• 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°C to 125°C. The SN7413 and SN74LS13 are characterized for operation from 0°C to 70°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.

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

Supply voltage, \( V_{CC} \) (see Note 1) .................................................. 7 V
Input voltage: '13 ................................................................. 5.5 V
'LS13 ............................................................................. 7 V
Operating free-air temperature: SN54' ........................................... \(-55^\circ C\) to \(125^\circ C\)
SN74' ........................................................................ \(0^\circ C\) to \(70^\circ C\)
Storage temperature range ......................................................... \(-65^\circ C\) to \(150^\circ C\)

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

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SN5413</th>
<th></th>
<th>SN7413</th>
<th></th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCC Supply voltage</td>
<td>4.5</td>
<td>5.5</td>
<td>4.75</td>
<td>5.25</td>
<td>V</td>
</tr>
<tr>
<td>IOH High-level output current</td>
<td>-0.8</td>
<td></td>
<td>-0.8</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>IOL Low-level output current</td>
<td>16</td>
<td></td>
<td>16</td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>TA Operating free-air temperature</td>
<td>-55</td>
<td>1/26</td>
<td>0</td>
<td>70</td>
<td>°C</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS†</th>
<th>MIN</th>
<th>TYP‡</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>VTT+</td>
<td>VCC = 5 V</td>
<td>1.5</td>
<td>1.7</td>
<td>2</td>
<td>V</td>
</tr>
<tr>
<td>VTT−</td>
<td>VCC = 5 V</td>
<td>0.6</td>
<td>0.9</td>
<td>1.1</td>
<td>V</td>
</tr>
<tr>
<td>Hysteresis</td>
<td>(VTT+ − VTT−)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>VTH</td>
<td>VCC = MIN, I1 = -12 mA</td>
<td>0.4</td>
<td>0.8</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>VGH</td>
<td>VCC = MIN, V1 = 0.6 V, IGH = -0.8 mA</td>
<td>2.4</td>
<td>3.4</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>VGL</td>
<td>VCC = MIN, V1 = 7 V, IGL = 18 mA</td>
<td>0.2</td>
<td>0.4</td>
<td>V</td>
<td></td>
</tr>
<tr>
<td>IT+</td>
<td>VCC = 5 V, V1 = VTT+</td>
<td>-0.65</td>
<td></td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>IT−</td>
<td>VCC = 5 V, V1 = VTT−</td>
<td>-0.85</td>
<td></td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>I1</td>
<td>VCC = MAX, V1 = 6.5 V</td>
<td>1</td>
<td></td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>ILH</td>
<td>VCC = MAX, VIL = 2.4 V</td>
<td>40</td>
<td></td>
<td>μA</td>
<td></td>
</tr>
<tr>
<td>IIL</td>
<td>VCC = MAX, VIL = 2.4 V</td>
<td>-1</td>
<td>-1.0</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>IOS§</td>
<td>VCC = MAX,</td>
<td>-10</td>
<td>-55</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>ICCH</td>
<td>VCC = MAX</td>
<td>14</td>
<td>23</td>
<td>mA</td>
<td></td>
</tr>
<tr>
<td>ICCL</td>
<td>VCC = MAX</td>
<td>20</td>
<td>32</td>
<td>mA</td>
<td></td>
</tr>
</tbody>
</table>

† For conditions shown at MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ All typical values are at VCC = 5 V, TA = 25°C.
§ Not more than one output should be shorted at a time.

switching characteristics, VCC = 5 V, TA = 25°C

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>FROM (INPUT)</th>
<th>TO (OUTPUT)</th>
<th>TEST CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>tPLH</td>
<td>Any</td>
<td>Y</td>
<td>RL = 400 Ω, CL = 15 pF</td>
<td>18</td>
<td>27</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>tPHL</td>
<td>Any</td>
<td>Y</td>
<td></td>
<td>15</td>
<td>22</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>
SN54LS13, SN74LS13
DUAL 4-INPUT
POSITIVE-NAND SCHMITT TRIGGERS

recommended operating conditions

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>SN54LS13</th>
<th>SN74LS13</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>VCC Supply voltage</td>
<td>4.5</td>
<td>5</td>
<td>5.5</td>
</tr>
<tr>
<td>IOH High-level output current</td>
<td>-0.4</td>
<td>-0.4</td>
<td>mA</td>
</tr>
<tr>
<td>IOL Low-level output current</td>
<td>4</td>
<td>8</td>
<td>mA</td>
</tr>
<tr>
<td>TA Operating free-air temperature</td>
<td>-55</td>
<td>125</td>
<td>0</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>TEST CONDITIONS†</th>
<th>SN54LS13</th>
<th>SN74LS13</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>VTO</td>
<td>VCC = 5 V</td>
<td>1.4</td>
<td>1.6</td>
<td>1.5</td>
</tr>
<tr>
<td>VT-</td>
<td>VCC = 5 V</td>
<td>0.5</td>
<td>0.6</td>
<td>0.6</td>
</tr>
<tr>
<td>Hysteresis</td>
<td>VCC = 5 V</td>
<td>0.4</td>
<td>0.5</td>
<td>0.4</td>
</tr>
<tr>
<td>VT+ - VT-</td>
<td>VCC = 5 V</td>
<td>-1.5</td>
<td>-1.5</td>
<td>V</td>
</tr>
<tr>
<td>VIL</td>
<td>VCC = MIN, V1 = 0 V</td>
<td>2.5</td>
<td>3.4</td>
<td>2.7</td>
</tr>
<tr>
<td>VOL</td>
<td>VCC = MIN, V1 = 1.0 V</td>
<td>0.25</td>
<td>0.4</td>
<td>0.26</td>
</tr>
<tr>
<td>IOL</td>
<td>IOL = 4 mA</td>
<td>0.35</td>
<td>0.5</td>
<td>mA</td>
</tr>
<tr>
<td>IOL</td>
<td>IOL = 8 mA</td>
<td></td>
<td></td>
<td>mA</td>
</tr>
<tr>
<td>IT+</td>
<td>VCC = 5 V, V1 = VCC</td>
<td>-0.65</td>
<td>-0.65</td>
<td>mA</td>
</tr>
<tr>
<td>IT-</td>
<td>VCC = 5 V, V1 = VCC</td>
<td>-0.18</td>
<td>-0.18</td>
<td>mA</td>
</tr>
<tr>
<td>IIL</td>
<td>VCC = MIN, V1 = 7 V</td>
<td>0.1</td>
<td>0.1</td>
<td>mA</td>
</tr>
<tr>
<td>IIL</td>
<td>VCC = MIN, V1 = 1.0 V</td>
<td>0.1</td>
<td>0.1</td>
<td>mA</td>
</tr>
<tr>
<td>IOS</td>
<td>VCC = MAX</td>
<td>-20</td>
<td>-100</td>
<td>-20</td>
</tr>
<tr>
<td>ICH</td>
<td>VCC = MAX</td>
<td>2.9</td>
<td>6</td>
<td>2.9</td>
</tr>
<tr>
<td>ICCL</td>
<td>VCC = MAX</td>
<td>4.1</td>
<td>7</td>
<td>4.1</td>
</tr>
</tbody>
</table>

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ All typical values are at VCC = 5 V, TA = 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, VCC = 5 V, TA = 25°C

<table>
<thead>
<tr>
<th>PARAMETER</th>
<th>FROM (INPUT)</th>
<th>TO (OUTPUT)</th>
<th>TEST CONDITIONS</th>
<th>MIN</th>
<th>TYP</th>
<th>MAX</th>
<th>UNIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>tPLH</td>
<td>Any</td>
<td>Y</td>
<td>RL = 2 kΩ, CL = 15 pF</td>
<td>15</td>
<td>22</td>
<td>ns</td>
<td></td>
</tr>
<tr>
<td>tPHL</td>
<td></td>
<td>Y</td>
<td></td>
<td>18</td>
<td>27</td>
<td>ns</td>
<td></td>
</tr>
</tbody>
</table>
PARAMETER MEASUREMENT INFORMATION

LOAD CIRCUIT
VOLTAGE WAVEFORMS

NOTES:
A. All diodes are 1N3934 or equivalent.
B. C_L includes probe and jig capacitance.
C. Generator characteristics and reference voltages are:

<table>
<thead>
<tr>
<th>Generator Characteristics</th>
<th>Reference Voltages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Z_out (Ohms)</td>
<td>PRR (MHz)</td>
</tr>
<tr>
<td>SN54V/SN74V</td>
<td>80</td>
</tr>
<tr>
<td>SN54LS/SN74LS</td>
<td>80</td>
</tr>
</tbody>
</table>

TYPICAL CHARACTERISTICS OF '13 CIRCUITS

POSITIVE GOING THRESHOLD VOLTAGE
FREE-AIR TEMPERATURE

NEGATIVE GOING THRESHOLD VOLTAGE
FREE-AIR TEMPERATURE

HYSTERESIS
FREE-AIR TEMPERATURE

FIGURE 1
FIGURE 2
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.
TYPICAL CHARACTERISTICS OF '13 CIRCUITS

DISTRIBUTION OF UNITS FOR HYSTERESIS

VCC = 5 V
TA = 25°C

99% ARE ABOVE 235 mV

FIGURE 4

THRESHOLD VOLTAGES VS SUPPLY VOLTAGE

TA = 25°C

Positive-Going Threshold Voltage, VT+

Negative-Going Threshold Voltage, VT−

FIGURE 5

HYSTERESIS VS SUPPLY VOLTAGE

TA = 25°C

FIGURE 6

OUTPUT VOLTAGE VS INPUT VOLTAGE

VCC = 5 V
TA = 25°C

VTC−

VTC+

FIGURE 7

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.
TYPICAL CHARACTERISTICS OF 'LS13 CIRCUITS

POSITIVE-GOING THRESHOLD VOLTAGE

V_{TC} \text{ vs. } T_A \text{ - Free-Air Temperature [°C]}

V_{TC} - Positive Going Threshold Voltage - V

\begin{align*}
V_{TC} & = 1.70 \\
& 1.69 \\
& 1.68 \\
& 1.67 \\
& 1.66 \\
& 1.65 \\
& 1.64 \\
& 1.63 \\
& 1.62 \\
& 1.61 \\
& 1.60
\end{align*}

-75 -50 -25 0 25 50 75 100 125

FIGURE 8

NEGATIVE GOING THRESHOLD VOLTAGE

V_{TL} \text{ vs. } T_A \text{ - Free-Air Temperature [°C]}

V_{TL} - Negative Going Threshold Voltage - V

\begin{align*}
V_{TL} & = 0.90 \\
& 0.89 \\
& 0.88 \\
& 0.87 \\
& 0.86 \\
& 0.85 \\
& 0.84 \\
& 0.83 \\
& 0.82 \\
& 0.81
\end{align*}

-75 -50 -25 0 25 50 75 100 125

FIGURE 9

HYSTERESIS

V_{TC} - V_{TL} \text{ vs. } T_A \text{ - Free-Air Temperature [°C]}

V_{TC} - V_{TL} - Hysteresis - mV

\begin{align*}
V_{TC} - V_{TL} & = 950 \\
& 940 \\
& 930 \\
& 920 \\
& 910 \\
& 900 \\
& 890 \\
& 880 \\
& 870 \\
& 860 \\
& 850
\end{align*}

-75 -50 -25 0 25 50 75 100 125

FIGURE 10

DISTRIBUTION OF UNITS FOR HYSTERESIS

Relative Frequency of Occurrence

99% ARE ABOVE 735 mV

VT+ - VT- - Hysteresis - mV

\begin{align*}
VT+ - VT- & = 720 \\
& 740 \\
& 760 \\
& 780 \\
& 800 \\
& 820 \\
& 840 \\
& 860 \\
& 880
\end{align*}

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.
TYPICAL CHARACTERISTICS OF 'LS13 CIRCUITS

THRESHOLD VOLTAGES AND HYSTERESIS
vs
SUPPLY VOLTAGE

\[
\begin{align*}
T_A &= 25^\circ C \\
V_T^+ &= \text{Positive-Going Threshold Voltage} \\
V_T^- &= \text{Negative-Going Threshold Voltage} \\
V_H &= V_T^+ - V_T^- \\
V_{CC} &= \text{Supply Voltage} \\
\end{align*}
\]

FIGURE 12

OUTPUT VOLTAGE
vs
INPUT VOLTAGE

\[
\begin{align*}
V_{CC} &= 5 \text{ V} \\
T_A &= 25^\circ C \\
V_O &= \text{Output Voltage} \\
V_I &= \text{Input Voltage} \\
\end{align*}
\]

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.
TYPICAL APPLICATION DATA

TTL SYSTEM INTERFACE FOR SLOW INPUT WAVEFORMS

PULSE SHAPE

MULTIVIBRATOR

THRESHOLD DETECTOR

PULSE STRETCHER
IMPORTANT NOTICE

Texas Instruments (TI) reserves the right to make changes to its products or to discontinue any semiconductor product or service without notice, and advises its customers to obtain the latest version of relevant information to verify, before placing orders, that the information being relied on is current.

TI warrants performance of its semiconductor products and related software 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, INTENDED, AUTHORIZED, OR WARRANTED TO BE SUITABLE FOR USE IN LIFE-SUPPORT APPLICATIONS, DEVICES OR SYSTEMS OR OTHER CRITICAL APPLICATIONS.

Inclusion of TI products in such applications is understood to be fully at the risk of the customer. Use of TI products in such applications requires the written approval of an appropriate TI officer. Questions concerning potential risk applications should be directed to TI through a local SC sales office.

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

TI assumes no liability for applications assistance, customer product design, software performance, or infringement of patents or services described herein. Nor does TI 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.

Copyright © 1996, Texas Instruments Incorporated
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.

Copyright © 1998, Texas Instruments Incorporated