

SN5414, SN54LS14, SN7414, SN74LS14

HEX SCHMITT-TRIGGER INVERTERS

SDLS049B – DECEMBER 1983 – REVISED FEBRUARY 2002

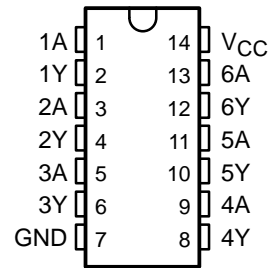
- Operation From Very Slow Edges
- Improved Line-Receiving Characteristics
- High Noise Immunity

description

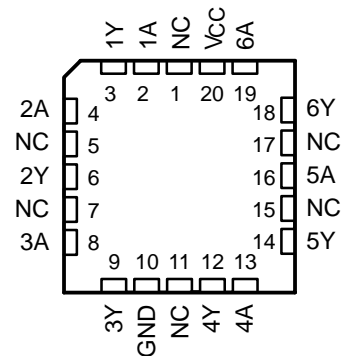
Each circuit functions as an inverter, but because of the Schmitt action, it has different input threshold levels for positive-going (V_{T+}) and negative-going (V_{T-}) signals.

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

SN5414, SN54LS14 . . . J OR W PACKAGE
SN7414 . . . D, N, OR NS PACKAGE
SN74LS14 . . . D, DB, OR N PACKAGE
(TOP VIEW)



SN54LS14 . . . FK PACKAGE
(TOP VIEW)



NC – No internal connection

ORDERING INFORMATION

| T_A | PACKAGE† | | ORDERABLE PART NUMBER | TOP-SIDE MARKING |
|----------------|---------------|---------------|-----------------------|------------------|
| 0°C to 70°C | PDIP – N | Tube | SN7414N | SN7414N |
| | | Tube | SN74LS14N | SN74LS14N |
| | SOIC – D | Tube | SN7414D | 7414 |
| | | Tape and reel | SN7414DR | |
| | | Tube | SN74LS14D | LS14 |
| | Tape and reel | SN74LS14DR | | |
| | SOP – NS | Tape and reel | SN7414NSR | SN7414 |
| SSOP – DB | Tape and reel | SN74LS14DBR | LS14 | |
| –55°C to 125°C | CDIP – J | Tube | SN5414J | SN5414J |
| | | Tube | SNJ5414J | SNJ5414J |
| | | Tube | SN54LS14J | SN54LS14J |
| | | Tube | SNJ54LS14J | SNJ54LS14J |
| | CFP – W | Tube | SNJ5414W | SNJ5414W |
| | | Tube | SNJ54LS14W | SNJ54LS14W |
| | LCCC – FK | Tube | SNJ54LS14FK | SNJ54LS14FK |

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.



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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.

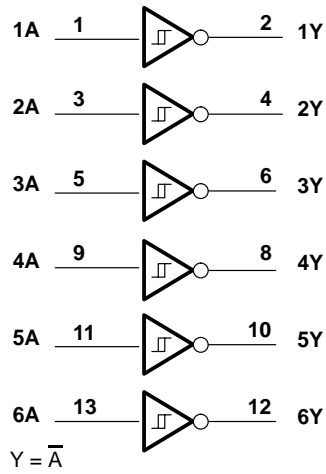


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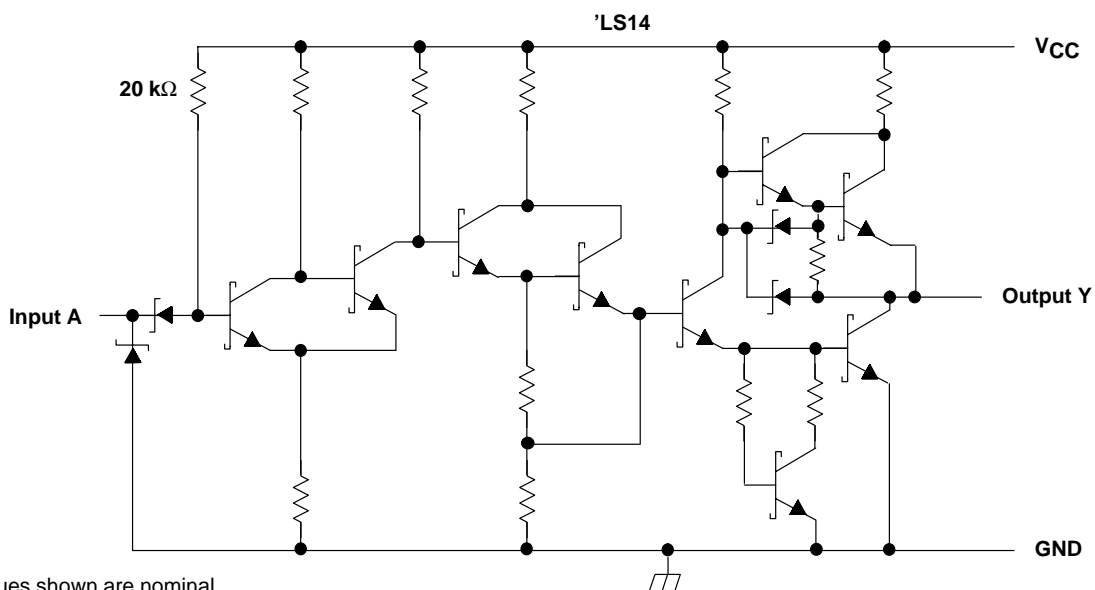
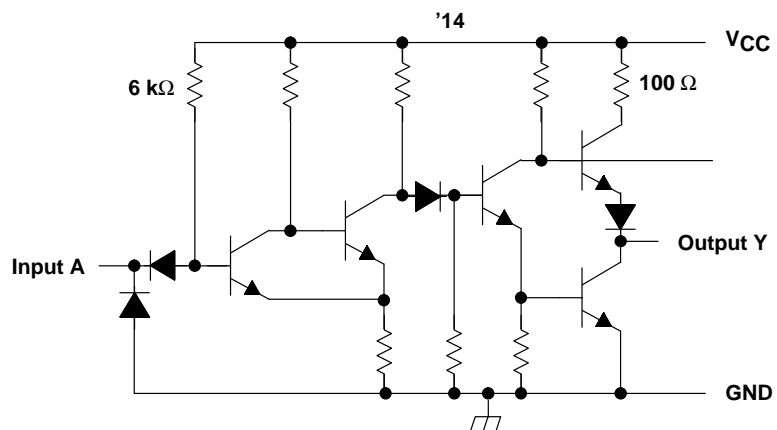
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SN7414, SN74LS14
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logic diagram (positive logic)



Pin numbers shown are for the D, DB, J, N, NS, and W packages.

schematic



Resistor values shown are nominal.

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

| | |
|--|----------------|
| Supply voltage, V_{CC} (see Note 1) | 7 V |
| Input voltage: '14 | 5.5 V |
| 'LS14 | 7 V |
| Package thermal impedance, θ_{JA} (see Note 2): D package | 86°C/W |
| DB package | 96°C/W |
| N package | 80°C/W |
| NS package | 76°C/W |
| Storage temperature range, T_{stg} | -65°C to 150°C |

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

- NOTES: 1. Voltage values are with respect to network ground terminal.
2. The package thermal impedance is calculated in accordance with JESD 51-7

recommended operating conditions

| | SN5414 | | | SN7414 | | | UNIT |
|--------------------------------------|--------|-----|------|--------|-----|------|------|
| | MIN | NOM | MAX | MIN | NOM | MAX | |
| V_{CC} Supply voltage | 4.5 | 5 | 5.5 | 4.75 | 5 | 5.25 | V |
| I_{OH} High-level output current | | | -0.8 | | | -0.8 | mA |
| I_{OL} Low-level output current | | | 16 | | | 16 | mA |
| T_A Operating free-air temperature | -55 | | 125 | 0 | | 70 | °C |

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

| PARAMETER | TEST CONDITIONS‡ | SN5414 SN7414 | | | UNIT |
|-------------------------------------|--|------------------|-------|------|------|
| | | MIN | TYP§ | MAX | |
| V_{T+} | $V_{CC} = 5 V$ | 1.5 | 1.7 | 2 | V |
| V_{T-} | $V_{CC} = 5 V$ | 0.6 | 0.9 | 1.1 | V |
| Hysteresis ($V_{T+} - V_{T-}$) | $V_{CC} = 5 V$ | 0.4 | 0.8 | | V |
| V_{IK} | $V_{CC} = \text{MIN}, I_I = -12 \text{ mA}$ | | | -1.5 | V |
| V_{OH} | $V_{CC} = \text{MIN}, V_I = 0.6 V, I_{OH} = -0.8 \text{ mA}$ | 2.4 | 3.4 | | V |
| V_{OL} | $V_{CC} = \text{MIN}, V_I = 2 V, I_{OL} = 16 \text{ mA}$ | | 0.2 | 0.4 | V |
| I_{T+} | $V_{CC} = 5 V, V_I = V_{T+}$ | | -0.43 | | mA |
| I_{T-} | $V_{CC} = 5 V, V_I = V_{T-}$ | | -0.56 | | mA |
| I_I | $V_{CC} = \text{MAX}, V_I = 5.5 V$ | | | 1 | mA |
| I_{IH} | $V_{CC} = \text{MAX}, V_{IH} = 2.4 V$ | | | 40 | µA |
| I_{IL} | $V_{CC} = \text{MAX}, V_{IL} = 0.4 V$ | | -0.8 | -1.2 | mA |
| $I_{OS}\¶$ | $V_{CC} = \text{MAX}$ | -18 | | -55 | mA |
| I_{CCH} | $V_{CC} = \text{MAX}$ | | 22 | 36 | mA |
| I_{CCL} | $V_{CC} = \text{MAX}$ | | 39 | 60 | mA |

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

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

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



switching characteristics, $V_{CC} = 5\text{ V}$, $T_A = 25^\circ\text{C}$ (see Figure 1)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | TEST CONDITIONS | SN5414 SN7414 | | | UNIT |
|-----------|--------------|-------------|---|------------------|-----|-----|------|
| | | | | MIN | TYP | MAX | |
| t_{PLH} | A | Y | $R_L = 400\ \Omega$, $C_L = 15\ \text{pF}$ | | 15 | 22 | ns |
| t_{PHL} | | | | | 15 | 22 | |

recommended operating conditions

| | SN54LS14 | | | SN74LS14 | | | UNIT |
|--------------------------------------|----------|-----|------|----------|-----|------|------------------|
| | MIN | NOM | MAX | MIN | NOM | MAX | |
| V_{CC} Supply voltage | 4.5 | 5 | 5.5 | 4.75 | 5 | 5.25 | V |
| I_{OH} High-level output current | | | -0.4 | | | -0.4 | mA |
| I_{OL} Low-level output current | | | 4 | | | 8 | mA |
| T_A Operating free-air temperature | -55 | | 125 | 0 | | 70 | $^\circ\text{C}$ |

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

| PARAMETER | TEST CONDITIONS† | SN54LS14 | | | SN74LS14 | | | UNIT |
|-------------------------------------|--|----------|-------|------|----------|-------|------|---------------|
| | | MIN | TYP‡ | MAX | MIN | TYP‡ | MAX | |
| V_{T+} | $V_{CC} = 5\text{ V}$ | 1.4 | 1.6 | 1.9 | 1.4 | 1.6 | 1.9 | V |
| V_{T-} | $V_{CC} = 5\text{ V}$ | 0.5 | 0.8 | 1 | 0.5 | 0.8 | 1 | V |
| Hysteresis ($V_{T+} - V_{T-}$) | $V_{CC} = 5\text{ V}$ | 0.4 | 0.8 | | 0.4 | 0.8 | | V |
| V_{IK} | $V_{CC} = \text{MIN}$, $I_I = -18\text{ mA}$ | | | -1.5 | | | -1.5 | V |
| V_{OH} | $V_{CC} = \text{MIN}$, $V_I = 0.5\text{ V}$, $I_{OH} = -0.4\text{ mA}$ | 2.5 | 3.4 | | 2.7 | 3.4 | | V |
| V_{OL} | $V_{CC} = \text{MIN}$, $V_I = -1.9\text{ V}$ | | 0.25 | 0.4 | | 0.25 | 0.4 | V |
| | | | | | | 0.35 | 0.5 | |
| I_{T+} | $V_{CC} = 5\text{ V}$, $V_I = V_{T+}$ | | -0.14 | | | -0.14 | | mA |
| I_{T-} | $V_{CC} = 5\text{ V}$, $V_I = V_{T-}$ | | -0.18 | | | -0.18 | | mA |
| I_I | $V_{CC} = \text{MAX}$, $V_I = 7\text{ V}$ | | | 0.1 | | | 0.1 | mA |
| I_{IH} | $V_{CC} = \text{MAX}$, $V_{IH} = 2.7\text{ V}$ | | | 20 | | | 20 | μA |
| I_{IL} | $V_{CC} = \text{MAX}$, $V_{IL} = 0.4\text{ V}$ | | | -0.4 | | | -0.4 | mA |
| I_{OS}^{\S} | $V_{CC} = \text{MAX}$ | -20 | | -100 | -20 | | -100 | mA |
| I_{CCH} | $V_{CC} = \text{MAX}$ | | 8.6 | 16 | | 8.6 | 16 | mA |
| I_{CCL} | $V_{CC} = \text{MAX}$ | | 12 | 21 | | 12 | 21 | 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.

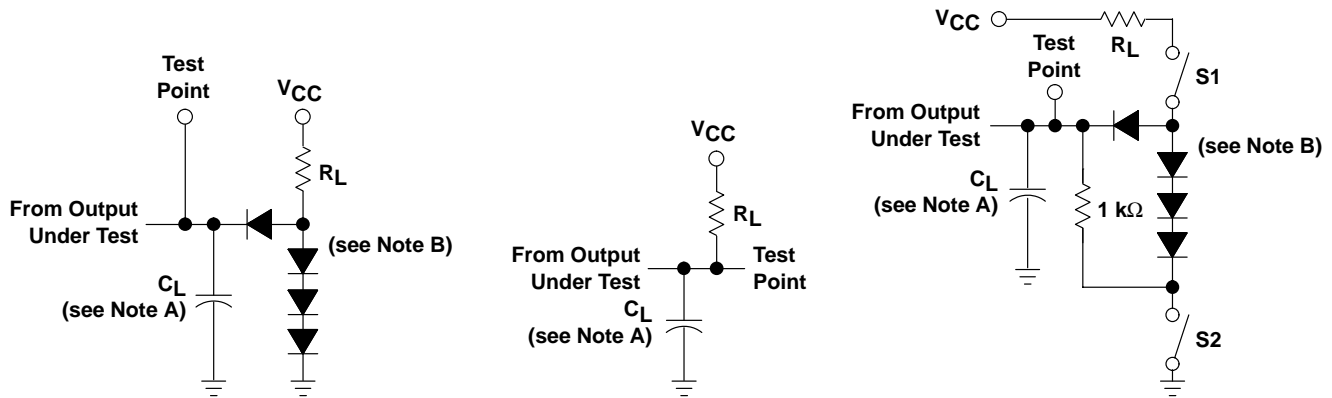
switching characteristics, $V_{CC} = 5\text{ V}$, $T_A = 25^\circ\text{C}$ (see Figure 2)

| PARAMETER | FROM (INPUT) | TO (OUTPUT) | TEST CONDITIONS | MIN | TYP | MAX | UNIT |
|-----------|--------------|-------------|---|-----|-----|-----|------|
| t_{PLH} | A | Y | $R_L = 2\ \text{k}\Omega$, $C_L = 15\ \text{pF}$ | | 15 | 22 | ns |
| t_{PHL} | | | | | 15 | 22 | |

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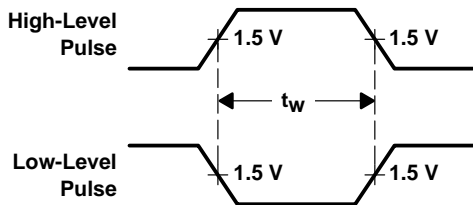
**PARAMETER MEASUREMENT INFORMATION
SERIES 54/74 DEVICES**



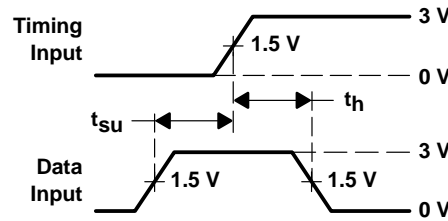
**LOAD CIRCUIT
FOR 2-STATE TOTEM-POLE OUTPUTS**

**LOAD CIRCUIT
FOR OPEN-COLLECTOR OUTPUTS**

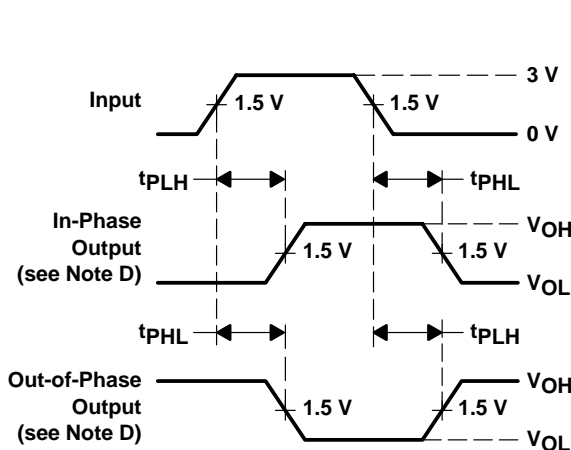
**LOAD CIRCUIT
FOR 3-STATE OUTPUTS**



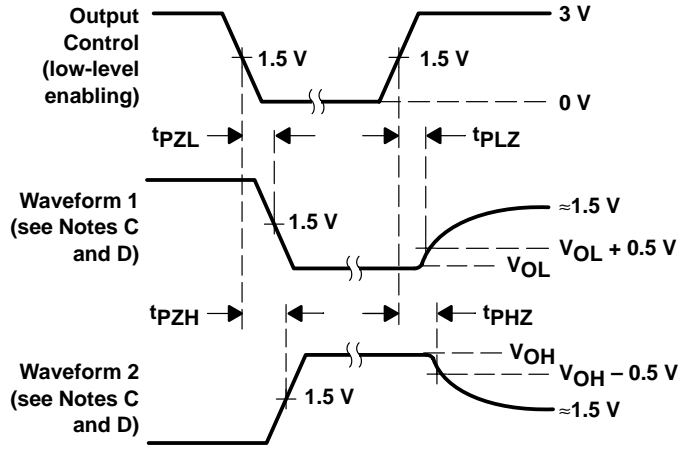
**VOLTAGE WAVEFORMS
PULSE DURATIONS**



**VOLTAGE WAVEFORMS
SETUP AND HOLD TIMES**



**VOLTAGE WAVEFORMS
PROPAGATION DELAY TIMES**

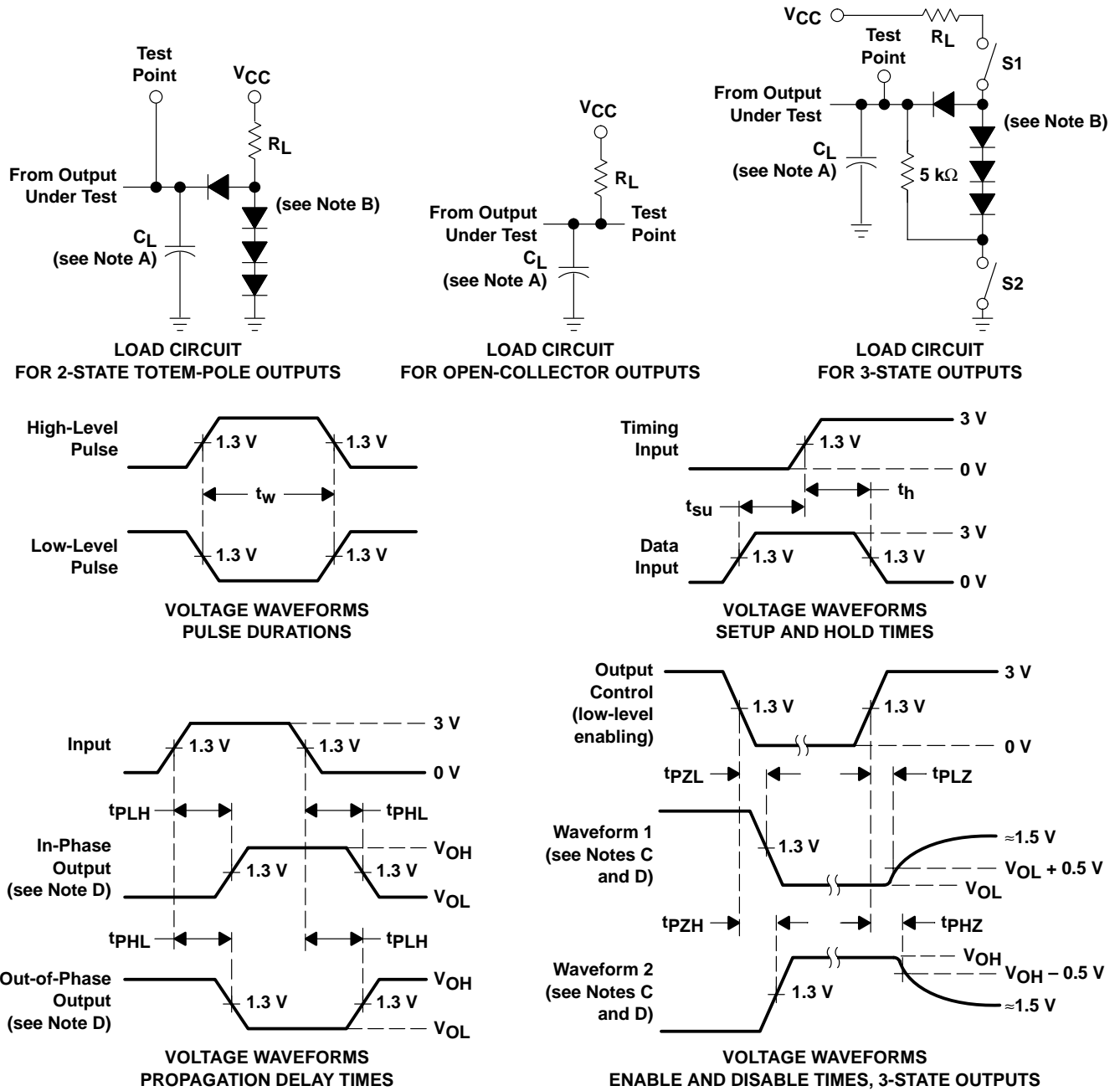


**VOLTAGE WAVEFORMS
ENABLE AND DISABLE TIMES, 3-STATE OUTPUTS**

- NOTES: A. C_L includes probe and jig capacitance.
 B. All diodes are 1N3064 or equivalent.
 C. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
 D. S_1 and S_2 are closed for t_{PLH} , t_{PHL} , t_{PHZ} , and t_{PLZ} ; S_1 is open and S_2 is closed for t_{PZH} ; S_1 is closed and S_2 is open for t_{PZL} .
 E. All input pulses are supplied by generators having the following characteristics: $PRR \leq 1$ MHz, $Z_O \approx 50 \Omega$; t_r and $t_f \leq 7$ ns for Series 54/74 devices and t_r and $t_f \leq 2.5$ ns for Series 54S/74S devices.
 F. The outputs are measured one at a time with one input transition per measurement.

Figure 1. Load Circuits and Voltage Waveforms

PARAMETER MEASUREMENT INFORMATION
SERIES 54LS/74LS DEVICES



- NOTES: A. C_L includes probe and jig capacitance.
 B. All diodes are 1N3064 or equivalent.
 C. Waveform 1 is for an output with internal conditions such that the output is low except when disabled by the output control. Waveform 2 is for an output with internal conditions such that the output is high except when disabled by the output control.
 D. S1 and S2 are closed for t_{PLH} , t_{PHL} , t_{PZH} , and t_{PHZ} ; S1 is open and S2 is closed for t_{PZH} ; S1 is closed and S2 is open for t_{PZL} .
 E. Phase relationships between inputs and outputs have been chosen arbitrarily for these examples.
 F. All input pulses are supplied by generators having the following characteristics: $PRR \leq 1$ MHz, $Z_O \approx 50 \Omega$, $t_r \leq 1.5$ ns, $t_f \leq 2.6$ ns.
 G. The outputs are measured one at a time with one input transition per measurement.

Figure 2. Load Circuits and Voltage Waveforms

TYPICAL CHARACTERISTICS OF '14 CIRCUITS†

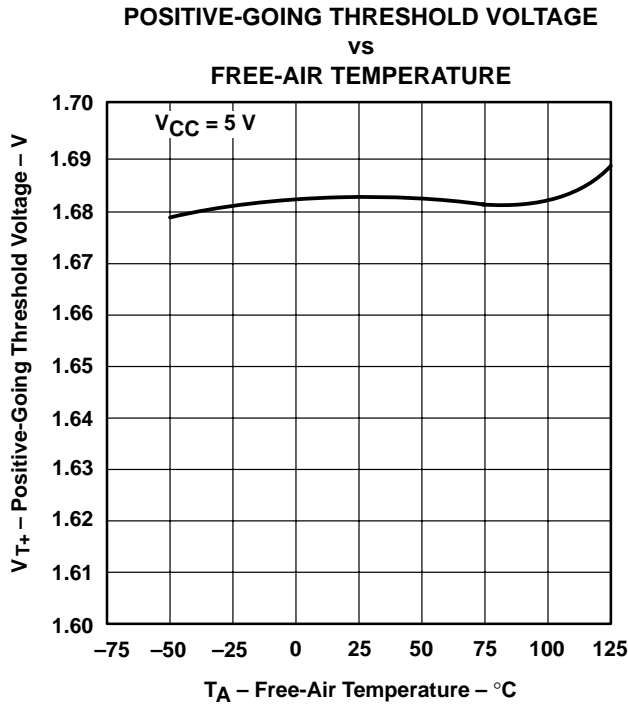


Figure 3

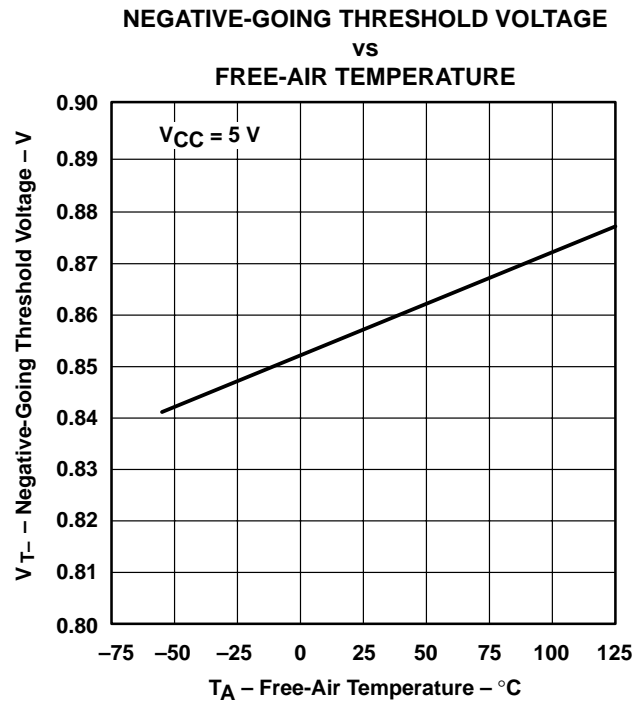


Figure 4

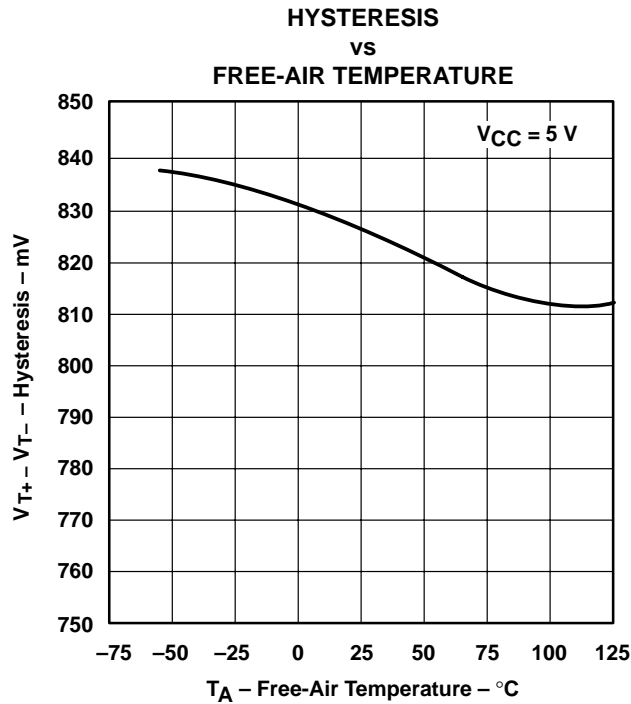


Figure 5

† Data for temperatures below 0°C and above 70°C and supply voltage below 4.75 V and above 5.25 V are applicable for SN5414 only.

TYPICAL CHARACTERISTICS OF '14 CIRCUIT†

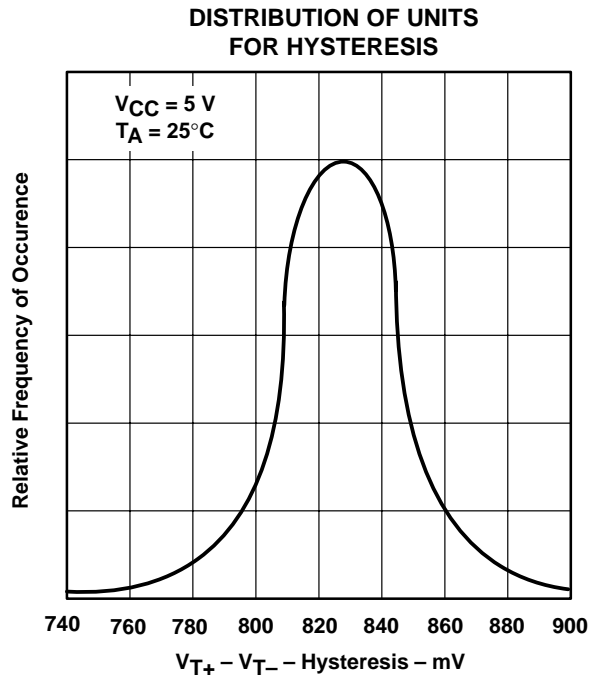


Figure 6



Figure 7

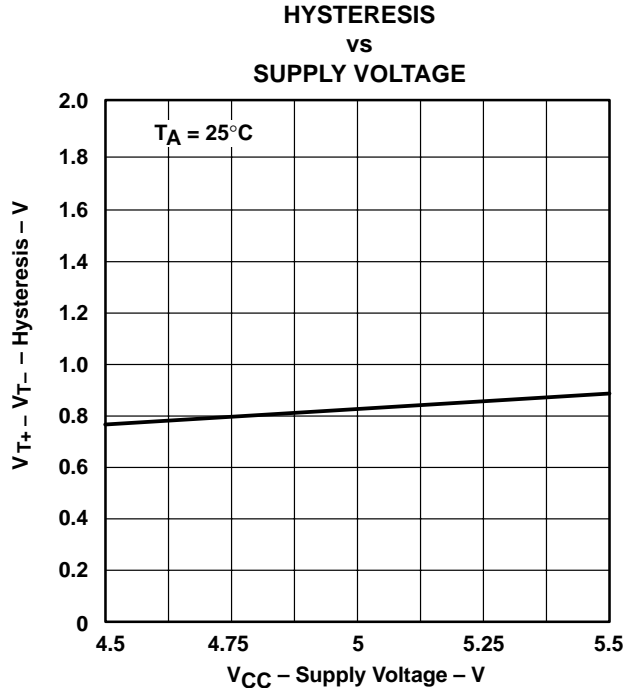


Figure 8

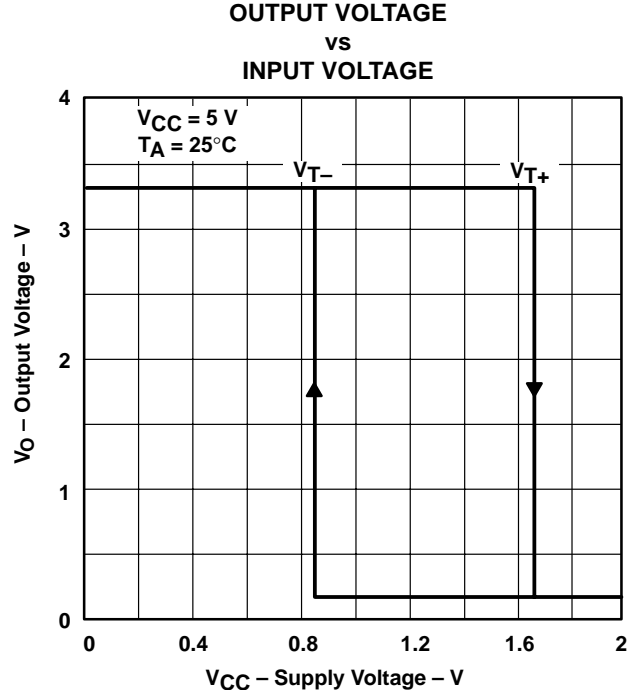


Figure 9

† Data for temperatures below 0°C and above 70°C and supply voltage below 4.75 V and above 5.25 V are applicable for SN5414 only.

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TYPICAL CHARACTERISTICS OF 'LS14 CIRCUITS†

**POSITIVE-GOING THRESHOLD VOLTAGE
vs
FREE-AIR TEMPERATURE**

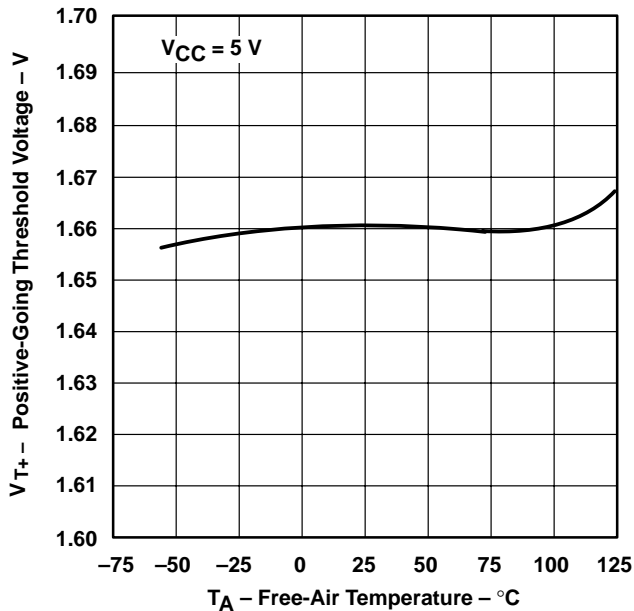


Figure 10

**NEGATIVE-GOING THRESHOLD VOLTAGE
vs
FREE-AIR TEMPERATURE**

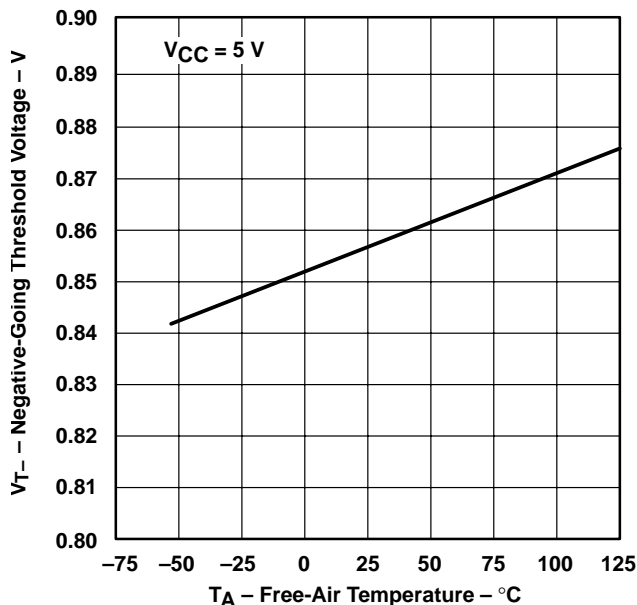


Figure 11

**HYSTERESIS
vs
FREE-AIR TEMPERATURE**

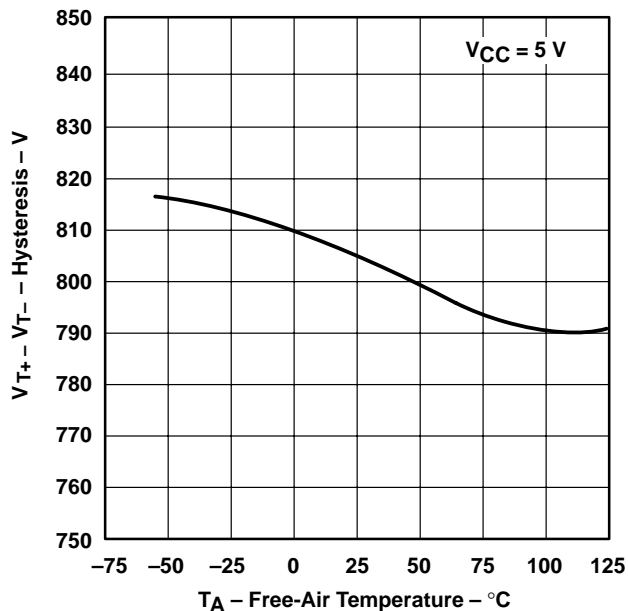


Figure 12

**DISTRIBUTION OF UNITS
FOR HYSTERESIS**

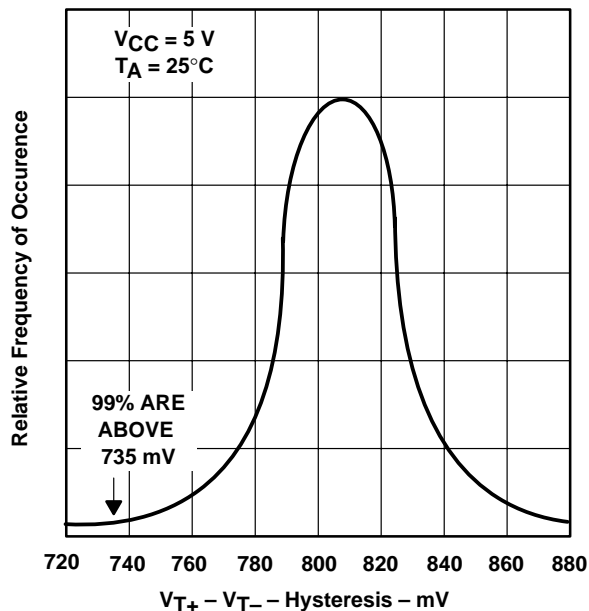


Figure 13

† Data for temperatures below 0°C and above 70°C and supply voltage below 4.75 V and above 5.25 V are applicable for SN5414 only.



TYPICAL CHARACTERISTICS OF 'LS14 CIRCUITS†

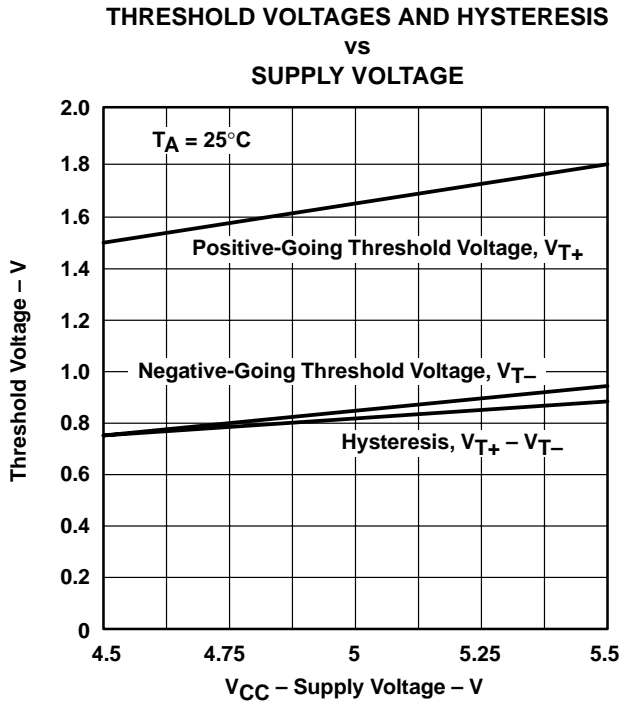


Figure 14

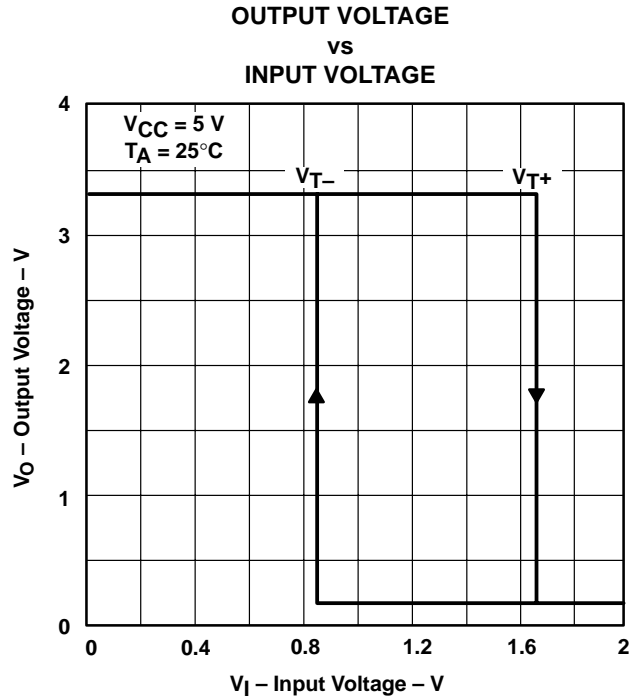


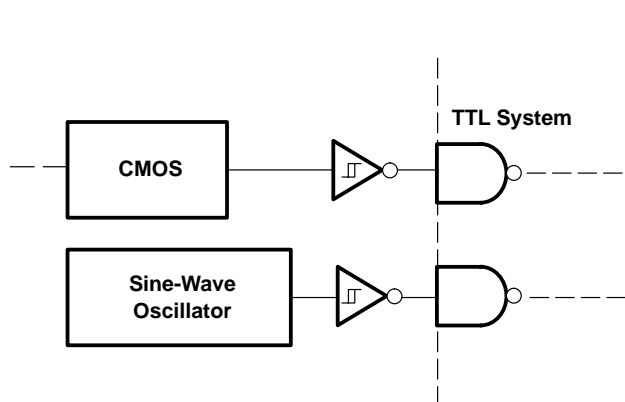
Figure 15

† Data for temperatures below 0°C and above 70°C and supply voltage below 4.75 V and above 5.25 V are applicable for SN5414 only.

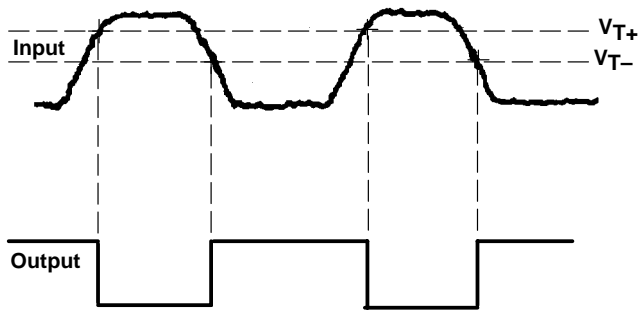
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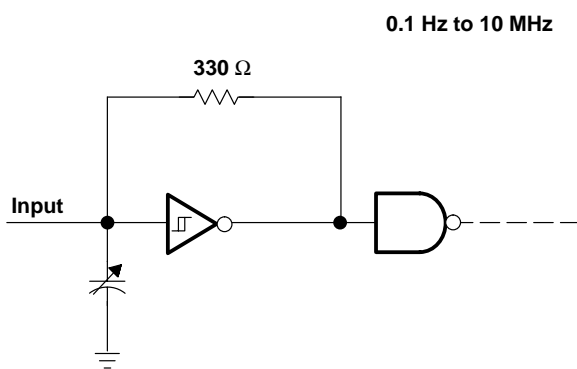
TYPICAL APPLICATION DATA



**TTL System Interface
for Slow Input Waveforms**

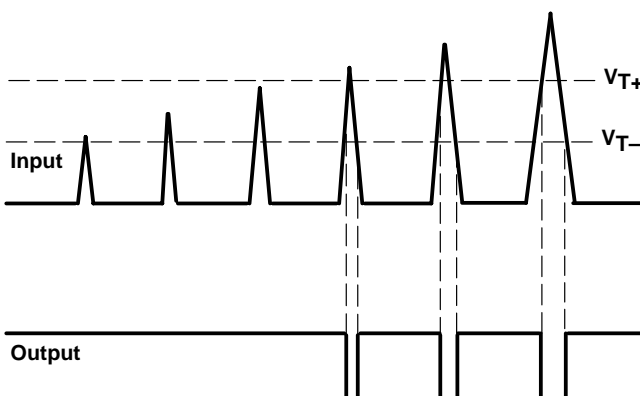


Pulse Shaper

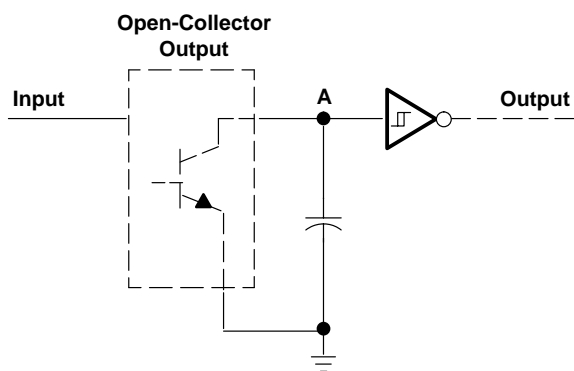


Multivibrator

0.1 Hz to 10 MHz



Threshold Detector



Pulse Stretcher

