

SN5485, SN54LS85, SN54S85 SN7485, SN74LS85, SN74S85 4-BIT MAGNITUDE COMPARATORS

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

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



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.

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



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 |

PRODUCTION DATA information is current as of publication date. Products conform to specifications per the terms of Texas Instruments standard warranty. Production processing does not necessarily include testing of all parameters.



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logic diagrams (positive logic)



logic symbol †



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



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schematics of inputs and outputs



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.

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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 | | | $^{\circ}C$ |

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 | $V_{CC} = \text{MIN}, I_I = -12 \text{ mA}$ | | | -1.5 | V |
| V_{OH} | High-level output voltage | $V_{CC} = \text{MIN}, V_{IL} = 0.8 \text{ V}, I_{OH} = -400 \mu A$ | 2.4 | 3.4 | | V |
| V_{OL} | Low-level output voltage | $V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, I_{OL} = 16 \text{ mA}$ | 0.2 | 0.4 | | V |
| I_I | Input current at maximum input voltage | $V_{CC} = \text{MAX}, V_I = 5.5 \text{ V}$ | | | 1 | mA |
| I_{IH} | High-level input current | A < B, A > B inputs | | | 40 | μA |
| | | all other inputs | | | 120 | |
| I_{IL} | Low-level input current | A < B, A > B inputs | | | -1.6 | mA |
| | | all other inputs | | | -4.8 | |
| I_{OS} | Short-circuit output current§ | $V_{CC} = \text{MAX}, V_O = 0$ | SN5485 | -20 | -55 | mA |
| | | | SN7485 | -18 | -55 | |
| I_{CC} | Supply current | $V_{CC} = \text{MAX},$ 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 $V_{CC} = 5 \text{ V}, T_A = 25^{\circ}C$.

§ 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, $V_{CC} = 5 \text{ V}, T_A = 25^{\circ}C$

| 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 | $C_L = 15 \text{ pF}, R_L = 400 \Omega,$ See Note 5 | | 7 | | ns |
| | | | 2 | | | 12 | | |
| | | 3 | | | 17 | 26 | | |
| | | 4 | | | 23 | 35 | | |
| t_{PHL} | Any A or B data input | A < B, A > B | 1 | | | 11 | | ns |
| | | | 2 | | | 15 | | |
| | | 3 | | | 20 | 30 | | |
| | | 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.



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recommended operating conditions

| | SN54LS85 | | | SN74LS85 | | | 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 | μ A |
| Low-level output current, I_{OL} | | | 4 | | | 8 | mA |
| Operating free-air temperature, T_A | -55 | | 125 | 0 | | 70 | $^{\circ}$ C |

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

| PARAMETER | | TEST CONDITIONS [†] | SN54LS85 | | SN74LS85 | | UNIT |
|-----------|---|---|----------|------------------|----------|------|---------|
| | | | MIN | TYP [‡] | MAX | MIN | |
| 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 | $V_{CC} = \text{MIN}, I_I = -18 \text{ mA}$ | | -1.5 | | -1.5 | V |
| V_{OH} | High-level output voltage | $V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = V_{IL \text{ max}}, I_{OH} = -400 \mu\text{A}$ | 2.5 | 3.4 | 2.7 | 3.4 | V |
| V_{OL} | Low-level output voltage | $V_{CC} = \text{MIN}, I_{OL} = 4 \text{ mA}$ | 0.25 | 0.4 | 0.25 | 0.4 | V |
| | | $V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = V_{IL \text{ max}}, I_{OL} = 8 \text{ mA}$ | | | 0.35 | 0.5 | |
| I_I | Input current at maximum input voltage | A < B, A > B inputs | 0.1 | | 0.1 | | mA |
| | | all other inputs | 0.3 | | 0.3 | | |
| I_{IH} | High-level input current | A < B, A > B inputs | 20 | | 20 | | μ A |
| | | all other inputs | 60 | | 60 | | |
| I_{IL} | Low-level input current | A < B, A > B inputs | -0.4 | | -0.4 | | mA |
| | | all other inputs | -1.2 | | -1.2 | | |
| I_{OS} | Short-circuit output current [§] | $V_{CC} = \text{MAX}$ | -20 | -100 | -20 | -100 | mA |
| I_{CC} | Supply current | $V_{CC} = \text{MAX}, \text{ See Note 4}$ | 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 $V_{CC} = 5 \text{ V}, T_A = 25^{\circ}\text{C}$.

[§]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, $V_{CC} = 5 \text{ V}, T_A = 25^{\circ}\text{C}$

| 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 | $C_L = 15 \text{ pF}, R_L = 2 \text{ k}\Omega, \text{ See Note 5}$ | | 14 | | ns |
| | | | 2 | | | 19 | | |
| | | | 3 | | | 24 | 36 | |
| | | | 4 | | | 27 | 45 | |
| t_{PHL} | Any A or B data input | A < B, A > B | 1 | | | 11 | | ns |
| | | | 2 | | | 15 | | |
| | | | 3 | | | 20 | 30 | |
| | | | 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.

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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 | $V_{CC} = \text{MIN}, I_I = -18 \text{ mA}$ | | | -1.2 | V |
| V_{OH} | High-level output voltage | $V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = 0.8 \text{ V}, I_{OH} = -1 \text{ mA}$ | SN54S85 2.5 | 3.4 | | V |
| V_{OL} | Low-level output voltage | $V_{CC} = \text{MIN}, V_{IH} = 2 \text{ V}, V_{IL} = 0.8 \text{ V}, I_{OL} = 20 \text{ mA}$ | | | 0.5 | V |
| I_I | Input current at maximum input voltage | $V_{CC} = \text{MAX}, V_I = 5.5 \text{ V}$ | | | 1 | mA |
| I_{IH} | High-level input current | A < B, A > B inputs | $V_{CC} = \text{MAX}, V_I = 2.7 \text{ V}$ | | 50 | μA |
| | | all other inputs | | | 150 | |
| I_{IL} | Low-level input current | A < B, A > B inputs | $V_{CC} = \text{MAX}, V_I = 0.5 \text{ V}$ | | -2 | mA |
| | | all other inputs | | | -6 | |
| I_{OS} | Short-circuit output current§ | $V_{CC} = \text{MAX}$ | -40 | | -100 | mA |
| I_{CC} | Supply current | $V_{CC} = \text{MAX}$, See Note 4 | | 73 | 115 | mA |
| | | $V_{CC} = \text{MAX}, T_A = 125^\circ\text{C}$, See Note 4 | SN54S85W | | | |

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

‡ All typical values are at $V_{CC} = 5 \text{ V}, T_A = 25^\circ\text{C}$.

§ 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, $V_{CC} = 5 \text{ V}, T_A = 25^\circ\text{C}$

| 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 | $C_L = 15 \text{ pF}, R_L = 280 \Omega,$ See Note 5 | | 5 | | ns |
| | | | 2 | | 7.5 | | | |
| | | 3 | 10.5 | | 16 | | | |
| | | 4 | 12 | | 18 | | | |
| t_{PHL} | Any A or B data input | A < B, A > B | 1 | | 5.5 | | ns | |
| | | | 2 | | 7 | | | |
| | | 3 | 11 | | 16.5 | | | |
| | | 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.



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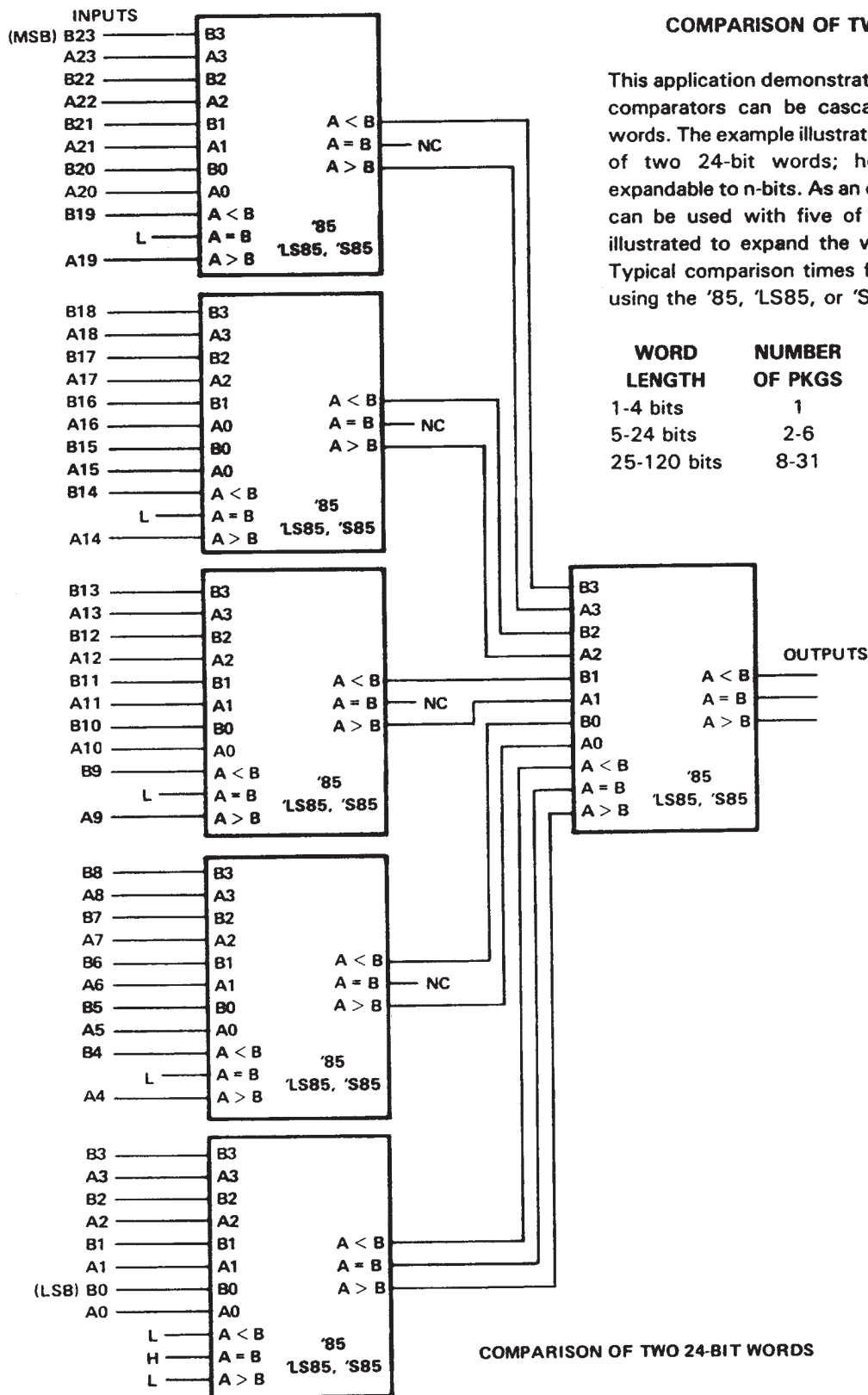
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TYPICAL APPLICATION DATA

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 |



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