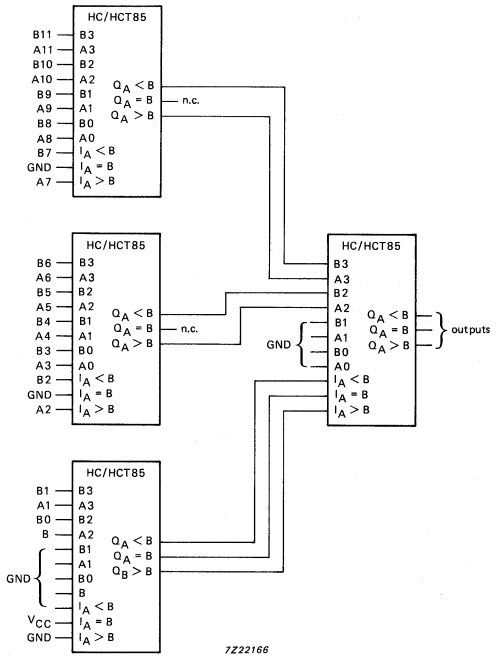

Fig. 8 Parallel cascading; comparing 12-bit words.