

High Speed CMOS Logic 4-Bit Magnitude Comparator

August 1997 - Revised May 2000

Features

- Buffered Inputs and Outputs
- Typical Propagation Delay: 13ns (Data to Output at $V_{CC} = 5V$, $C_L = 15pF$, $T_A = 25^\circ C$)
- Serial or Parallel Expansion Without External Gating
- Fanout (Over Temperature Range)
 - Standard Outputs 10 LSTTL Loads
 - Bus Driver Outputs 15 LSTTL Loads
- Wide Operating Temperature Range . . . $-55^\circ C$ to $125^\circ C$
- Balanced Propagation Delay and Transition Times
- Significant Power Reduction Compared to LSTTL Logic ICs
- HC Types
 - 2V to 6V Operation
 - High Noise Immunity: $N_{IL} = 30\%$, $N_{IH} = 30\%$ of V_{CC} at $V_{CC} = 5V$
- HCT Types
 - 4.5V to 5.5V Operation
 - Direct LSTTL Input Logic Compatibility, $V_{IL} = 0.8V$ (Max), $V_{IH} = 2V$ (Min)
 - CMOS Input Compatibility, $I_I \leq 1\mu A$ at V_{OL} , V_{OH}

Description

The 'HC85 and 'HCT85 are high speed magnitude comparators that use silicon-gate CMOS technology to achieve operating speeds similar to LSTTL with the low power consumption of standard CMOS integrated circuits.

These 4-bit devices compare two binary, BCD, or other monotonic codes and present the three possible magnitude results at the outputs ($A > B$, $A < B$, and $A = B$). The 4-bit input words 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 devices are expandable without external gating, in both serial and parallel fashion. The upper part of the truth table indicates operation using a single device or devices in a serially expanded application. The parallel expansion scheme is described by the last three entries in the truth table.

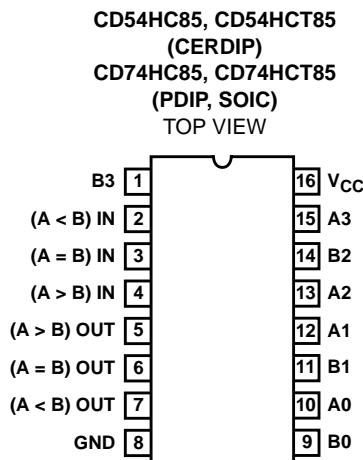
Ordering Information

PART NUMBER	TEMP. RANGE (°C)	PACKAGE
CD54HC85F3A	-55 to 125	16 Ld CERDIP
CD74HC85E	-55 to 125	16 Ld PDIP
CD74HC85M	-55 to 125	16 Ld SOIC
CD54HCT85F3A	-55 to 125	16 Ld CERDIP
CD74HCT85E	-55 to 125	16 Ld PDIP
CD74HCT85M	-55 to 125	16 Ld SOIC

NOTES:

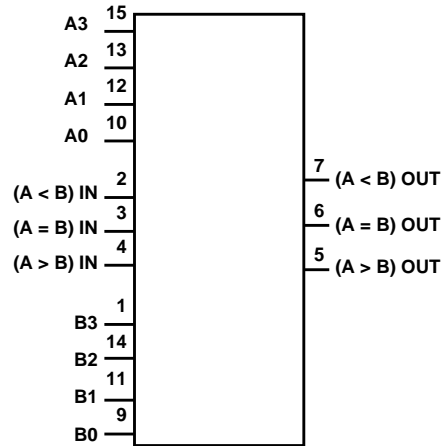
1. When ordering, use the entire part number. Add the suffix 96 to obtain the variant in the tape and reel.
2. Die for this part number is available which meets all electrical specifications. Please contact your local TI sales office or customer service for ordering information.

Pinout



CD54/74HC85, CD54/74HCT85

Functional Diagram



TRUTH TABLE

COMPARING INPUTS				CASCADING INPUTS			OUTPUTS		
A3, B3	A2, B2	A1, B1	A0, B0	A > B	A < B	A = B	A > B	A < B	A = B
SINGLE DEVICE OR SERIES CASCADING									
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
PARALLEL CASCADING									
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 = B2S	A1 = B1	A0 = B0	L	L	L	H	H	L

NOTE: H = High Voltage Level, L = Low Voltage, Level, X = Don't Care

CD54/74HC85, CD54/74HCT85

Absolute Maximum Ratings

DC Supply Voltage, V_{CC}	-0.5V to 7V
DC Input Diode Current, I_{IK}	
For $V_I < -0.5V$ or $V_I > V_{CC} + 0.5V$	$\pm 20mA$
DC Output Diode Current, I_{OK}	
For $V_O < -0.5V$ or $V_O > V_{CC} + 0.5V$	$\pm 20mA$
DC Output Source or Sink Current per Output Pin, I_O	
For $V_O > -0.5V$ or $V_O < V_{CC} + 0.5V$	$\pm 25mA$
DC V_{CC} or Ground Current, I_{CC} or I_{GND}	$\pm 50mA$

Thermal Information

Thermal Resistance (Typical, Note 3)	θ_{JA} ($^{\circ}C/W$)
PDIP Package	90
SOIC Package	190
Maximum Junction Temperature	$150^{\circ}C$
Maximum Storage Temperature Range	$-65^{\circ}C$ to $150^{\circ}C$
Maximum Lead Temperature (Soldering 10s)	$300^{\circ}C$ (SOIC - Lead Tips Only)

Operating Conditions

Temperature Range (T_A)	$-55^{\circ}C$ to $125^{\circ}C$
Supply Voltage Range, V_{CC}	
HC Types2V to 6V
HCT Types	4.5V to 5.5V
DC Input or Output Voltage, V_I , V_O	0V to V_{CC}
Input Rise and Fall Time	
2V	1000ns (Max)
4.5V	500ns (Max)
6V	400ns (Max)

CAUTION: Stresses above those listed in "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress only rating and operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied.

NOTE:

- θ_{JA} is measured with the component mounted on an evaluation PC board in free air.

DC Electrical Specifications

PARAMETER	SYMBOL	TEST CONDITIONS		V_{CC} (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS	
		V_I (V)	I_O (mA)		MIN	TYP	MAX	MIN	MAX	MIN	MAX		
HC TYPES													
High Level Input Voltage	V_{IH}	-	-	2	1.5	-	-	1.5	-	1.5	-	V	
				4.5	3.15	-	-	3.15	-	3.15	-	V	
				6	4.2	-	-	4.2	-	4.2	-	V	
Low Level Input Voltage	V_{IL}	-	-	2	-	-	0.5	-	0.5	-	0.5	V	
				4.5	-	-	1.35	-	1.35	-	1.35	V	
				6	-	-	1.8	-	1.8	-	1.8	V	
High Level Output Voltage CMOS Loads	V_{OH}	V_{IH} or V_{IL}	-0.02	-0.02	2	1.9	-	-	1.9	-	1.9	-	V
			-0.02	-0.02	4.5	4.4	-	-	4.4	-	4.4	-	V
			-0.02	-0.02	6	5.9	-	-	5.9	-	5.9	-	V
High Level Output Voltage TTL Loads	V_{OH}	V_{IH} or V_{IL}	-	-	-	-	-	-	-	-	-	V	
			-4	-4	4.5	3.98	-	-	3.84	-	3.7	-	V
			-5.2	-5.2	6	5.48	-	-	5.34	-	5.2	-	V
Low Level Output Voltage CMOS Loads	V_{OL}	V_{IH} or V_{IL}	0.02	0.02	2	-	-	0.1	-	0.1	-	0.1	V
			0.02	0.02	4.5	-	-	0.1	-	0.1	-	0.1	V
			0.02	0.02	6	-	-	0.1	-	0.1	-	0.1	V
Low Level Output Voltage TTL Loads	V_{OL}	V_{IH} or V_{IL}	4	4	4.5	-	-	0.26	-	0.33	-	0.4	V
			5.2	5.2	6	-	-	0.26	-	0.33	-	0.4	V
Input Leakage Current	I_I	V_{CC} or GND	-	6	-	-	± 0.1	-	± 1	-	± 1	μA	
Quiescent Device Current	I_{CC}	V_{CC} or GND	0	6	-	-	8	-	80	-	160	μA	

CD54/74HC85, CD54/74HCT85

DC Electrical Specifications (Continued)

PARAMETER	SYMBOL	TEST CONDITIONS		V _{CC} (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS
		V _I (V)	I _O (mA)		MIN	TYP	MAX	MIN	MAX	MIN	MAX	
HCT TYPES												
High Level Input Voltage	V _{IH}	-	-	4.5 to 5.5	2	-	-	2	-	2	-	V
Low Level Input Voltage	V _{IL}	-	-	4.5 to 5.5	-	-	0.8	-	0.8	-	0.8	V
High Level Output Voltage CMOS Loads	V _{OH}	V _{IH} or V _{IL}	-0.02	4.5	4.4	-	-	4.4	-	4.4	-	V
High Level Output Voltage TTL Loads			-4	4.5	3.98	-	-	3.84	-	3.7	-	V
Low Level Output Voltage CMOS Loads	V _{OL}	V _{IH} or V _{IL}	0.02	4.5	-	-	0.1	-	0.1	-	0.1	V
Low Level Output Voltage TTL Loads			4	4.5	-	-	0.26	-	0.33	-	0.4	V
Input Leakage Current	I _I	V _{CC} and GND	0	5.5	-	-	±0.1	-	±1	-	±1	μA
Quiescent Device Current	I _{CC}	V _{CC} or GND	0	5.5	-	-	8	-	80	-	160	μA
Additional Quiescent Device Current Per Input Pin: 1 Unit Load (Note)	ΔI _{CC}	V _{CC} -2.1	-	4.5 to 5.5	-	100	360	-	450	-	490	μA

NOTE: For dual-supply systems theoretical worst case (V_I = 2.4V, V_{CC} = 5.5V) specification is 1.8mA.

HCT Input Loading Table

INPUT	UNIT LOADS
A0-A3, B0-B3 and (A = B) IN	1.5
(A > B) IN, (A < B) IN	1

NOTE: Unit Load is ΔI_{CC} limit specified in DC Electrical Table, e.g. 360μA max at 25°C.

Switching Specifications Input t_r, t_f = 6ns

PARAMETER	SYMBOL	TEST CONDITIONS	V _{CC} (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
HC TYPES											
Propagation Delay, A _n , B _n to (A > B) OUT, (A < B) OUT	t _{pLH} , t _{pHL}	C _L = 50pF	2	-	-	195	-	245	-	295	ns
			4.5	-	-	39	-	47	-	59	ns
		C _L = 15pF	5	-	16	-	-	-	-	-	ns
		C _L = 50pF	6	-	-	33	-	42	-	50	ns
A _n , B _n to (A = B) OUT	t _{pLH} , t _{pHL}	C _L = 50pF	2	-	-	175	-	240	-	265	ns
			4.5	-	-	35	-	44	-	53	ns
		C _L = 15pF	5	-	14	-	-	-	-	-	ns
		C _L = 50pF	6	-	-	30	-	37	-	45	ns

CD54/74HC85, CD54/74HCT85

Switching Specifications Input $t_r, t_f = 6\text{ns}$ (Continued)

PARAMETER	SYMBOL	TEST CONDITIONS	V_{CC} (V)	25°C			-40°C TO 85°C		-55°C TO 125°C		UNITS	
				MIN	TYP	MAX	MIN	MAX	MIN	MAX		
(A > B) IN, (A < B) IN, (A = B) IN to (A > B) OUT, (A < B) OUT	t_{PLH}, t_{PHL}	$C_L = 50\text{pF}$	2	-	-	140	-	175	-	210	ns	
			4.5	-	-	28	-	35	-	42	ns	
			$C_L = 15\text{pF}$	5	-	11	-	-	-	-	-	ns
			$C_L = 50\text{pF}$	6	-	-	24	-	30	-	36	ns
(A > B) IN to (A = B) OUT	t_{PLH}, t_{PHL}	$C_L = 50\text{pF}$	2	-	-	120	-	150	-	180	ns	
			4.5	-	-	24	-	30	-	36	ns	
			$C_L = 15\text{pF}$	5	-	9	-	-	-	-	-	ns
			$C_L = 50\text{pF}$	6	-	-	20	-	26	-	31	ns
Power Dissipation Capacitance (Notes 4, 5)	C_{PD}	-	5	-	24	-	-	-	-	-	pF	
Output Transition Times (Figure 1)	t_{TLH}, t_{THL}	$C_L = 50\text{pF}$	2	-	-	75	-	95	-	110	ns	
			4.5	-	-	15	-	19	-	22	ns	
			6	-	-	13	-	16	-	19	ns	
Input Capacitance	C_{IN}	-	-	-	-	10	-	10	-	10	pF	
HCT TYPES												
Propagation Delay, An, Bn to (A > B) OUT, (A < B) OUT	t_{PLH}, t_{PHL}	$C_L = 50\text{pF}$	4.5	-	-	37	-	46	-	56	ns	
			$C_L = 15\text{pF}$	5	-	15	-	-	-	-	-	ns
An, Bn to (A = B) OUT	t_{PLH}, t_{PHL}	$C_L = 50\text{pF}$	4.5	-	-	40	-	50	-	60	ns	
			$C_L = 15\text{pF}$	5	-	17	-	-	-	-	-	ns
(A > B) IN, (A < B) IN, (A = B) IN to (A > B) OUT, (A < B) OUT	t_{PLH}, t_{PHL}	$C_L = 50\text{pF}$	4.5	-	-	30	-	38	-	45	ns	
			$C_L = 15\text{pF}$	5	-	12	-	-	-	-	-	ns
(A > B) IN to (A = B) OUT	t_{PLH}, t_{PHL}	$C_L = 50\text{pF}$	4.5	-	-	31	-	39	-	47	ns	
			$C_L = 15\text{pF}$	5	-	13	-	-	-	-	-	ns
Output Transition Times (Figure 1)	t_{TLH}, t_{THL}	$C_L = 50\text{pF}$	4.5	-	-	15	-	19	-	22	ns	
Power Dissipation Capacitance (Notes 4, 5)	C_{PD}	-	5	-	26	-	-	-	-	-	pF	
Input Capacitance	C_{IN}	-	-	-	-	10	-	10	-	10	pF	

NOTES:

- C_{PD} is used to determine the dynamic power consumption, per gate/package.
- $P_D = V_{CC}^2 f_i (C_{PD} + C_L)$ where f_i = Input Frequency, C_L = Output Load Capacitance, V_{CC} = Supply Voltage.

Test Circuits and Waveforms

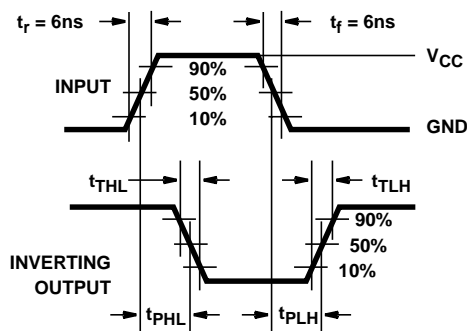


FIGURE 1. HC AND HCU TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

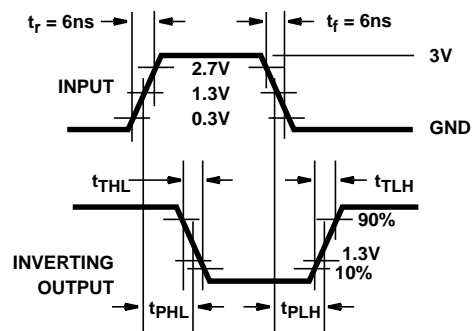


FIGURE 2. HCT TRANSITION TIMES AND PROPAGATION DELAY TIMES, COMBINATION LOGIC

Test Circuits and Waveforms

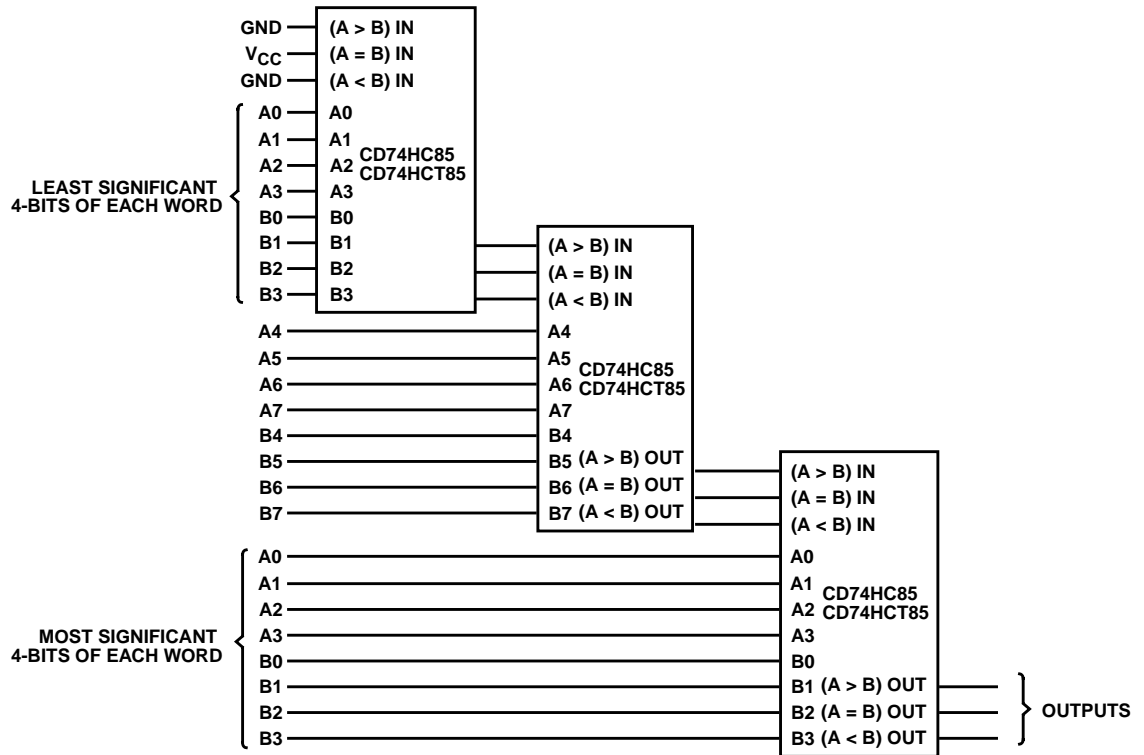


FIGURE 3. SERIES CASCADING - COMPARING 12-BIT WORDS

Test Circuits and Waveforms

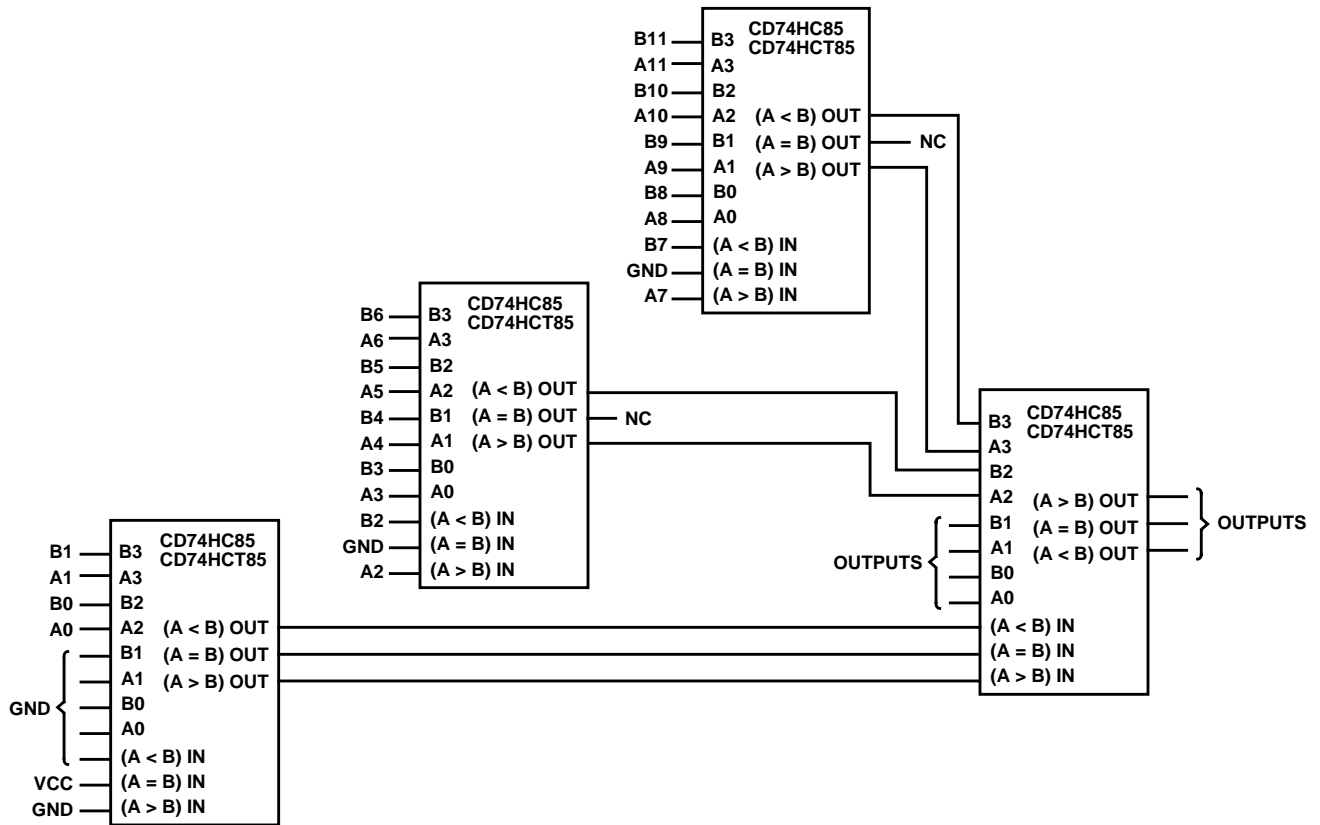


FIGURE 4. PARALLEL CASCADING - COMPARING 12-BIT WORDS

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