TYPE	TYPICAL POWER DISSIPATION	TYPICAL DELAY (4-BIT WORDS)
'85	275 mW	23 ns
'LS85	52 mW	24 ns
'S85	365 mW	11 ns

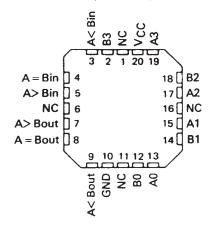## description

These four-bit magnitude comparators perform comparison of straight binary and straight BCD (8-4-2-1) codes. Three fully decoded decisions about two 4-bit words (A, B) are made and are externally available at three outputs. These devices are fully expandable to any number of bits without external gates. Words of greater length may be compared by connecting comparators in cascade. The $A > B$, $A < B$, and $A = B$ outputs of a stage handling less-significant bits are connected to the corresponding $A > B$, $A < B$, and $A = B$ inputs of the next stage handling more-significant bits. The stage handling the least-significant bits must have a high-level voltage applied to the $A = B$ input. The cascading paths of the '85, 'LS85, and 'S85 are implemented with only a two-gate-level delay to reduce overall comparison times for long words. An alternate method of cascading which further reduces the comparison time is shown in the typical application data.

SN5485, SN54LS85, SN54S85 . . . J OR W PACKAGE
SN7485 : . . N PACKAGE
SN74LS85, SN74S85 . . . D OR N PACKAGE
(TOP VIEW)

```
          B3  [ 1  ⌴ 16 ]  VCC
      A< Bin  [ 2    15 ]  A3
      A = Bin [ 3    14 ]  B2
      A> Bin  [ 4    13 ]  A2
      A> Bout [ 5    12 ]  A1
      A = Bout[ 6    11 ]  B1
      A< Bout [ 7    10 ]  A0
         GND  [ 8     9 ]  B0
```

SN54LS85, SN54S85 . . . FK PACKAGE
(TOP VIEW)

```
              A< Bin
              B3
              NC
              VCC
              A3
               3  2  1  20 19
   A = Bin  [ 4             18 ]  B2
   A> Bin   [ 5             17 ]  A2
     NC     [ 6             16 ]  NC
   A> Bout  [ 7             15 ]  A1
   A = Bout [ 8             14 ]  B1
               9  10 11 12 13
              A< Bout
              GND
              NC
              B0
              A0
```

NC - No internal connection

FUNCTION 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
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 = B2	A2 = B2	A1 > B1	X	X	X	X	H	L	L
A3 = B3	A2 = B2	A1 < B1	X	X	X	X	L	H	L
A2 = 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	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

TEXAS INSTRUMENTS

logic diagrams (positive logic)

A3 (15)
B3 (1)

A2 (13)
B2 (14)

A < B (2)
A = B (3)
A > B (4)

A1 (12)
B1 (11)

A0 (10)
B0 (9)

(5) A > B

(6) A = B

(7) A < B

logic symbol†

COMP

P0 (10)   0
P1 (12)
P2 (13)   P
P3 (15)   3
P<Q (2)   <   P<Q (7)   P<Q
P=Q (3)   =   P=Q (6)   P=Q
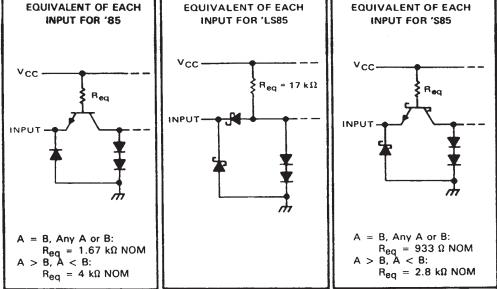P>Q (4)   >   P>Q (5)   P>Q
Q0 (9)   0
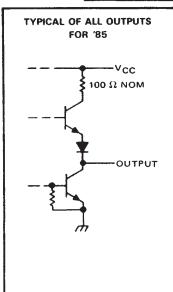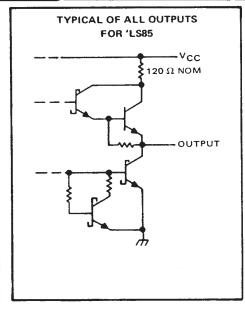Q1 (11)
Q2 (14)   Q
Q3 (1)   3

†This symbol is in accordancae with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.
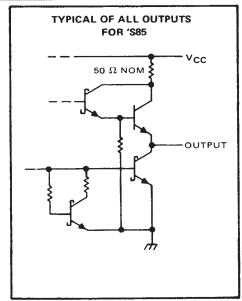Pin numbers shown are for D, J, N, and W packages.

schematics of inputs and outputs

EQUIVALENT OF EACH INPUT FOR '85

A = B, Any A or B:
R_{eq} = 1.67 kΩ NOM
A > B, A < B:
R_{eq} = 4 kΩ NOM

EQUIVALENT OF EACH INPUT FOR 'LS85

R_{eq} = 17 kΩ

EQUIVALENT OF EACH INPUT FOR 'S85

A = B, Any A or B:
R_{eq} = 933 Ω NOM
A > B, A < B:
R_{eq} = 2.8 kΩ NOM

TYPICAL OF ALL OUTPUTS FOR '85

100 Ω NOM

TYPICAL OF ALL OUTPUTS FOR 'LS85

120 Ω NOM

TYPICAL OF ALL OUTPUTS FOR 'S85

50 Ω NOM

absolute maximum ratings over operating free-air temperature range (unless otherwise noted)

	SN54' SN54S'	SN54LS'	SN74' SN74S'	SN74LS'	UNIT
Supply voltage, V_{CC} (see Note 1)	7	7	7	7	V
Input voltage	5.5	7	5.5	7	V
Interemitter voltage (see Note 2)	5.5		5.5		V
Operating free-air temperature range	– 55 to 125		– 0 to 70		°C
Storage temperature range	– 65 to 150		– 65 to 150		°C

NOTES: 1. Voltage values, except interemitter voltage, are with respect to network ground terminal.
2. This is the voltage between two emitters of a multiple-emitter input transistor. This rating applies to each A input in conjunction with its respective B input of the '85 and 'S85.

recommended operating conditions

	SN5485			SN7485			UNIT
	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			−400			−400	μA
Low-level output current, I_{OL}			16			16	mA
Operating free-air temperature, T_A	−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS[†]			MIN	TYP[‡]	MAX	UNIT
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.8	V
V_{IK}	Input clamp voltage	V_{CC} = MIN,	I_I = −12 mA				−1.5	V
V_{OH}	High-level output voltage	V_{CC} = MIN, V_{IL} = 0.8 V,	V_{IH} = 2 V, I_{OH} = −400 μA		2.4	3.4		V
V_{OL}	Low-level output voltage	V_{CC} = MIN, V_{IL} = 0.8 V,	V_{IH} = 2 V, I_{OL} = 16 mA			0.2	0.4	V
I_I	Input current at maximum input voltage	V_{CC} = MAX,	V_I = 5.5 V				1	mA
I_{IH}	High-level input current	$A < B, A > B$ inputs	V_{CC} = MAX,	V_I = 2.4 V			40	μA
		all other inputs					120	
I_{IL}	Low-level input current	$A < B, A > B$ inputs	V_{CC} = MAX,	V_I = 0.4 V			−1.6	mA
		all other inputs					−4.8	
I_{OS}	Short-circuit output current[§]	V_{CC} = MAX, V_O = 0	SN5485		−20		−55	mA
			SN7485		−18		−55	
I_{CC}	Supply current	V_{CC} = MAX, See Note 4				55	88	mA

[†]For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
[‡]All typical values are at V_{CC} = 5 V, T_A = 25°C.
[§]Not more than one output should be shorted at a time.
NOTE 4: I_{CC} is measured with outputs open, A = B grounded, and all other inputs at 4.5 V.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER[¶]	FROM INPUT	TO OUTPUT	NUMBER OF GATE LEVELS	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}	Any A or B data input	$A < B, A > B$	1			7		ns
			2			12		
			3			17	26	
		$A = B$	4			23	35	
t_{PHL}	Any A or B data input	$A < B, A > B$	1	C_L = 15 pF, R_L = 400 Ω, See Note 5		11		ns
			2			15		
			3			20	30	
		$A = B$	4			20	30	
t_{PLH}	$A < B$ or $A = B$	$A > B$	1			7	11	ns
t_{PHL}	$A < B$ or $A = B$	$A > B$	1			11	17	ns
t_{PLH}	$A = B$	$A = B$	2			13	20	ns
t_{PHL}	$A = B$	$A = B$	2			11	17	ns
t_{PLH}	$A > B$ or $A = B$	$A < B$	1			7	11	ns
t_{PHL}	$A > B$ or $A = B$	$A < B$	1			11	17	ns

[¶]t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output
NOTE 5: Load circuits and voltage waveforms are shown in Section 1.

TEXAS INSTRUMENTS

recommended operating conditions

	SN54LS85 MIN	SN54LS85 NOM	SN54LS85 MAX	SN74LS85 MIN	SN74LS85 NOM	SN74LS85 MAX	UNIT
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			−400			−400	μA
Low-level output current, I_{OL}			4			8	mA
Operating free-air temperature, T_A	−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS[†]		SN54LS85 MIN	SN54LS85 TYP[‡]	SN54LS85 MAX	SN74LS85 MIN	SN74LS85 TYP[‡]	SN74LS85 MAX	UNIT
V_{IH}	High-level input voltage			2			2			V
V_{IL}	Low-level input voltage					0.7			0.7	V
V_{IK}	Input clamp voltage	V_{CC} = MIN,	I_I = −18 mA			−1.5			−1.5	V
V_{OH}	High-level output voltage	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = V_{IL} max, I_{OH} = −400 μA		2.5	3.4		2.7	3.4		V
V_{OL}	Low-level output voltage	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = V_{IL} max	I_{OL} = 4 mA		0.25	0.4		0.25	0.4	V
			I_{OL} = 8 mA					0.35	0.5	
I_I	Input current at maximum input voltage	A < B, A > B inputs	V_{CC} = MAX, V_I = 7 V			0.1			0.1	mA
		all other inputs				0.3			0.3	
I_{IH}	High-level input current	A < B, A > B inputs	V_{CC} = MAX, V_I = 2.7 V			20			20	μA
		all other inputs				60			60	
I_{IL}	Low-level input current	A < B, A > B inputs	V_{CC} = MAX, V_I = 0.4 V			−0.4			−0.4	mA
		all other inputs				−1.2			−1.2	
I_{OS}	Short-circuit output current[§]	V_{CC} = MAX		−20		−100	−20		−100	mA
I_{CC}	Supply current	V_{CC} = MAX,	See Note 4		10.4	20		10.4	20	mA

[†]For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
[‡]All typical values are at V_{CC} = 5 V, T_A = 25°C.
[§]Not more than one output should be shorted at a time, and duration of the short-circuit should not exceed one second.
NOTE 4: I_{CC} is measured with outputs open, A = B grounded, and all other inputs at 4.5 V.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER[¶]	FROM INPUT	TO OUTPUT	NUMBER OF GATE LEVELS	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}	Any A or B data input	A < B, A > B	1			14		ns
			2			19		
			3			24	36	
		A = B	4			27	45	
t_{PHL}	Any A or B data input	A < B, A > B	1	C_L = 15 pF, R_L = 2 kΩ, See Note 5		11		ns
			2			15		
			3			20	30	
		A = B	4			23	45	
t_{PLH}	A < B or A = B	A > B	1			14	22	ns
t_{PHL}	A < B or A = B	A > B	1			11	17	ns
t_{PLH}	A = B	A = B	2			13	20	ns
t_{PHL}	A = B	A = B	2			13	26	ns
t_{PLH}	A > B or A = B	A < B	1			14	22	ns
t_{PHL}	A > B or A = B	A < B	1			11	17	ns

[¶]t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output
NOTE 5: Load circuits and voltage waveforms are shown in Section 1.

recommended operating conditions

	SN54S85			SN74S85			UNIT
	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}			−1			−1	mA
Low-level output current, I_{OL}			20			20	mA
Operating free-air temperature, T_A	−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS[†]		MIN	TYP[‡]	MAX	UNIT
V_{IH}	High-level input voltage			2			V
V_{IL}	Low-level input voltage					0.8	V
V_{IK}	Input clamp voltage	V_{CC} = MIN, I_I = −18 mA				−1.2	V
V_{OH}	High-level output voltage	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OH} = −1 mA	SN54S85	2.5	3.4		V
			SN74S85	2.7	3.4		
V_{OL}	Low-level output voltage	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OL} = 20 mA				0.5	V
I_I	Input current at maximum input voltage	V_{CC} = MAX, V_I = 5.5 V				1	mA
I_{IH}	High-level input current	A < B, A > B inputs	V_{CC} = MAX, V_I = 2.7 V			50	μA
		all other inputs				150	
I_{IL}	Low-level input current	A < B, A > B inputs	V_{CC} = MAX, V_I = 0.5 V			−2	mA
		all other inputs				−6	
I_{OS}	Short-circuit output current[§]	V_{CC} = MAX		−40		−100	mA
I_{CC}	Supply current	V_{CC} = MAX, See Note 4			73	115	mA
		V_{CC} = MAX, T_A = 125°C, See Note 4	SN54S85W			110	

[†] For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
[‡] All typical values are at V_{CC} = 5 V, T_A = 25°C.
[§] Not more than one output should be shorted at a time, and duration of the short-circuit should not exceed one second.
NOTE 4: I_{CC} is measured with outputs open, A = B grounded, and all other inputs at 4.5 V.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER[¶]	FROM INPUT	TO OUTPUT	NUMBER OF GATE LEVELS	TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PLH}	Any A or B data input	A < B, A > B	1			5		ns
			2			7.5		
			3			10.5	16	
		A = B	4			12	18	
t_{PHL}	Any A or B data input	A < B, A > B	1	C_L = 15 pF, R_L = 280 Ω, See Note 5		5.5		ns
			2			7		
			3			11	16.5	
		A = B	4			11	16.5	
t_{PLH}	A < B or A = B	A > B	1			5	7.5	ns
t_{PHL}	A < B or A = B	A > B	1			5.5	8.5	ns
t_{PLH}	A = B	A = B	2			7	10.5	ns
t_{PHL}	A = B	A = B	2			5	7.5	ns
t_{PLH}	A > B or A = B	A < B	1			5	7.5	ns
t_{PHL}	A > B or A = B	A < B	1			5.5	8.5	ns

[¶] t_{PLH} = propagation delay time, low-to-high-level output
t_{PHL} = propagation delay time, high-to-low-level output
NOTE 5: Load circuits and voltage waveforms are shown in Section 1.

![Texas Instruments logo]
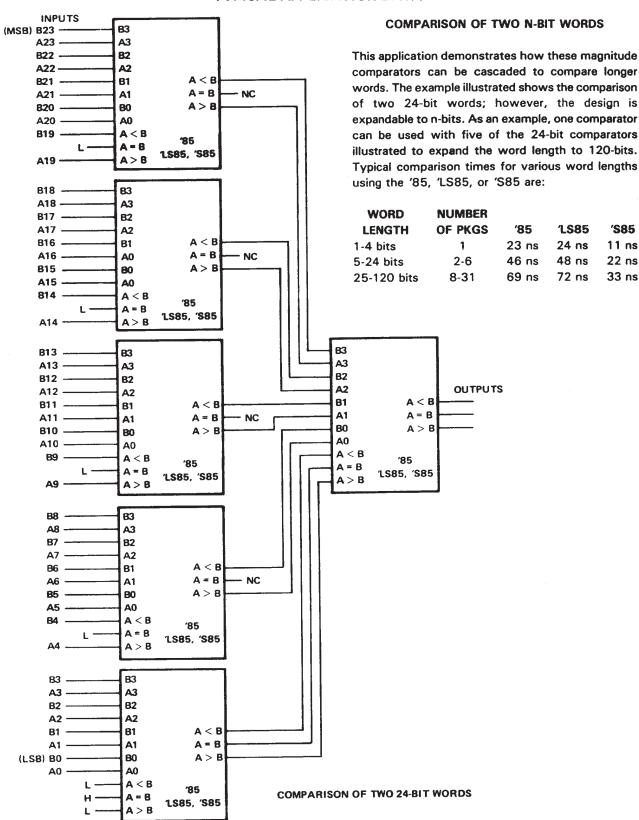**TEXAS INSTRUMENTS**

TYPICAL APPLICATION DATA

COMPARISON OF TWO N-BIT WORDS

This application demonstrates how these magnitude comparators can be cascaded to compare longer words. The example illustrated shows the comparison of two 24-bit words; however, the design is expandable to n-bits. As an example, one comparator can be used with five of the 24-bit comparators illustrated to expand the word length to 120-bits. Typical comparison times for various word lengths using the '85, 'LS85, or 'S85 are:

WORD LENGTH	NUMBER OF PKGS	'85	'LS85	'S85
1-4 bits	1	23 ns	24 ns	11 ns
5-24 bits	2-6	46 ns	48 ns	22 ns
25-120 bits	8-31	69 ns	72 ns	33 ns

COMPARISON OF TWO 24-BIT WORDS

IMPORTANT NOTICE

Texas Instruments and its subsidiaries (TI) reserve the right to make changes to their products or to discontinue any product or service without notice, and advise customers to obtain the latest version of relevant information to verify, before placing orders, that information being relied on is current and complete. All products are sold subject to the terms and conditions of sale supplied at the time of order acknowledgement, including those pertaining to warranty, patent infringement, and limitation of liability.

TI warrants performance of its semiconductor products to the specifications applicable at the time of sale in accordance with TI's standard warranty. Testing and other quality control techniques are utilized to the extent TI deems necessary to support this warranty. Specific testing of all parameters of each device is not necessarily performed, except those mandated by government requirements.

CERTAIN APPLICATIONS USING SEMICONDUCTOR PRODUCTS MAY INVOLVE POTENTIAL RISKS OF DEATH, PERSONAL INJURY, OR SEVERE PROPERTY OR ENVIRONMENTAL DAMAGE ("CRITICAL APPLICATIONS"). TI SEMICONDUCTOR PRODUCTS ARE NOT DESIGNED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS. INCLUSION OF TI PRODUCTS IN SUCH APPLICATIONS IS UNDERSTOOD TO BE FULLY AT THE CUSTOMER'S RISK.

In order to minimize risks associated with the customer's applications, adequate design and operating safeguards must be provided by the customer to minimize inherent or procedural hazards.

TI assumes no liability for applications assistance or customer product design. TI does not warrant or represent that any license, either express or implied, is granted under any patent right, copyright, mask work right, or other intellectual property right of TI covering or relating to any combination, machine, or process in which such semiconductor products or services might be or are used. TI's publication of information regarding any third party's products or services does not constitute TI's approval, warranty or endorsement thereof.