

SN5414, SN54LS14, SN7414, SN74LS14

HEX SCHMITT-TRIGGER INVERTERS

SDLS049B – DECEMBER 1983 – REVISED FEBRUARY 2002

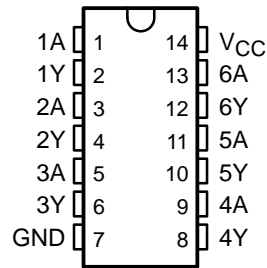
- Operation From Very Slow Edges
- Improved Line-Receiving Characteristics
- High Noise Immunity

description

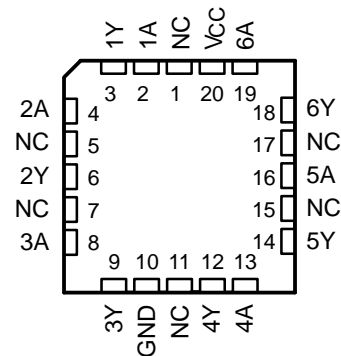
Each circuit functions as an inverter, but because of the Schmitt action, it has different input threshold levels for positive-going (V_{T+}) and negative-going (V_{T-}) signals.

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.



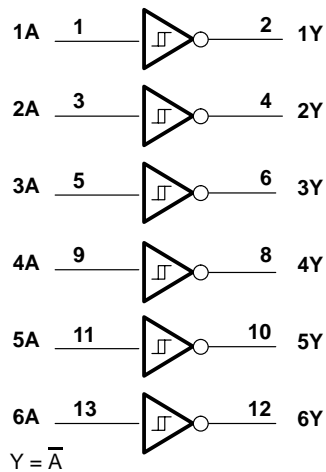
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On products compliant to MIL-PRF-38535, all parameters are tested unless otherwise noted. On all other products, production processing does not necessarily include testing of all parameters.

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SN7414, SN74LS14
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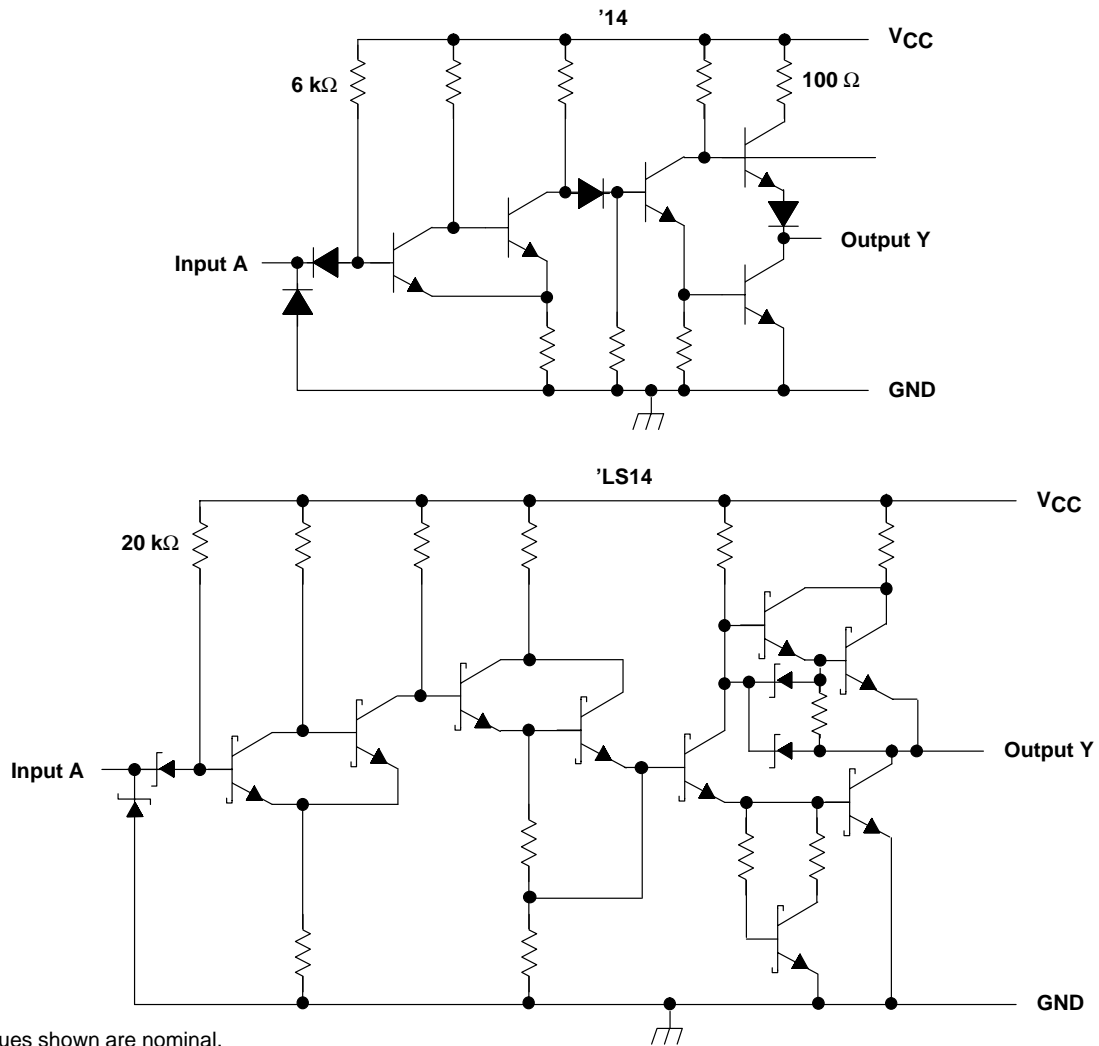
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logic diagram (positive logic)



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

schematic



Resistor values shown are nominal.

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HEX SCHMITT-TRIGGER INVERTERS**

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

¶ 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
	$I_{OL} = 4\text{ mA}$ $I_{OL} = 8\text{ mA}$					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.

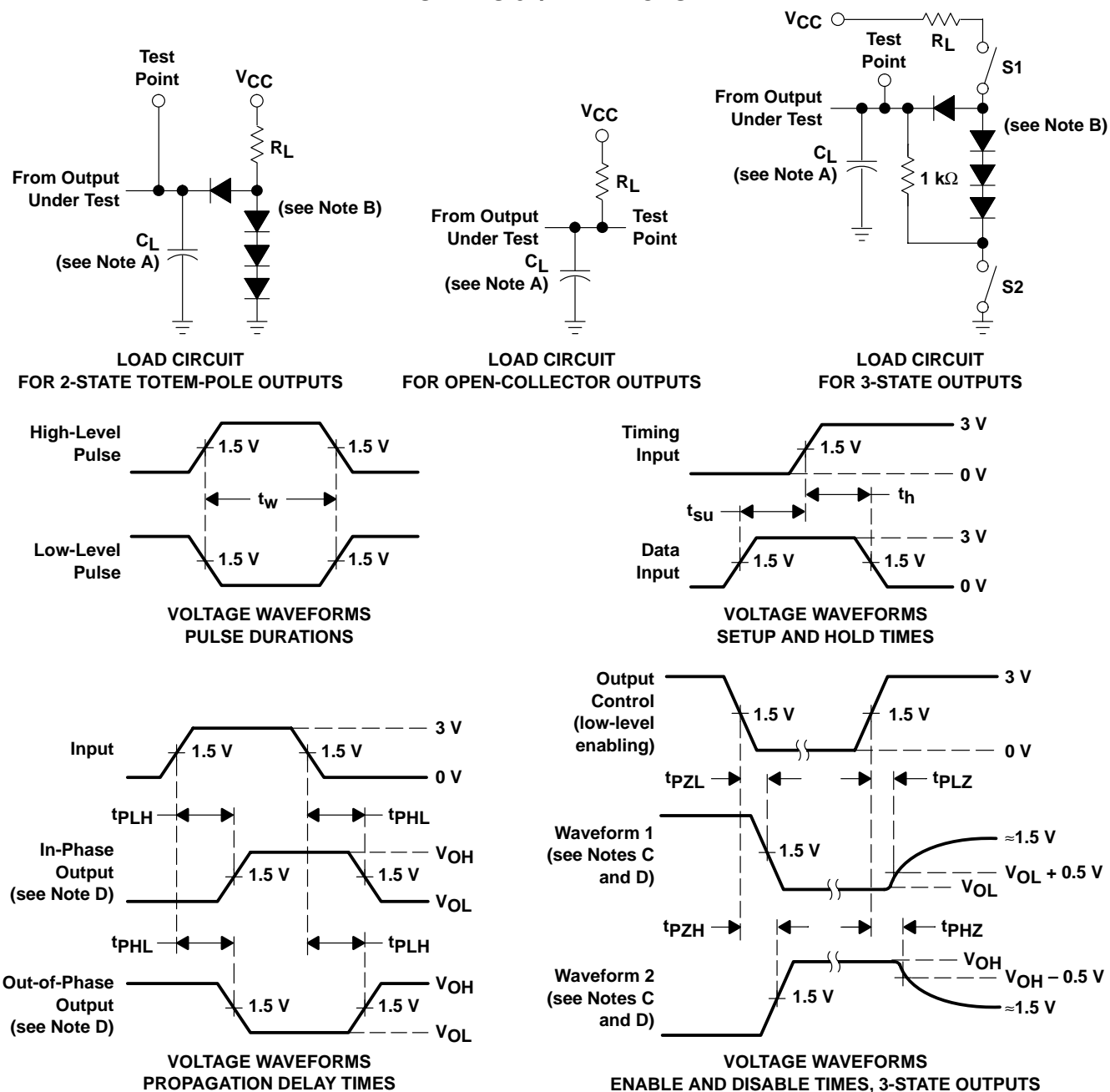
switching characteristics, $V_{CC} = 5\text{ V}$, $T_A = 25^\circ\text{C}$ (see Figure 2)

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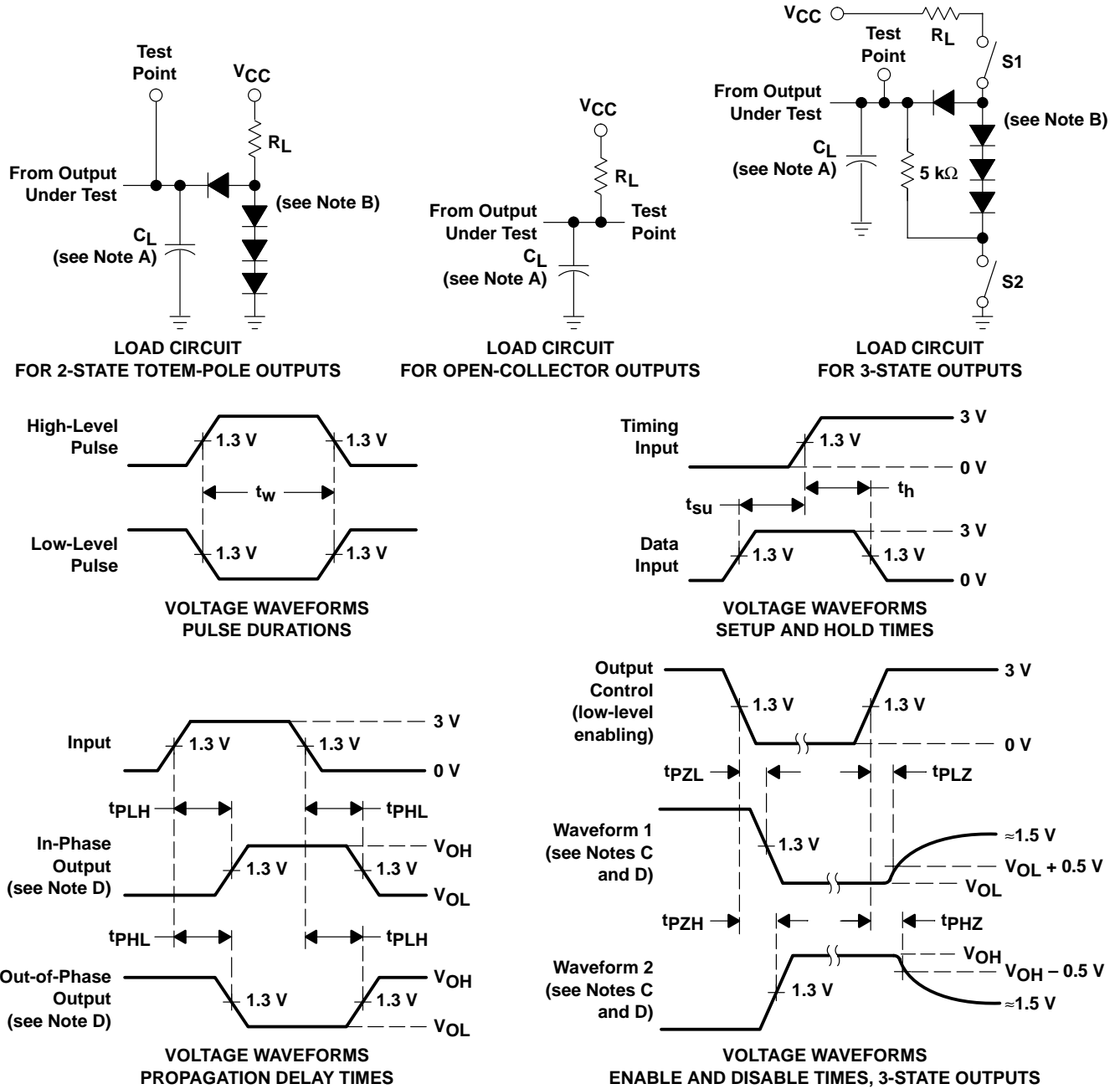
**PARAMETER MEASUREMENT INFORMATION
SERIES 54/74 DEVICES**



- 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_{PHZ} , and t_{PLZ} ; S1 is open and S2 is closed for t_{PZH} ; S1 is closed and S2 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_{PHZ} , and t_{PLZ} ; 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

**SN5414, SN54LS14,
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TYPICAL CHARACTERISTICS OF '14 CIRCUITS†

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

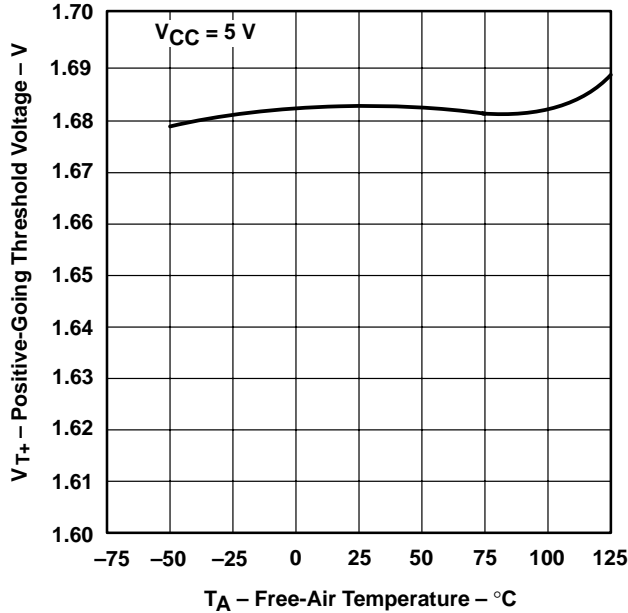


Figure 3

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

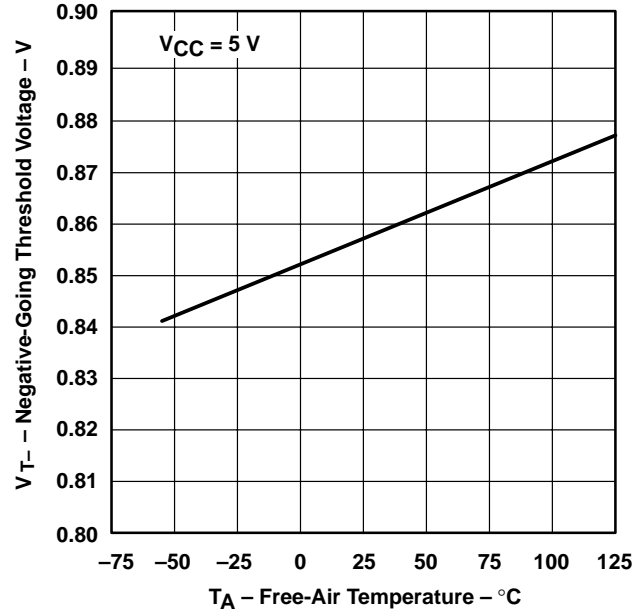


Figure 4

**HYSTERESIS
vs
FREE-AIR TEMPERATURE**

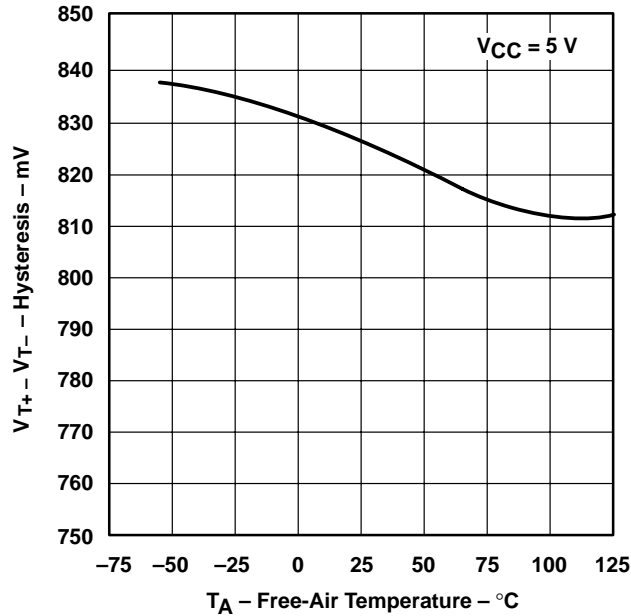


Figure 5

† 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†

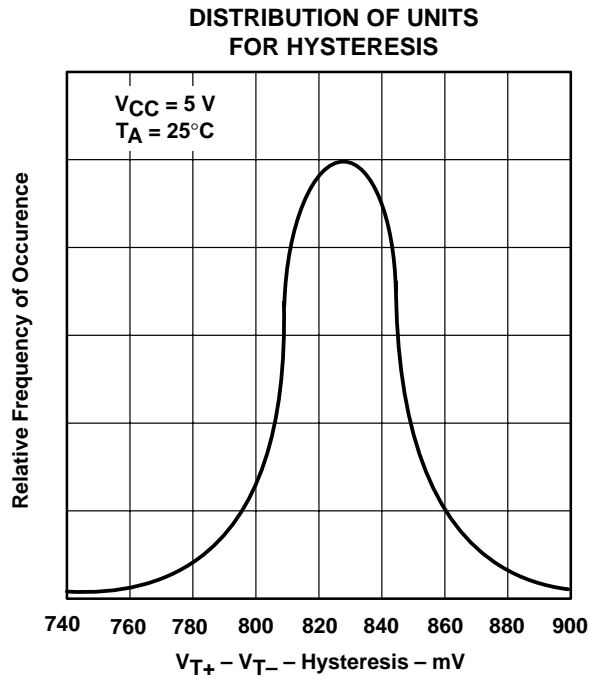


Figure 6

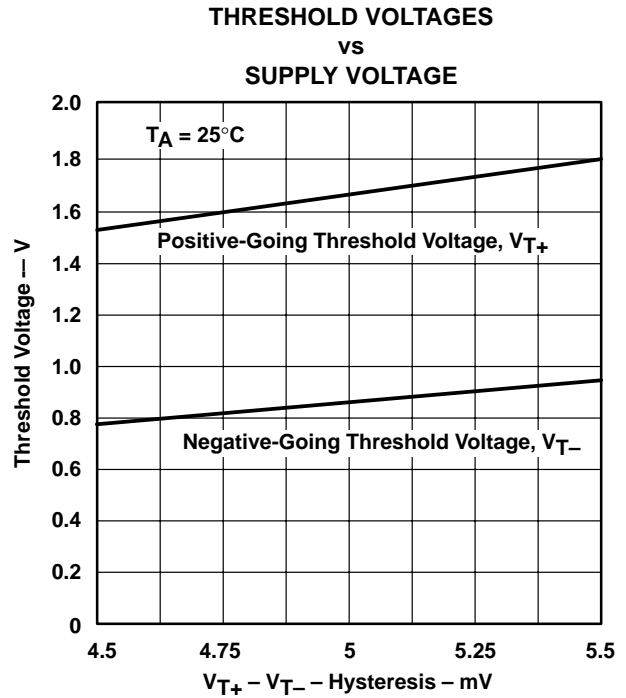


Figure 7

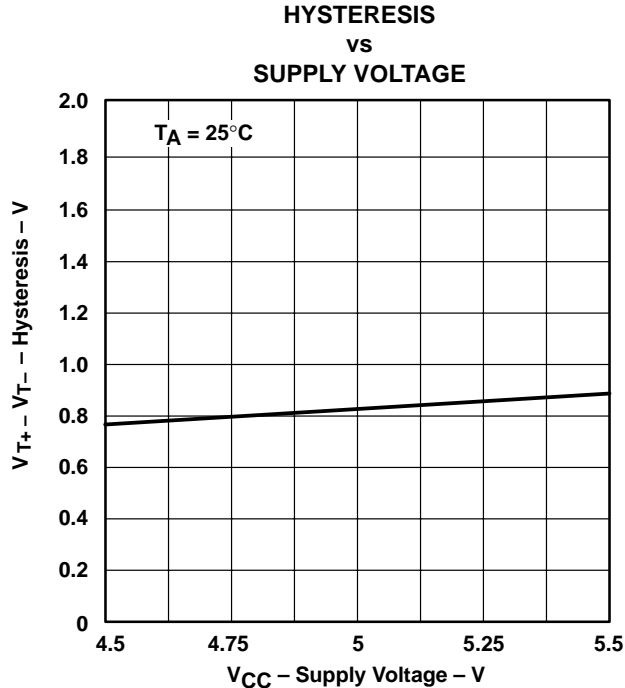


Figure 8

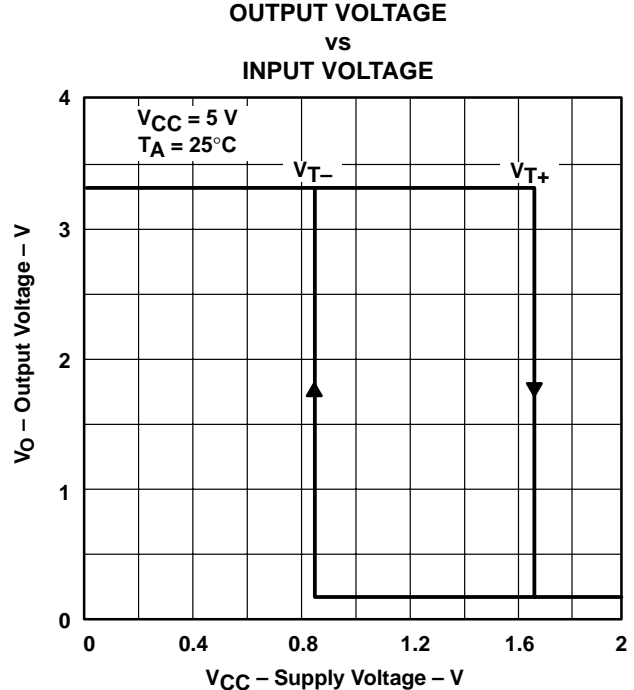


Figure 9

† 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.

**SN5414, SN54LS14,
SN7414, SN74LS14
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TYPICAL CHARACTERISTICS OF 'LS14 CIRCUITS†

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

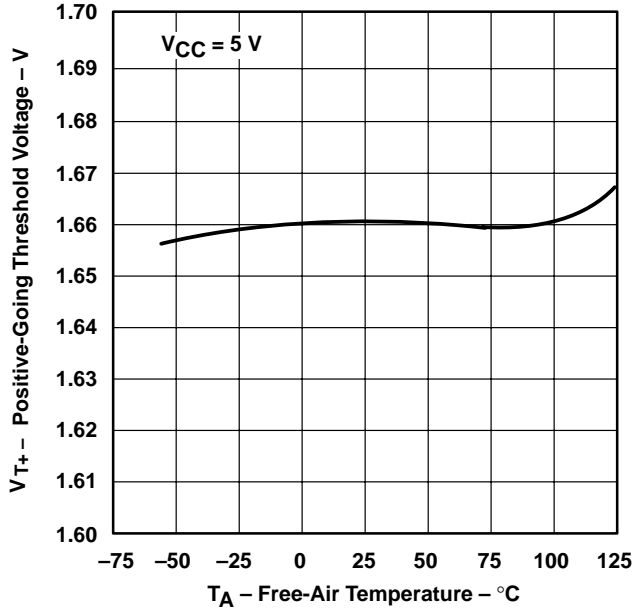


Figure 10

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

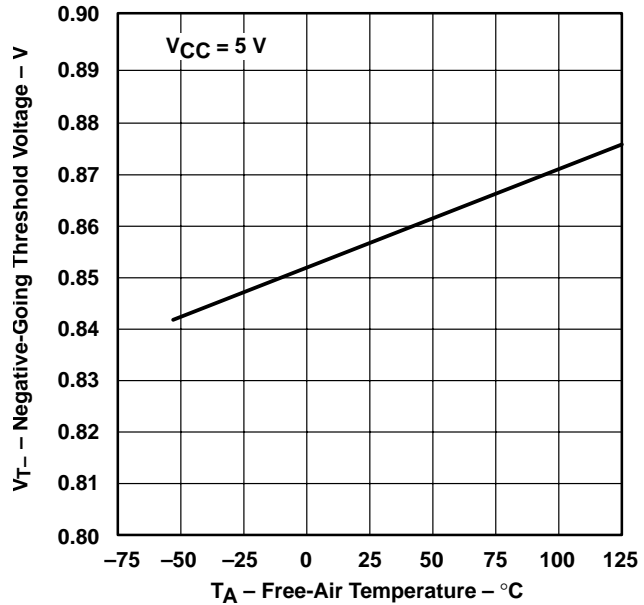


Figure 11

**HYSTERESIS
vs
FREE-AIR TEMPERATURE**

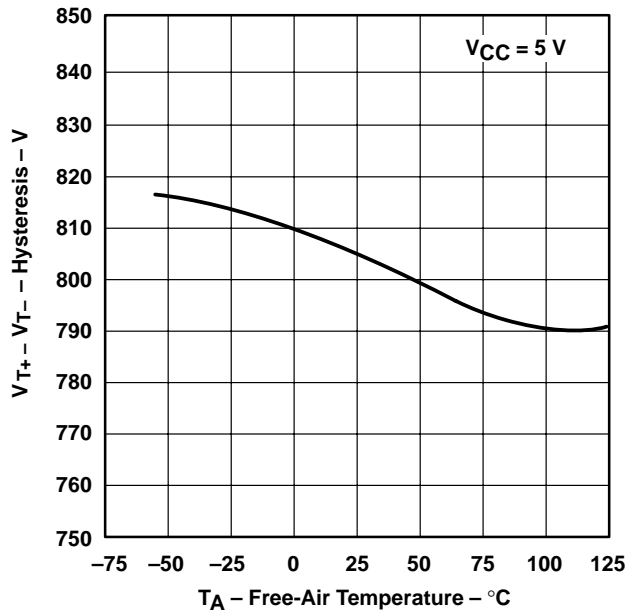


Figure 12

**DISTRIBUTION OF UNITS
FOR HYSTERESIS**

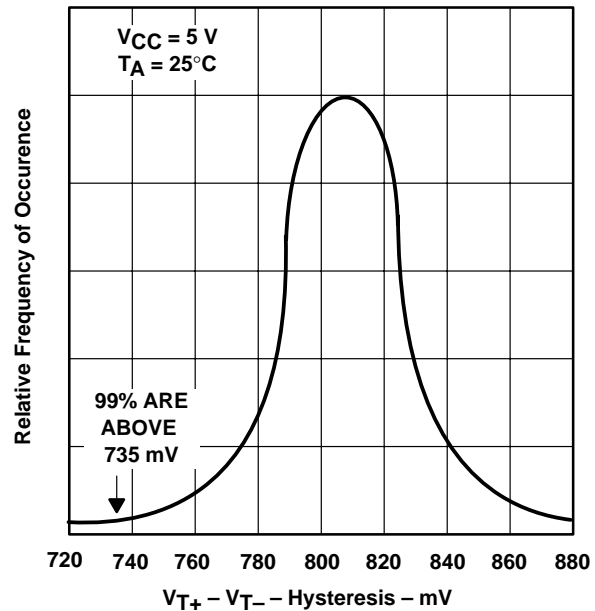
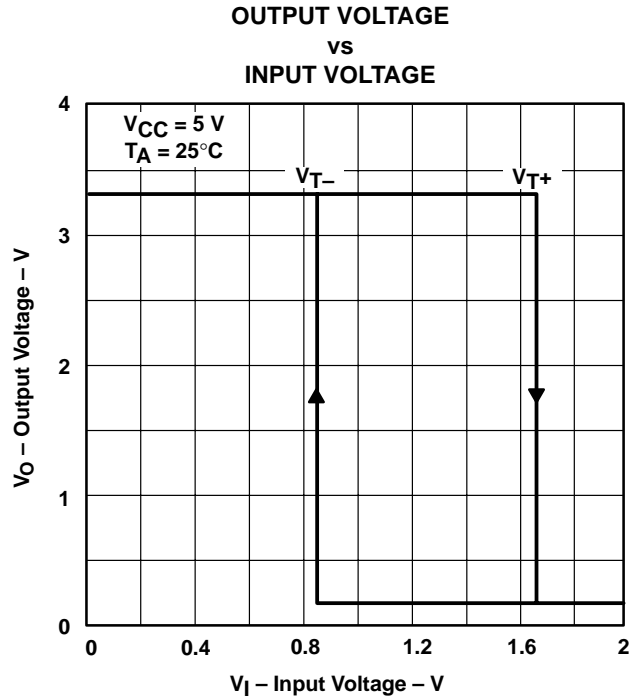
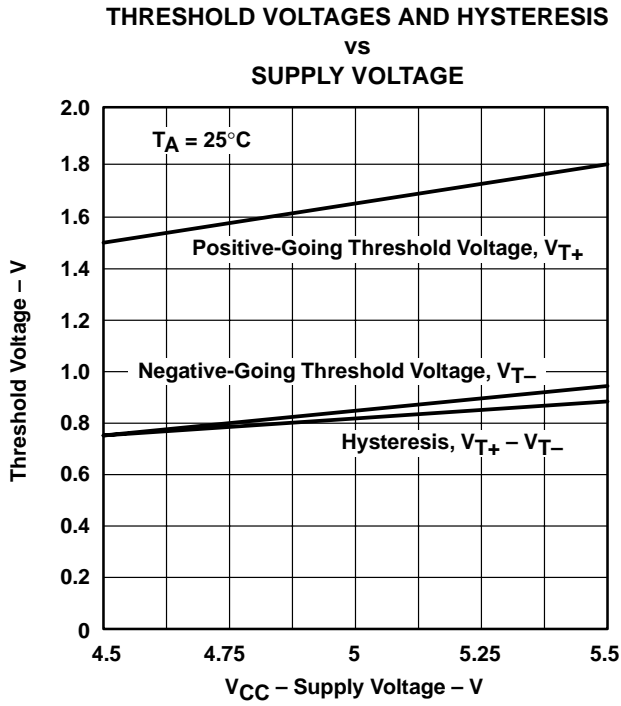


Figure 13

† 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.

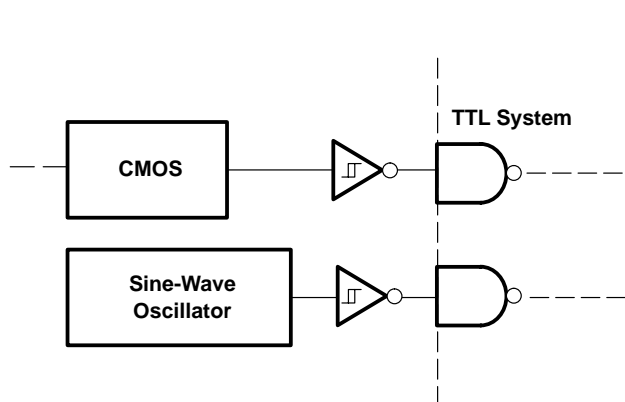
TYPICAL CHARACTERISTICS OF 'LS14 CIRCUITS†



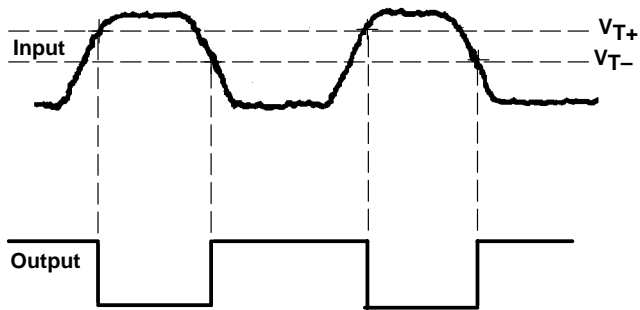
† Data for temperatures below 0°C and above 70°C and supply voltage below 4.75 V and above 5.25 V are applicable for SN5414 only.

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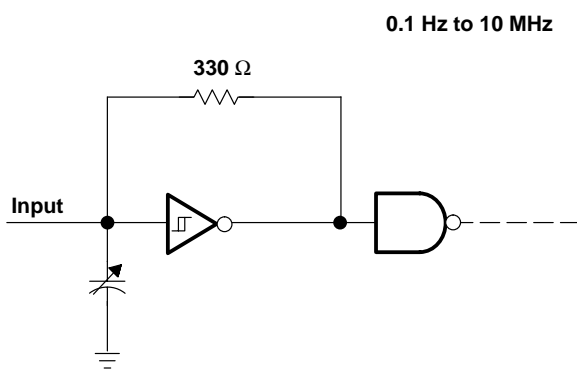
TYPICAL APPLICATION DATA



**TTL System Interface
for Slow Input Waveforms**

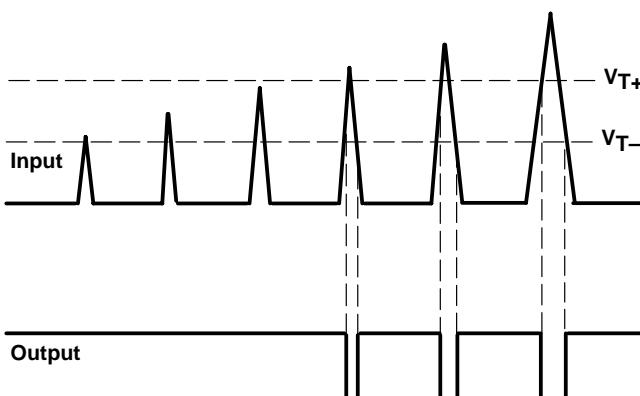


Pulse Shaper

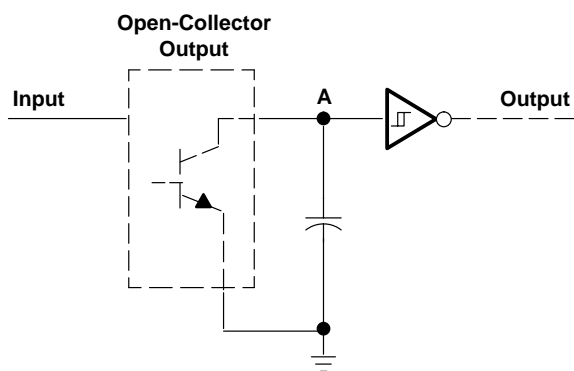


Multivibrator

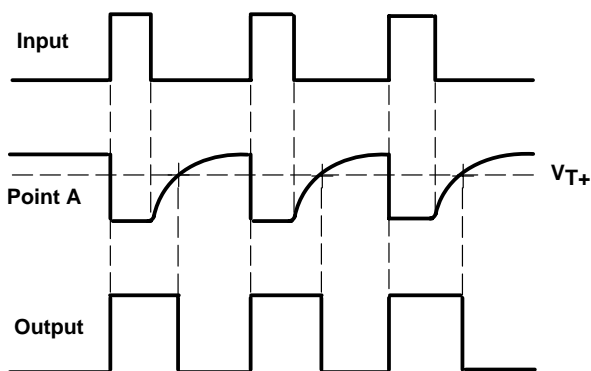
0.1 Hz to 10 MHz



Threshold Detector



Pulse Stretcher



PACKAGING INFORMATION

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
5962-9665801Q2A	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type
5962-9665801QCA	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	N / A for Pkg Type
5962-9665801QDA	ACTIVE	CFP	W	14	1	TBD	A42	N / A for Pkg Type
5962-9665801VCA	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	N / A for Pkg Type
5962-9665801VDA	ACTIVE	CFP	W	14	1	TBD	A42	N / A for Pkg Type
JM38510/31302BCA	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	N / A for Pkg Type
SN5414J	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	N / A for Pkg Type
SN54LS14J	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	N / A for Pkg Type
SN7414D	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN7414DE4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN7414DG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN7414DR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN7414DRE4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN7414DRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN7414N	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
SN7414N3	OBSOLETE	PDIP	N	14		TBD	Call TI	Call TI
SN7414NE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
SN7414NSR	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN7414NSRE4	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LS14D	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LS14DBR	ACTIVE	SSOP	DB	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LS14DBRE4	ACTIVE	SSOP	DB	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LS14DE4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LS14DG4	ACTIVE	SOIC	D	14	50	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LS14DR	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LS14DRE4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LS14DRG4	ACTIVE	SOIC	D	14	2500	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LS14N	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
SN74LS14N3	OBSOLETE	PDIP	N	14		TBD	Call TI	Call TI

Orderable Device	Status ⁽¹⁾	Package Type	Package Drawing	Pins	Package Qty	Eco Plan ⁽²⁾	Lead/Ball Finish	MSL Peak Temp ⁽³⁾
SN74LS14NE4	ACTIVE	PDIP	N	14	25	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
SN74LS14NSR	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LS14NSRE4	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SN74LS14NSRG4	ACTIVE	SO	NS	14	2000	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
SNJ5414J	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	N / A for Pkg Type
SNJ5414W	ACTIVE	CFP	W	14	1	TBD	A42	N / A for Pkg Type
SNJ54LS14FK	ACTIVE	LCCC	FK	20	1	TBD	POST-PLATE	N / A for Pkg Type
SNJ54LS14J	ACTIVE	CDIP	J	14	1	TBD	A42 SNPB	N / A for Pkg Type
SNJ54LS14W	ACTIVE	CFP	W	14	1	TBD	A42	N / A for Pkg Type

⁽¹⁾ The marketing status values are defined as follows:

ACTIVE: Product device recommended for new designs.

LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.

NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.

PREVIEW: Device has been announced but is not in production. Samples may or may not be available.

OBSOLETE: TI has discontinued the production of the device.

⁽²⁾ Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check <http://www.ti.com/productcontent> for the latest availability information and additional product content details.

TBD: The Pb-Free/Green conversion plan has not been defined.

Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.

Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.

Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

⁽³⁾ MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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J (R-GDIP-T**)

14 LEADS SHOWN

CERAMIC DUAL IN-LINE PACKAGE



DIM \ PINS **	14	16	18	20
A	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC	0.300 (7,62) BSC
B MAX	0.785 (19,94)	.840 (21,34)	0.960 (24,38)	1.060 (26,92)
B MIN	—	—	—	—
C MAX	0.300 (7,62)	0.300 (7,62)	0.310 (7,87)	0.300 (7,62)
C MIN	0.245 (6,22)	0.245 (6,22)	0.220 (5,59)	0.245 (6,22)



4040083/F 03/03

- NOTES:
- All linear dimensions are in inches (millimeters).
 - This drawing is subject to change without notice.
 - This package is hermetically sealed with a ceramic lid using glass frit.
 - Index point is provided on cap for terminal identification only on press ceramic glass frit seal only.
 - Falls within MIL STD 1835 GDIP1-T14, GDIP1-T16, GDIP1-T18 and GDIP1-T20.

FK (S-CQCC-N**)

LEADLESS CERAMIC CHIP CARRIER

28 TERMINAL SHOWN



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C. This package can be hermetically sealed with a metal lid.
 - D. The terminals are gold plated.
 - E. Falls within JEDEC MS-004

N (R-PDIP-T**)

PLASTIC DUAL-IN-LINE PACKAGE

16 PINS SHOWN

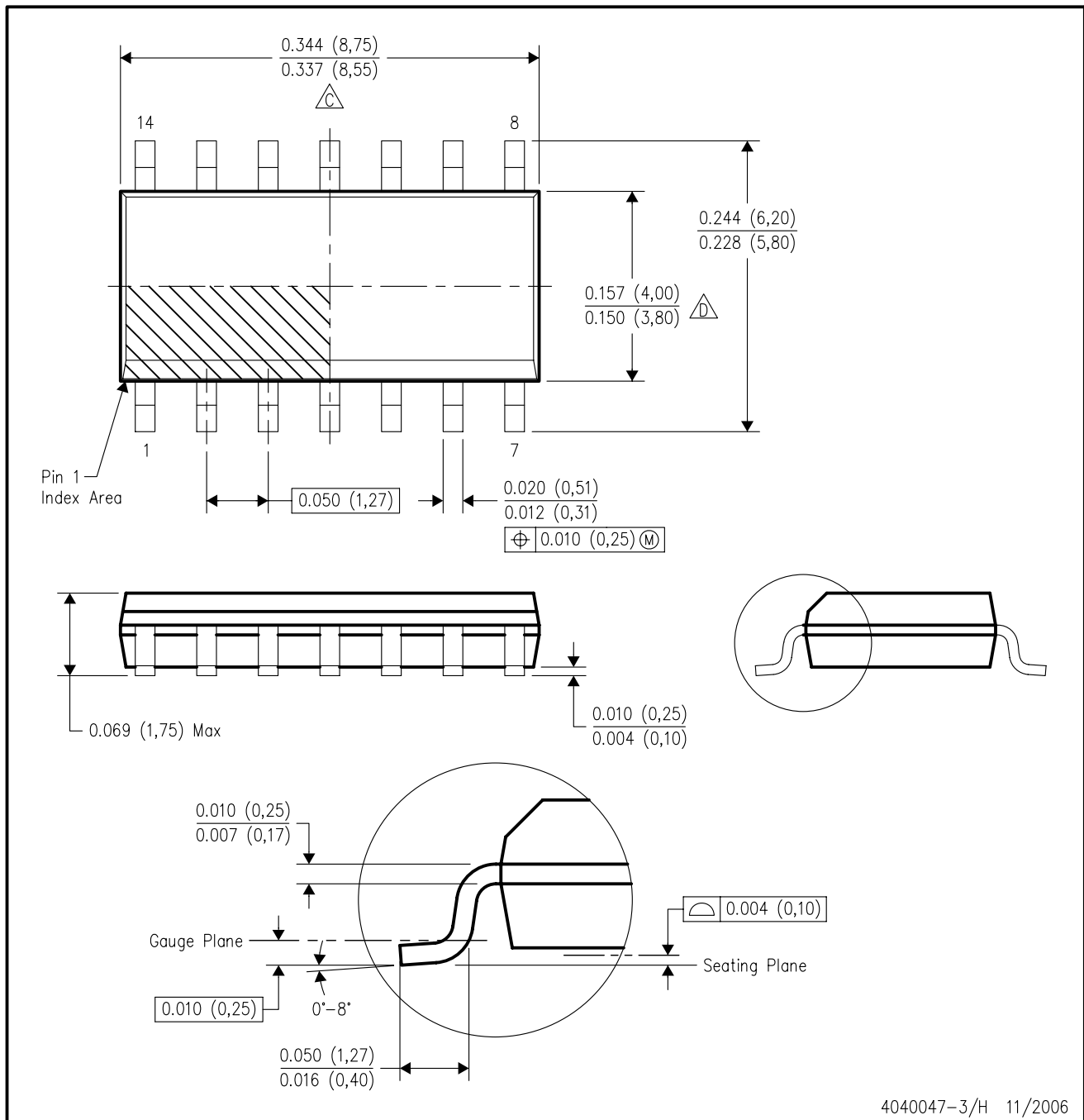


- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - C Falls within JEDEC MS-001, except 18 and 20 pin minimum body length (Dim A).
 - D The 20 pin end lead shoulder width is a vendor option, either half or full width.

4040049/E 12/2002

D (R-PDSO-G14)

PLASTIC SMALL-OUTLINE PACKAGE



- NOTES:
- A. All linear dimensions are in inches (millimeters).
 - B. This drawing is subject to change without notice.
 - $\triangle C$ Body length does not include mold flash, protrusions, or gate burrs. Mold flash, protrusions, or gate burrs shall not exceed .006 (0,15) per end.
 - $\triangle D$ Body width does not include interlead flash. Interlead flash shall not exceed .017 (0,43) per side.
 - E. Reference JEDEC MS-012 variation AB.

MECHANICAL DATA

NS (R-PDSO-G**)

PLASTIC SMALL-OUTLINE PACKAGE

14-PINS SHOWN



- NOTES:
- A. All linear dimensions are in millimeters.
 - B. This drawing is subject to change without notice.
 - C. Body dimensions do not include mold flash or protrusion, not to exceed 0,15.

DB (R-PDSO-G**)

PLASTIC SMALL-OUTLINE

28 PINS SHOWN



- NOTES: A. All linear dimensions are in millimeters.
 B. This drawing is subject to change without notice.
 C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
 D. Falls within JEDEC MO-150

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