

**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

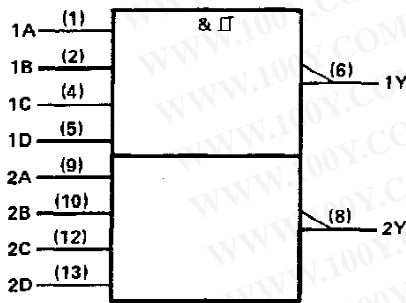
**description**

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 ( $V_{T-}$ ) signals.

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

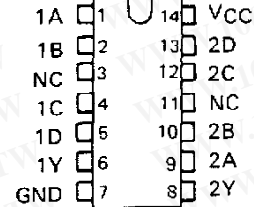
The SN5413 and SN54LS13 are characterized for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $125^{\circ}\text{C}$ . The SN7413 and SN74LS13 are characterized for operation from  $0^{\circ}\text{C}$  to  $70^{\circ}\text{C}$ .

**logic symbol†**

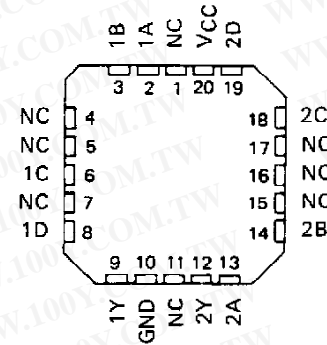


† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-13. Pin numbers shown are for D, J, N, and W packages.

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

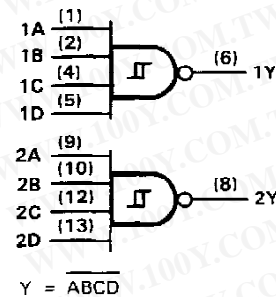


SN54LS13 . . . FK PACKAGE  
 (TOP VIEW)



NC—No internal connection

**logic diagram (positive logic)**



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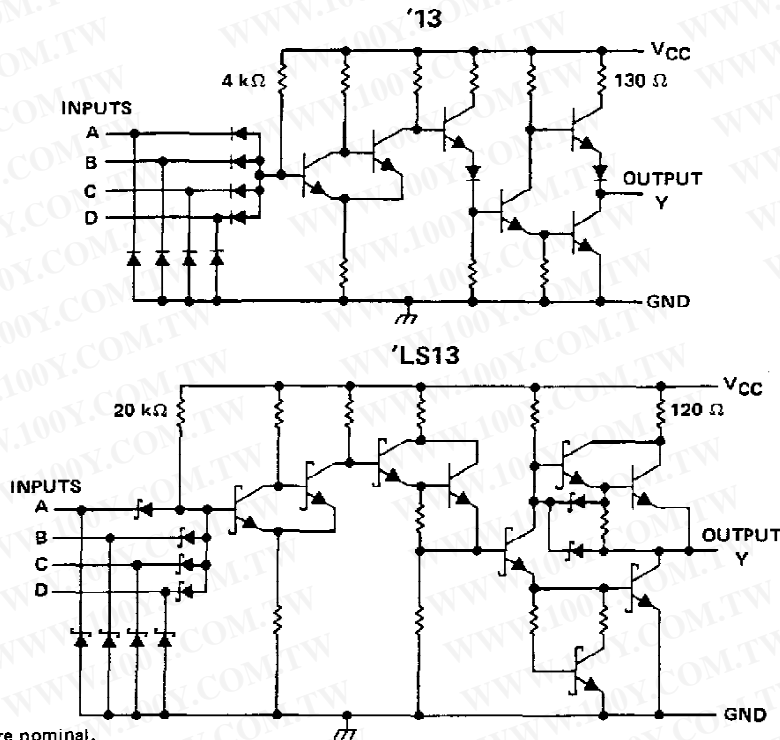


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schematics



Resistor values are nominal.

**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°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**  
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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 <sup>†</sup>	MIN	TYP <sup>‡</sup>	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 (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

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

<sup>‡</sup> 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 (INPUT)	TO (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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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	V
		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.

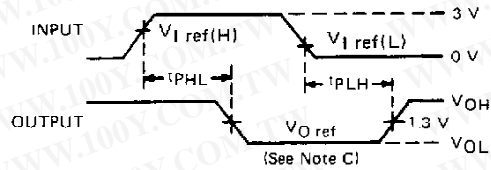
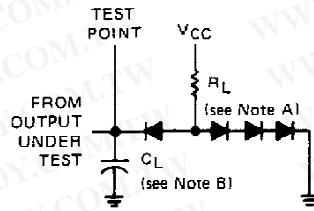
switching characteristics, V<sub>CC</sub> = 5 V, T<sub>A</sub> = 25°C

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



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PARAMETER MEASUREMENT INFORMATION



LOAD CIRCUIT

VOLTAGE WAVEFORMS

NOTES: A. All diodes are 1N3064 or equivalent.  
 B.  $C_L$  includes probe and jig capacitance.  
 C. Generator characteristics and reference voltages are:

	Generator Characteristics				Reference Voltages		
	$Z_{out}$	PRR	$t_r$	$t_f$	$V_{I\ ref(H)}$	$V_{I\ ref(L)}$	$V_{O\ ref}$
SN54'/SN74'	50 $\Omega$	1 MHz	10 ns	10 ns	1.7 V	0.9 V	1.5 V
SN54LS'/SN74LS'	50 $\Omega$	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

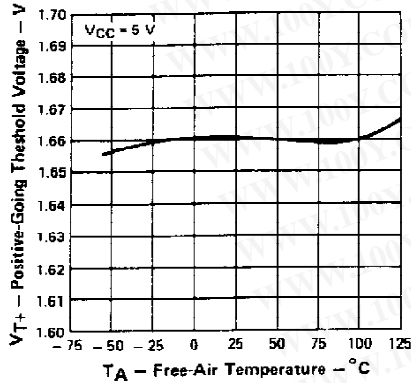


FIGURE 1

NEGATIVE-GOING THRESHOLD VOLTAGE  
 vs  
 FREE-AIR TEMPERATURE

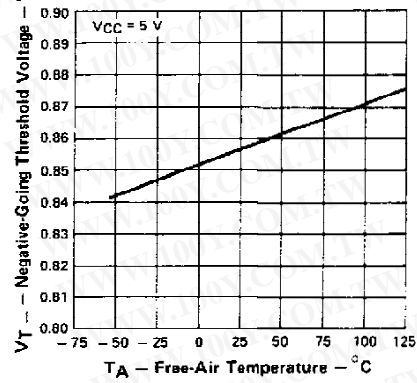


FIGURE 2

HYSTERESIS  
 vs  
 FREE-AIR TEMPERATURE

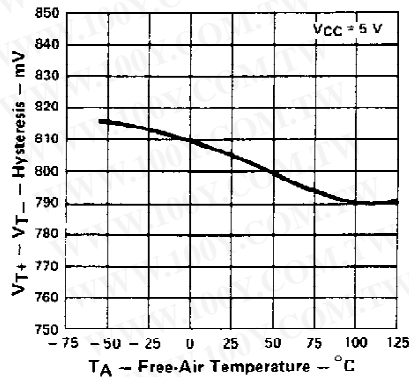


FIGURE 3

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.



SN5413, SN7413  
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TYPICAL CHARACTERISTICS OF '13 CIRCUITS

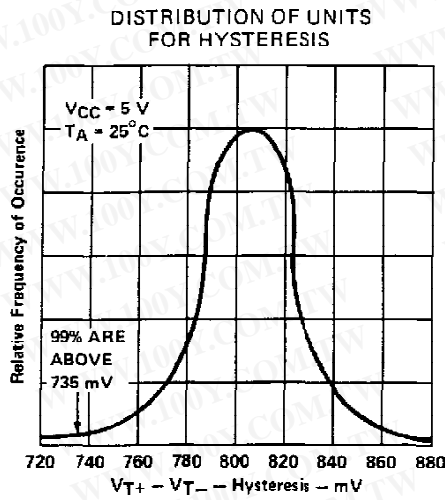


FIGURE 4

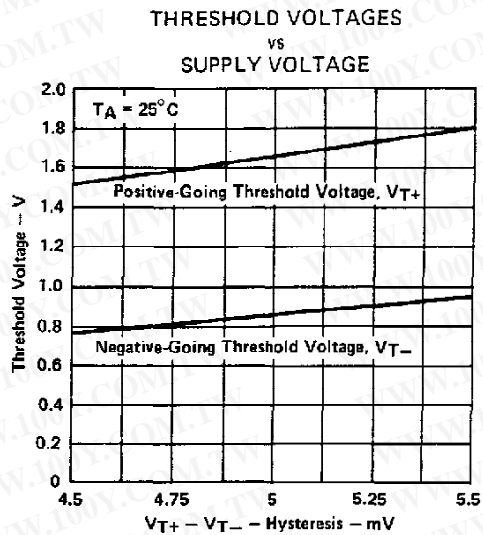


FIGURE 5

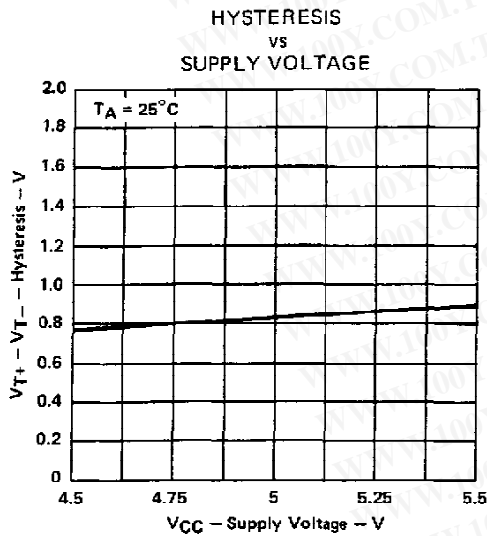


FIGURE 6

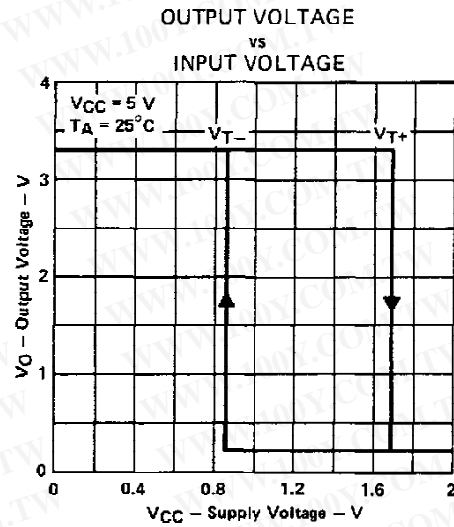


FIGURE 7

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.



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TYPICAL CHARACTERISTICS OF 'LS13 CIRCUITS

POSITIVE-GOING THRESHOLD VOLTAGE  
 vs  
 FREE-AIR TEMPERATURE

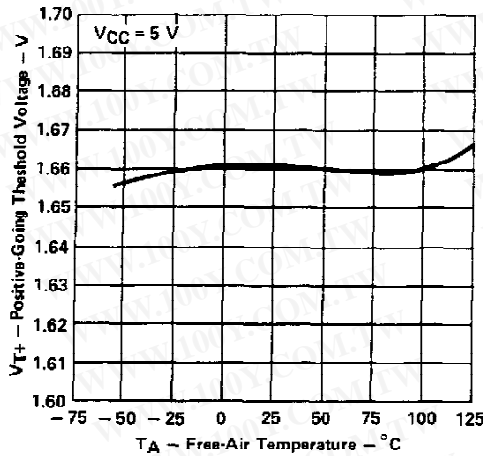


FIGURE 8

NEGATIVE GOING THRESHOLD VOLTAGE  
 vs  
 FREE-AIR TEMPERATURE

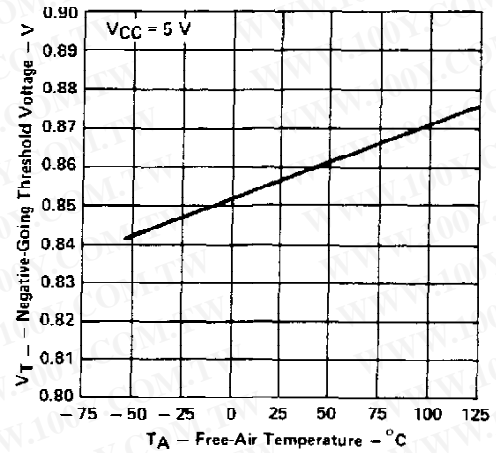


FIGURE 9

HYSTERESIS  
 vs  
 FREE-AIR TEMPERATURE

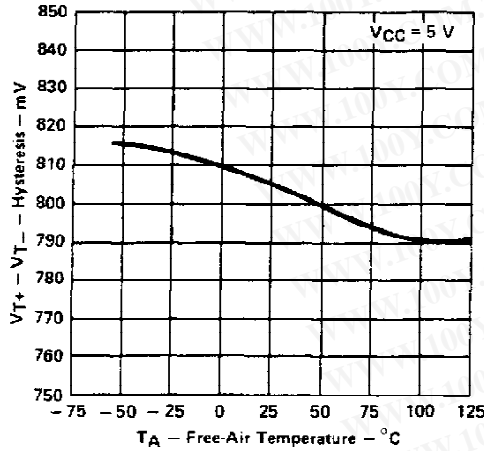


FIGURE 10

DISTRIBUTION OF UNITS  
 FOR HYSTERESIS

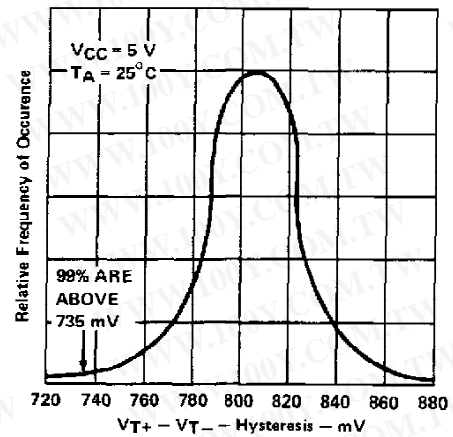


FIGURE 11

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**  
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**TYPICAL CHARACTERISTICS OF 'LS13 CIRCUITS**

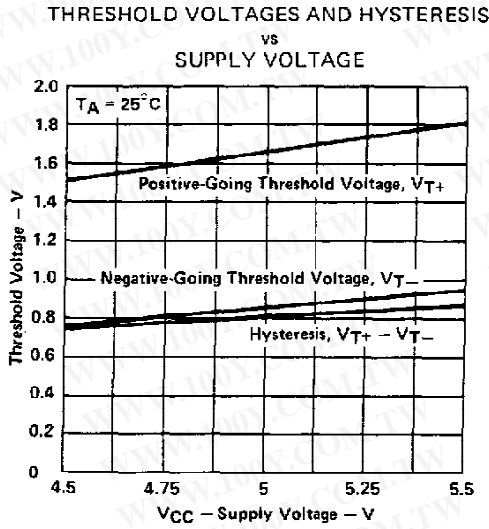


FIGURE 12

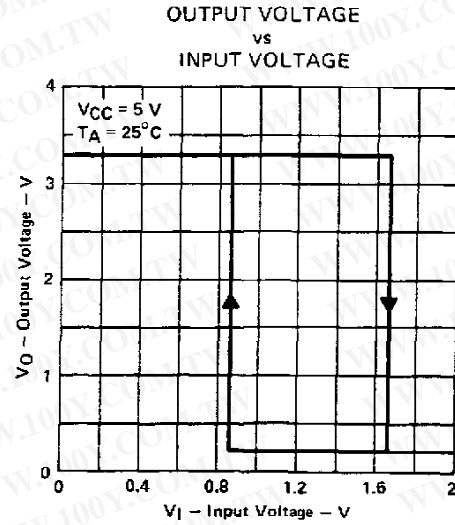


FIGURE 13

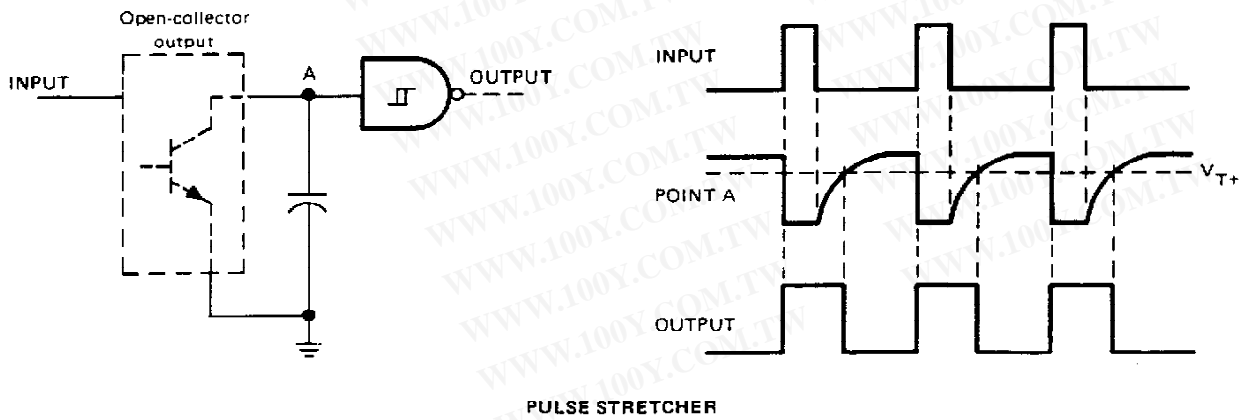
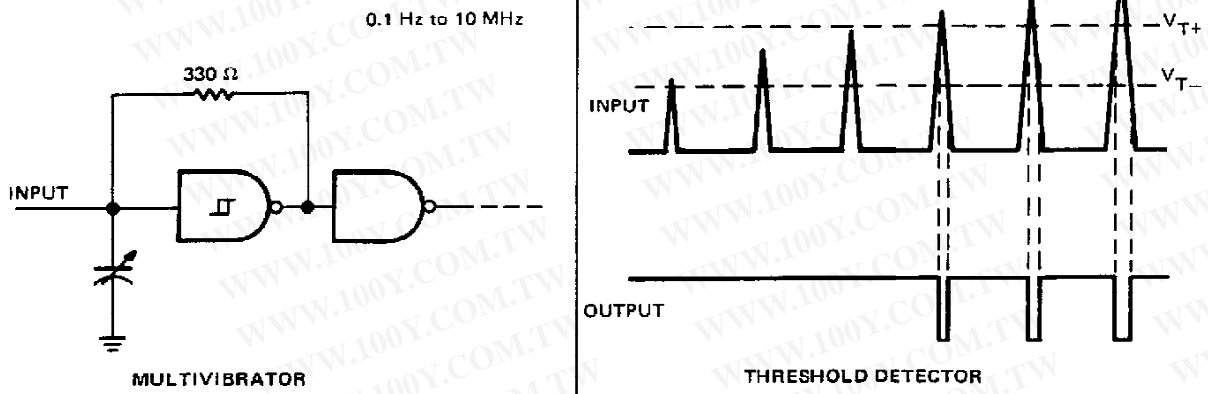
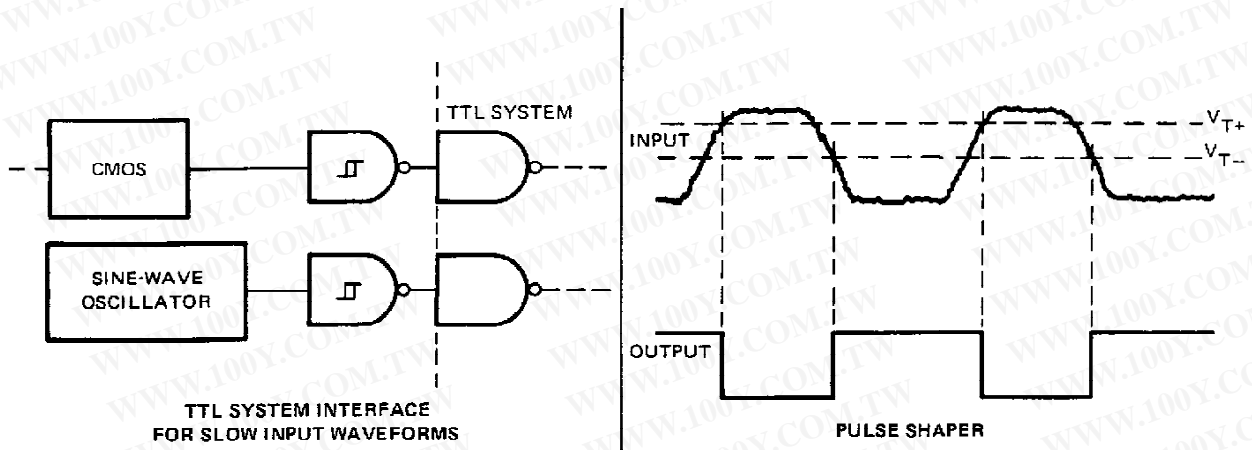
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TYPICAL APPLICATION DATA



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