

SN5413, SN54LS13, SN7413, SN74LS13  
**DUAL 4-INPUT  
 POSITIVE-NAND SCHMITT TRIGGERS**  
 DECEMBER 1983—REVISED MARCH 1988

SDLS046

- Operation from Very Slow Edges
- Improved Line-Receiving Characteristics
- High Noise Immunity

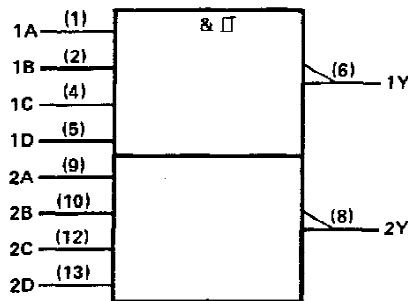
**description**

Each circuit functions as a 4-input NAND gate, but because of the Schmitt action, it has different input threshold levels for positive ( $V_{T+}$ ) and for negative going ( $V_{T-}$ ) signals.

These circuits are temperature-compensated and can be triggered from the slowest of input ramps and still give clean, jitter-free output signals.

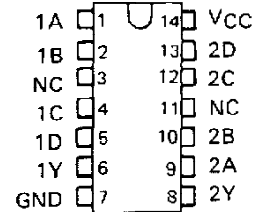
The SN5413 and SN54LS13 are characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SN7413 and SN74LS13 are characterized for operation from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ .

**logic symbol†**

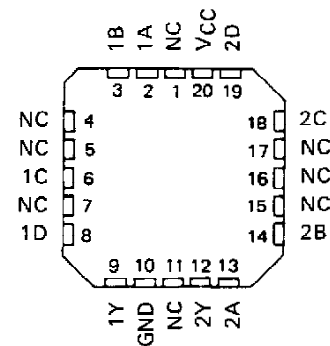


† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-13. Pin numbers shown are for D, J, N, and W packages.

SN5413, SN54LS13 . . . J OR W PACKAGE  
 SN7413 . . . N PACKAGE  
 SN74LS13 . . . D OR N PACKAGE  
 (TOP VIEW)

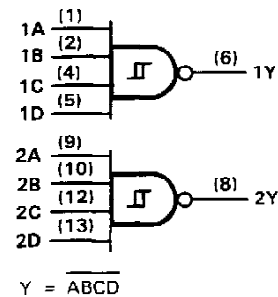


SN54LS13 . . . FK PACKAGE  
 (TOP VIEW)



NC—No internal connection

**logic diagram (positive logic)**



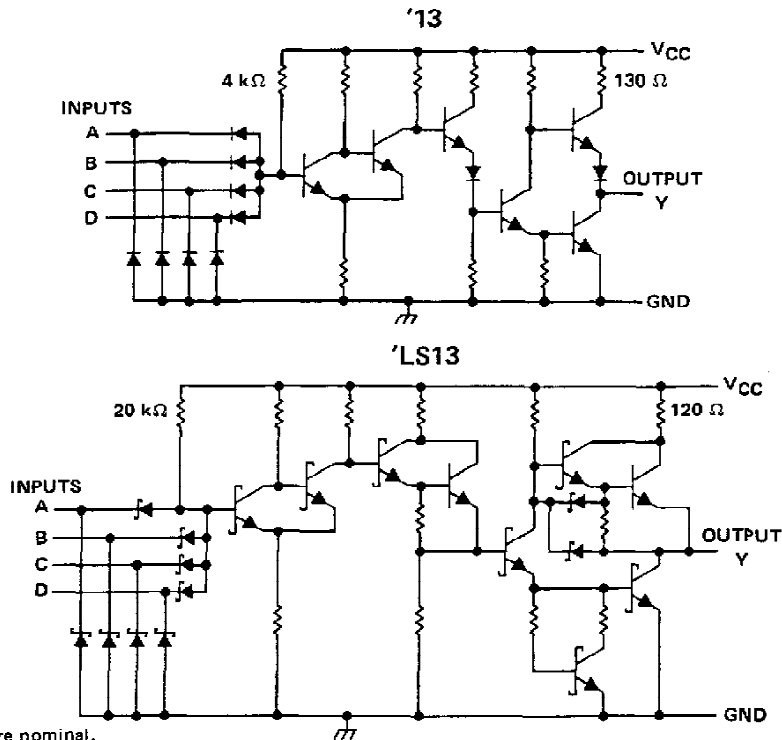
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**SN5413, SN54LS13, SN7413, SN74LS13**  
**DUAL 4-INPUT**  
**POSITIVE-NAND SCHMITT TRIGGERS**

schematics



Resistor values are nominal.

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

|   |                |
|---|----------------|
| Supply voltage, VCC (see Note 1) .....      | 7 V            |
| Input voltage: '13 .....                    | 5.5 V          |
| 'LS13 .....                                 | 7 V            |
| Operating free-air temperature: SN54' ..... | -55°C to 125°C |
| SN74' .....                                 | 0°C to 70°C    |
| Storage temperature range .....             | -65°C to 150°C |

NOTE 1: Voltage values are with respect to network ground terminal.



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**SN5413, SN7413**  
**DUAL 4-INPUT**  
**POSITIVE-NAND SCHMITT TRIGGERS**

**recommended operating conditions**

|   | SN5413 |     |      | SN7413 |     |      | UNIT |
|---|--------|-----|------|--------|-----|------|------|
|   | MIN    | NOM | MAX  | MIN    | NOM | MAX  |      |
| V <sub>CC</sub> Supply voltage                | 4.5    | 5   | 5.5  | 4.75   | 5   | 5.25 | V    |
| I <sub>OH</sub> High-level output current     |        |     | -0.8 |        |     | -0.8 | mA   |
| I <sub>OL</sub> Low-level output current      |        |     | 16   |        |     | 16   | mA   |
| T <sub>A</sub> Operating free-air temperature | -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 <sub>T+</sub>                                    | V <sub>CC</sub> = 5 V  | 1.5 | 1.7   | 2    | V    |
| V <sub>T-</sub>                                    | V <sub>CC</sub> = 5 V  | 0.6 | 0.9   | 1.1  | V    |
| Hysteresis<br>(V <sub>T+</sub> - V <sub>T-</sub> ) | V <sub>CC</sub> = 5 V  | 0.4 | 0.8   |      | V    |
| V <sub>IK</sub>                                    | V <sub>CC</sub> = MIN, I <sub>I</sub> = -12 mA                           |     |       | -1.5 | V    |
| V <sub>OH</sub>                                    | V <sub>CC</sub> = MIN, V <sub>I</sub> = 0.6 V, I <sub>OH</sub> = -0.8 mA | 2.4 | 3.4   |      | V    |
| V <sub>OL</sub>                                    | V <sub>CC</sub> = MIN, V <sub>I</sub> = 2 V, I <sub>OL</sub> = 16 mA     |     | 0.2   | 0.4  | V    |
| I <sub>T+</sub>                                    | V <sub>CC</sub> = 5 V, V <sub>I</sub> = V <sub>T+</sub>                  |     | -0.65 |      | mA   |
| I <sub>T-</sub>                                    | V <sub>CC</sub> = 5 V, V <sub>I</sub> = V <sub>T-</sub>                  |     | -0.85 |      | mA   |
| I <sub>I</sub>                                     | V <sub>CC</sub> = MAX, V <sub>I</sub> = 5.5 V                            |     |       | 1    | mA   |
| I <sub>IH</sub>                                    | V <sub>CC</sub> = MAX, V <sub>IH</sub> = 2.4 V                           |     |       | 40   | μA   |
| I <sub>IL</sub>                                    | V <sub>CC</sub> = MAX, V <sub>IL</sub> = 0.4 V                           |     | -1    | -1.6 | mA   |
| I <sub>OS</sub> §                                  | V <sub>CC</sub> = MAX,   | -18 |       | -55  | mA   |
| I <sub>CCH</sub>                                   | V <sub>CC</sub> = MAX  |     | 14    | 23   | mA   |
| I <sub>CCL</sub>                                   | V <sub>CC</sub> = MAX  |     | 20    | 32   | mA   |

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

‡ All typical values are at V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25° C.

§ Not more than one output should be shorted at a time.

**switching characteristics, V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25° C**

| PARAMETER        | FROM<br>(INPUT) | TO<br>(OUTPUT) | TEST CONDITIONS                                | MIN | TYP | MAX | UNIT |
|------------------|-----------------|----------------|--|-----|-----|-----|------|
| t <sub>PLH</sub> | Any             | Y              | R <sub>L</sub> = 400 Ω, C <sub>L</sub> = 15 pF |     | 18  | 27  | ns   |
| t <sub>PHL</sub> |                 |                |  |     | 15  | 22  | ns   |

  
**TEXAS**  
**INSTRUMENTS**

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**SN54LS13, SN74LS13**  
**DUAL 4-INPUT**  
**POSITIVE-NAND SCHMITT TRIGGERS**

**recommended operating conditions**

|   | SN54LS13 |     |      | SN74LS13 |     |      | UNIT |
|---|----------|-----|------|----------|-----|------|------|
|   | MIN      | NOM | MAX  | MIN      | NOM | MAX  |      |
| V <sub>CC</sub> Supply voltage                | 4.5      | 5   | 5.5  | 4.75     | 5   | 5.25 | V    |
| I <sub>OH</sub> High-level output current     |          |     | -0.4 |          |     | -0.4 | mA   |
| I <sub>OL</sub> Low-level output current      |          |     | 4    |          |     | 8    | mA   |
| T <sub>A</sub> Operating free-air temperature | -55      |     | 125  | 0        |     | 70   | °C   |

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

| PARAMETER                                       | TEST CONDITIONS†   | SN54LS13               |      |      | SN74LS13 |      |      | UNIT |
|---|--|------------------------|------|------|----------|------|------|------|
|   |  | MIN                    | TYP‡ | MAX  | MIN      | TYP‡ | MAX  |      |
| V <sub>T+</sub>                                 | V <sub>CC</sub> = 5 V  | 1.4                    | 1.6  | 1.9  | 1.4      | 1.6  | 1.9  | V    |
| V <sub>T-</sub>                                 | V <sub>CC</sub> = 5 V  | 0.5                    | 0.8  | 1    | 0.5      | 0.8  | 1    | V    |
| Hysteresis (V <sub>T+</sub> - V <sub>T-</sub> ) | V <sub>CC</sub> = 5 V  | 0.4                    | 0.8  |      | 0.4      | 0.8  |      | V    |
| V <sub>IK</sub>                                 | V <sub>CC</sub> = MIN, I <sub>I</sub> = -18 mA                           |                        |      | -1.5 |          |      | -1.5 | V    |
| V <sub>OH</sub>                                 | V <sub>CC</sub> = MIN, V <sub>I</sub> = 0.5 V, I <sub>OH</sub> = -0.4 mA | 2.5                    | 3.4  |      | 2.7      | 3.4  |      | V    |
| V <sub>OL</sub>                                 | V <sub>CC</sub> = MIN, V <sub>I</sub> = 1.9 V                            | I <sub>OL</sub> = 4 mA |      | 0.25 | 0.4      | 0.25 |      | 0.4  |
|   |  | I <sub>OL</sub> = 8 mA |      |      |          | 0.35 | 0.5  |      |
| I <sub>T+</sub>                                 | V <sub>CC</sub> = 5 V, V <sub>I</sub> = V <sub>T+</sub>                  | -0.14                  |      |      | -0.14    |      |      | mA   |
| I <sub>T-</sub>                                 | V <sub>CC</sub> = 5 V, V <sub>I</sub> = V <sub>T-</sub>                  | -0.18                  |      |      | -0.18    |      |      | mA   |
| I <sub>I</sub>                                  | V <sub>CC</sub> = MAX, V <sub>I</sub> = 7 V                              | 0.1                    |      |      | 0.1      |      |      | mA   |
| I <sub>IH</sub>                                 | V <sub>CC</sub> = MAX, V <sub>IH</sub> = 2.7 V                           | 20                     |      |      | 20       |      |      | μA   |
| I <sub>IL</sub>                                 | V <sub>CC</sub> = MAX, V <sub>IL</sub> = 0.4 V                           | -0.4                   |      |      | -0.4     |      |      | mA   |
| I <sub>OS</sub> §                               | V <sub>CC</sub> = MAX  | -20                    |      | -100 | -20      |      | -100 | mA   |
| I <sub>CCH</sub>                                | V <sub>CC</sub> = MAX  | 2.9                    |      | 6    | 2.9      |      | 6    | mA   |
| I <sub>CCL</sub>                                | V <sub>CC</sub> = MAX  | 4.1                    |      | 7    | 4.1      |      | 7    | mA   |

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

‡ All typical values are at V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C.

§ Not more than one output should be shorted at a time, and duration of the short-circuit should not exceed one second.

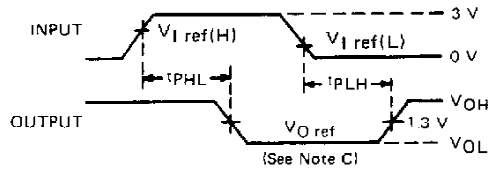
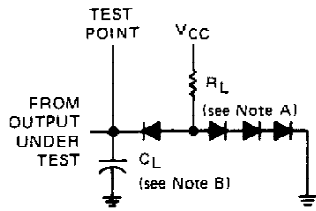
**switching characteristics, V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C**

| PARAMETER        | FROM (INPUT) | TO (OUTPUT) | TEST CONDITIONS                               | MIN | TYP | MAX | UNIT |
|------------------|--------------|-------------|---|-----|-----|-----|------|
| t <sub>PLH</sub> | Any          | Y           | R <sub>L</sub> = 2 kΩ, C <sub>L</sub> = 15 pF | 15  | 22  |     | ns   |
| t <sub>PHL</sub> |              |             |   | 18  | 27  |     | ns   |



SN5413, SN54LS13, SN7413, SN74LS13  
DUAL 4-INPUT  
POSITIVE-NAND SCHMITT TRIGGERS

PARAMETER MEASUREMENT INFORMATION



LOAD CIRCUIT

VOLTAGE WAVEFORMS

- NOTES: A. All diodes are 1N3064 or equivalent.  
B. C<sub>L</sub> includes probe and jig capacitance.  
C. Generator characteristics and reference voltages are:

|                 | Generator Characteristics |       |                |                | Reference Voltages    |                       |                    |
|-----------------|---------------------------|-------|----------------|----------------|-----------------------|-----------------------|--------------------|
|                 | Z <sub>out</sub>          | PRR   | t <sub>r</sub> | t <sub>f</sub> | V <sub>I ref(H)</sub> | V <sub>I ref(L)</sub> | V <sub>O ref</sub> |
| SN54'/SN74'     | 50 Ω                      | 1 MHz | 10 ns          | 10 ns          | 1.7 V                 | 0.9 V                 | 1.5 V              |
| SN54LS'/SN74LS' | 50 Ω                      | 1 MHz | 15 ns          | 6 ns           | 1.6 V                 | 0.8 V                 | 1.3 V              |

TYPICAL CHARACTERISTICS OF '13 CIRCUITS

POSITIVE-GOING THRESHOLD VOLTAGE  
vs  
FREE-AIR TEMPERATURE

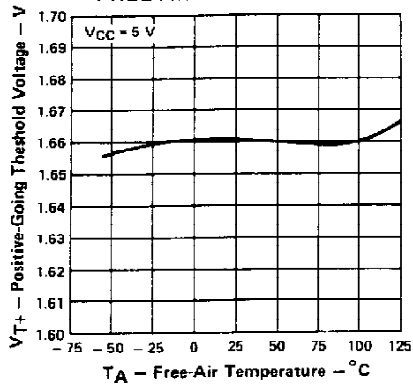


FIGURE 1

NEGATIVE-GOING THRESHOLD VOLTAGE  
vs  
FREE-AIR TEMPERATURE

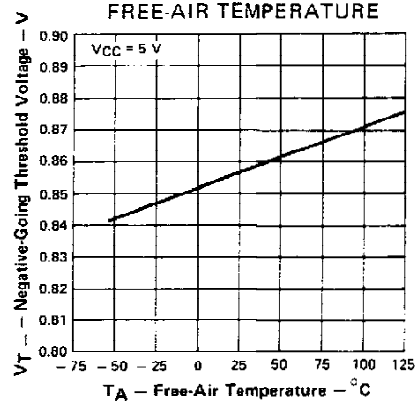


FIGURE 2

HYSTERESIS  
vs  
FREE-AIR TEMPERATURE

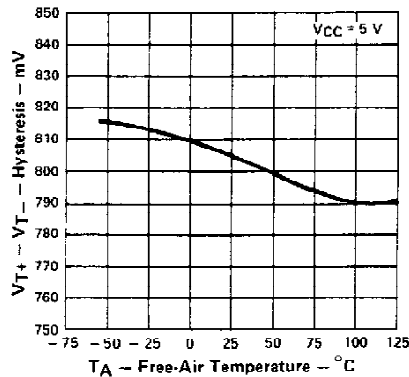


FIGURE 3

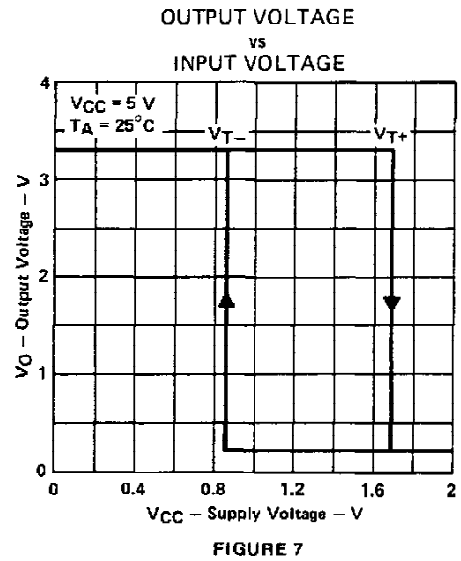
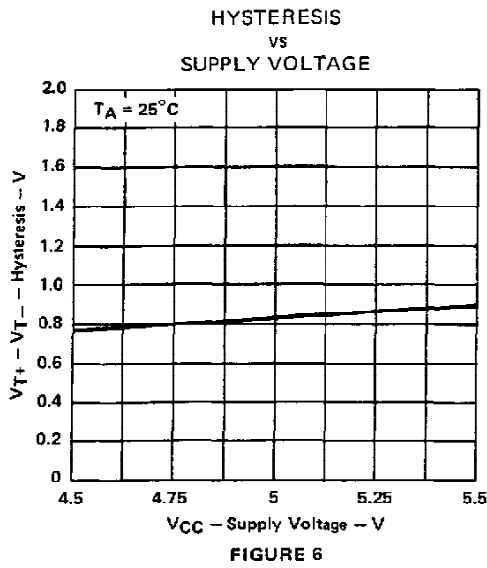
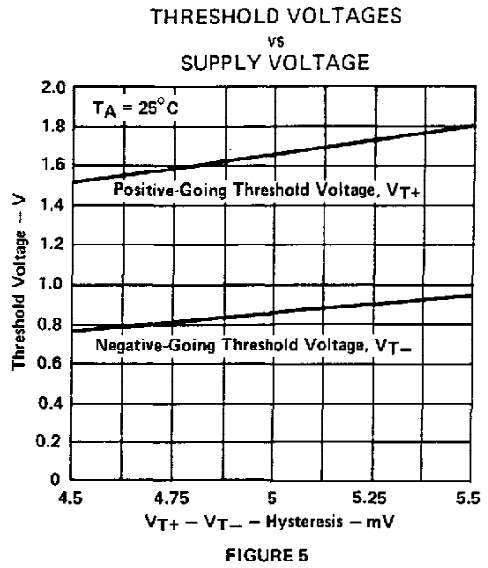
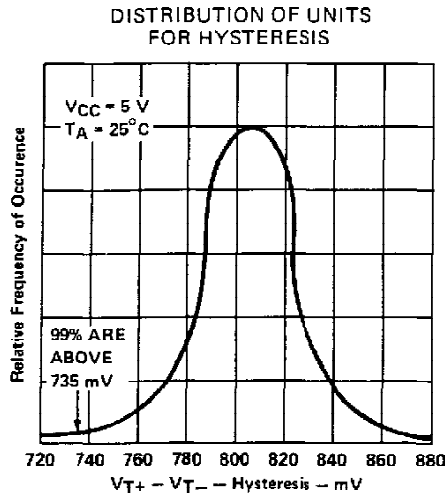
Data for temperatures below 0°C and 70°C and supply voltages below 4.75 V and above 5.25 V are applicable for SN5413 only.

TEXAS  
INSTRUMENTS

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**SN5413, SN7413**  
**DUAL 4-INPUT**  
**POSITIVE-NAND SCHMITT TRIGGERS**

**TYPICAL CHARACTERISTICS OF '13 CIRCUITS**



Data for temperatures below 0°C and 70°C and supply voltages below 4.75 V and above 5.25 V are applicable for SN5413 only.

SN54LS13, SN74LS13  
 DUAL 4-INPUT  
 POSITIVE-NAND SCHMITT TRIGGERS

TYPICAL CHARACTERISTICS OF 'LS13 CIRCUITS

POSITIVE-GOING THRESHOLD VOLTAGE  
 vs  
 FREE-AIR TEMPERATURE

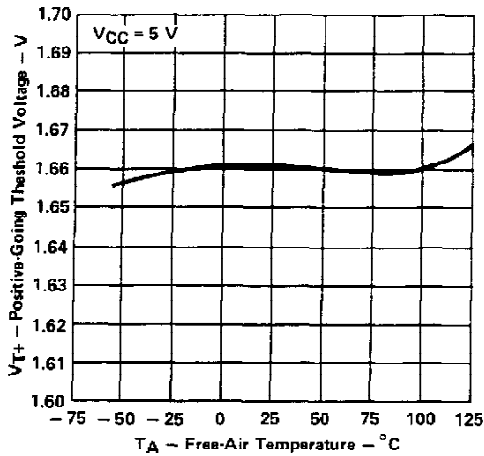


FIGURE 8

NEGATIVE GOING THRESHOLD VOLTAGE  
 vs  
 FREE-AIR TEMPERATURE

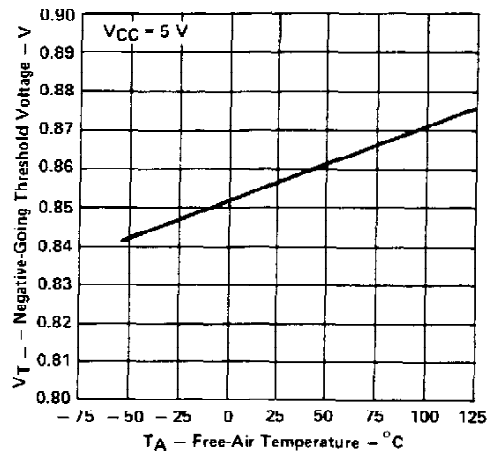


FIGURE 9

HYSTERESIS  
 vs  
 FREE-AIR TEMPERATURE

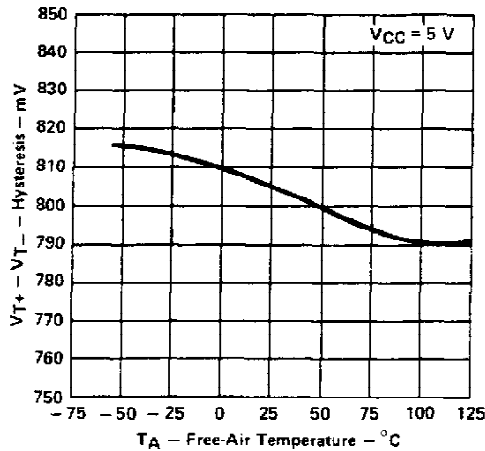


FIGURE 10

DISTRIBUTION OF UNITS  
 FOR HYSTERESIS

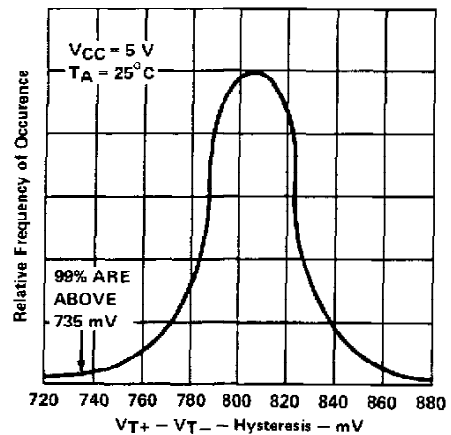


FIGURE 11

Data for temperatures below 0°C and above 70°C and supply voltages below 4.75 V and above 5.25 V are applicable for SN54LS13 only.

**SN54LS13, SN74LS13**  
**DUAL 4-INPUT**  
**POSITIVE-NAND SCHMITT TRIGGERS**

**TYPICAL CHARACTERISTICS OF 'LS13 CIRCUITS**

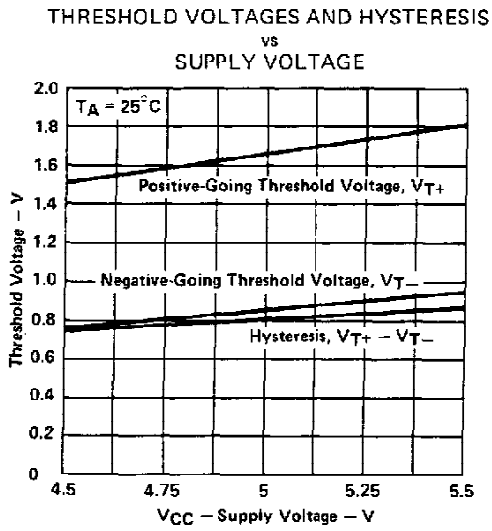


FIGURE 12

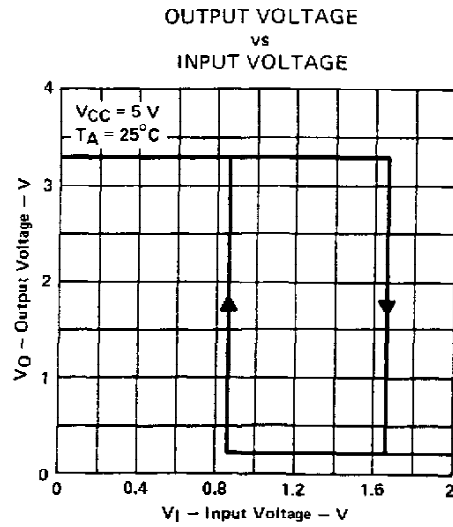


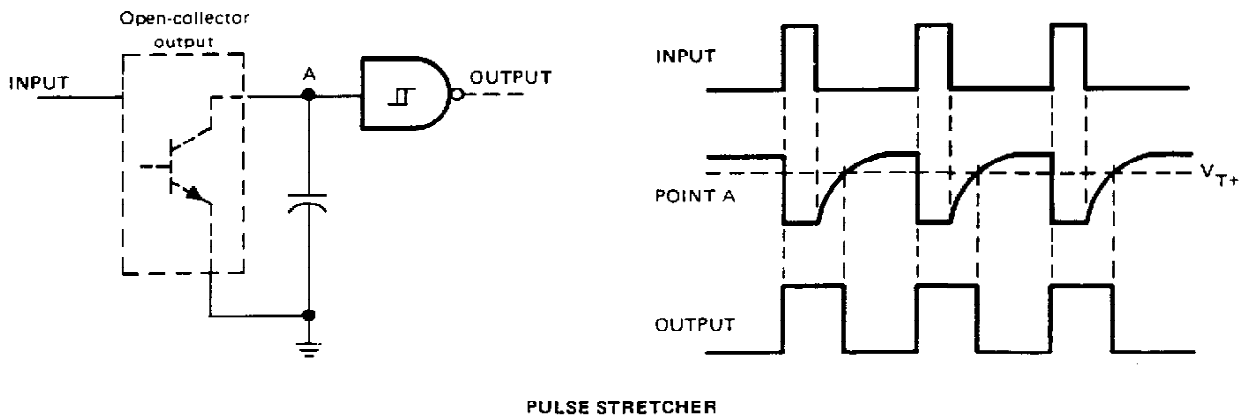
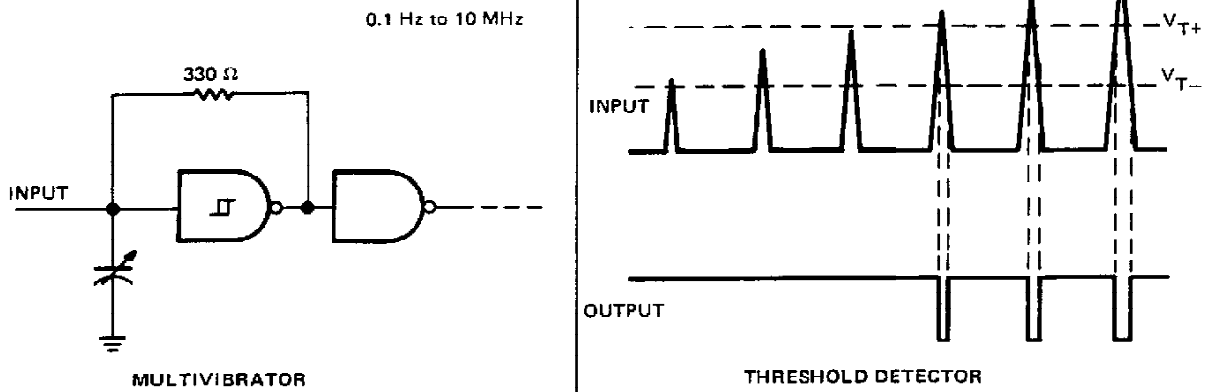
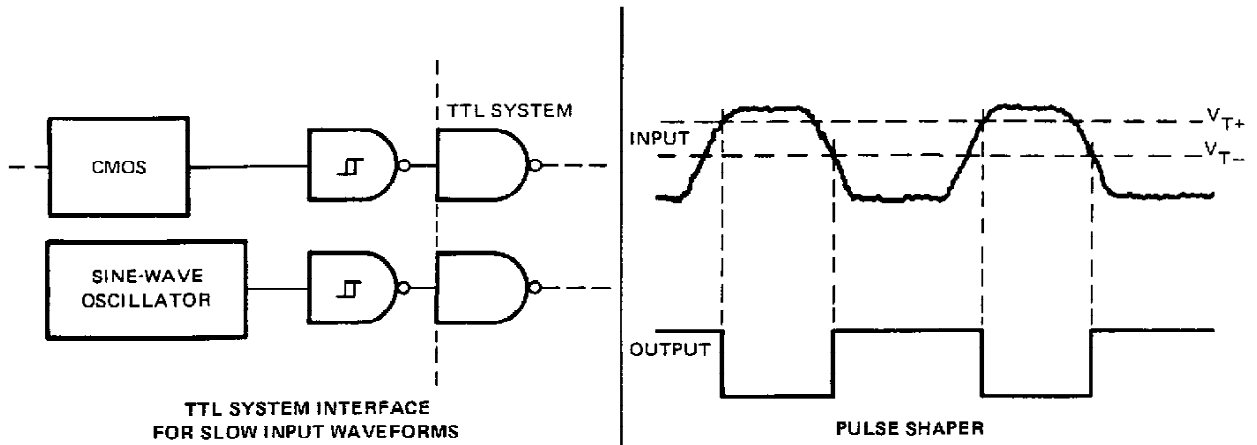
FIGURE 13

Data for temperatures below 0°C and above 70°C and supply voltages below 4.75 V and above 5.25 V are applicable for SN54LS13 only.



SN5413, SN54LS13, SN7413, SN74LS13  
 DUAL 4-INPUT  
 POSITIVE-NAND SCHMITT TRIGGERS

TYPICAL APPLICATION DATA



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