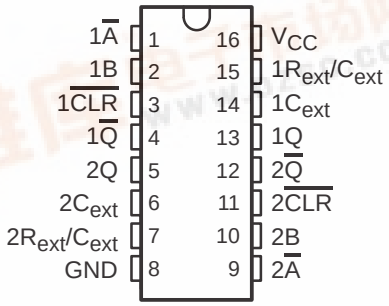
DUAL MONOSTABLE MULTIVIBRATORS WITH SCHMITT-TRIGGER INPUTS

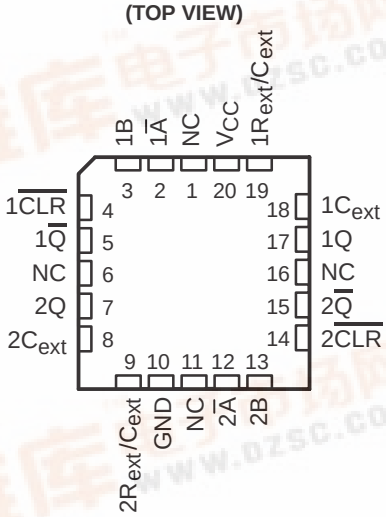
SCLS450 – DECEMBER 1999

- ***EPIC***™ **(Enhanced-Performance Implanted CMOS) Process**
- **Schmitt-Trigger Circuitry on $\overline{A}$, B, and $\overline{CLR}$ Inputs for Slow Input Transition Rates**
- **Edge Triggered From Active-High or Active-Low Gated Logic Inputs**
- **Overriding Clear Terminates Output Pulse**
- **Glitch-Free Power-Up Reset on Outputs**
- **Latch-Up Performance Exceeds 100 mA Per JESD 78, Class II**
- **ESD Protection Exceeds JESD 22**
  - **2000-V Human-Body Model (A114-A)**
  - **200-V Machine Model (A115-A)**
  - **1000-V Charged-Device Model (C101)**
- **Package Options Include Plastic Small-Outline (D, NS), Shrink Small-Outline (DB), Thin Very Small-Outline (DGV), and Thin Shrink Small-Outline (PW) Packages, Ceramic Flat (W) Packages, Chip Carriers (FK), and DIPs (J)**

SN54LV221A . . . J OR W PACKAGE
SN74LV221A . . . D, DB, DGV, NS, OR PW PACKAGE
(TOP VIEW)



SN54LV221A . . . FK PACKAGE
(TOP VIEW)



NC – No internal connection

description

The ’LV221A devices are dual multivibrators designed for 2-V to 5.5-V V_{CC} operation. Each multivibrator has a negative-transition-triggered ($\overline{A}$) input and a positive-transition-triggered (B) input, either of which can be used as an inhibit input.

These edge-triggered multivibrators feature output pulse-duration control by three methods. In the first method, the $\overline{A}$ input is low and the B input goes high. In the second method, the B input is high and the $\overline{A}$ input goes low. In the third method, the $\overline{A}$ input is low, the B input is high, and the clear ($\overline{CLR}$) input goes high.

The output pulse duration is programmable by selecting external resistance and capacitance values. The external timing capacitor must be connected between C_{ext} and R_{ext}/C_{ext}(positive) and an external resistor connected between R_{ext}/C_{ext} and V_{CC}. To obtain variable pulse durations, connect an external variable resistor between and R_{ext}/C_{ext} and V_{CC}. The output pulse duration can also be reduced by taking $\overline{CLR}$ low.

Pulse triggering occurs at a particular voltage level and is not directly related to the transition time of the input pulse. The $\overline{A}$, B, and $\overline{CLR}$ inputs have Schmitt triggers with sufficient hysteresis to handle slow input transition rates with jitter-free triggering at the outputs.

description (continued)

Once triggered, the outputs are independent of further transitions of the $\overline{A}$ and B inputs and are a function of the timing components, or the output pulses can be terminated by the overriding clear. Input pulses may be of any duration relative to the output pulse. Output pulse duration can be varied by choosing the appropriate timing components. Output rise and fall times are TTL compatible and independent of pulse duration. Typical triggering and clearing sequences are illustrated in the input/output timing diagram.

The variance in output pulse duration from device to device typically is less than ±0.5% for given external timing components. An example of this distribution for the 'LV221A is shown in Figure 8. Variations in output pulse duration versus supply voltage and temperature are shown in Figure 5.

During power up, Q outputs will be in the high state, and $\overline{Q}$ outputs will be in the low state. The outputs will be glitch free without applying a reset pulse.

Pin assignments are identical to those of the 'AHC123A and 'AHCT123A devices, so the 'LV221A can be substituted for those devices not using the retrigger feature.

The SN54LV221A is characterized for operation over the full military temperature range of –55°C to 125°C. The SN74LV221A is characterized for operation from –40°C to 85°C.

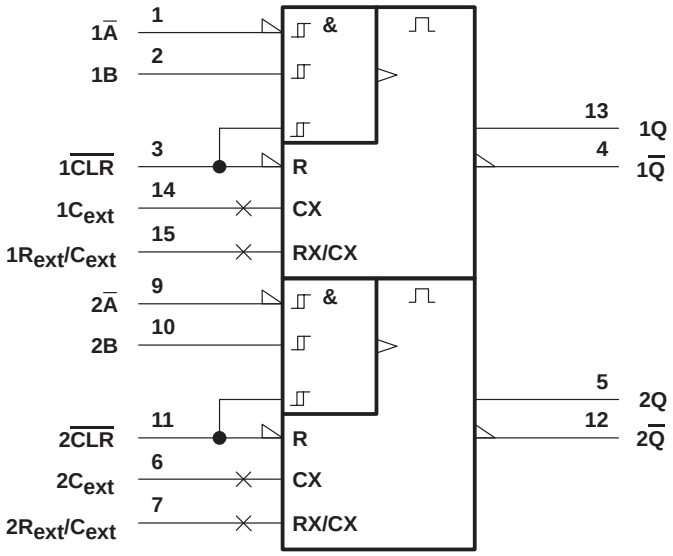
For additional application information on multivibrators, see the application report *Designing With The SN74AHC123A and SN74AHCT123A*, literature number SCLA014.

FUNCTION TABLE
(each multivibrator)

INPUTS			OUTPUTS		FUNCTION
$\overline{CLR}$	$\overline{A}$	B	Q	$\overline{Q}$	
L	X	X	L	H	Reset
H	H	X	L	H	Inhibit
H	X	L	L	H	Inhibit
H	L	↑	⎍	⎎	Outputs enabled
H	↓	H	⎍	⎎	Outputs enabled
↑†	L	H	⎍	⎎	Outputs enabled

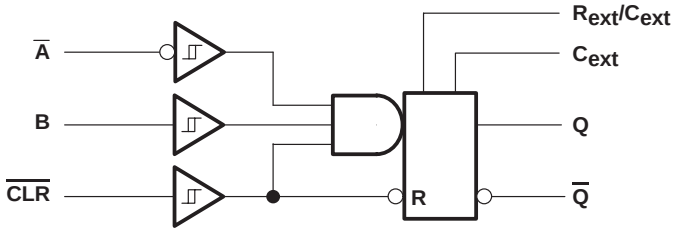
† This condition is true only if the output of the latch formed by the NAND gate has been conditioned to the logic 1 state prior to $\overline{CLR}$ going high. This latch is conditioned by taking either $\overline{A}$ high or B low while $\overline{CLR}$ is inactive (high).

logic symbol†

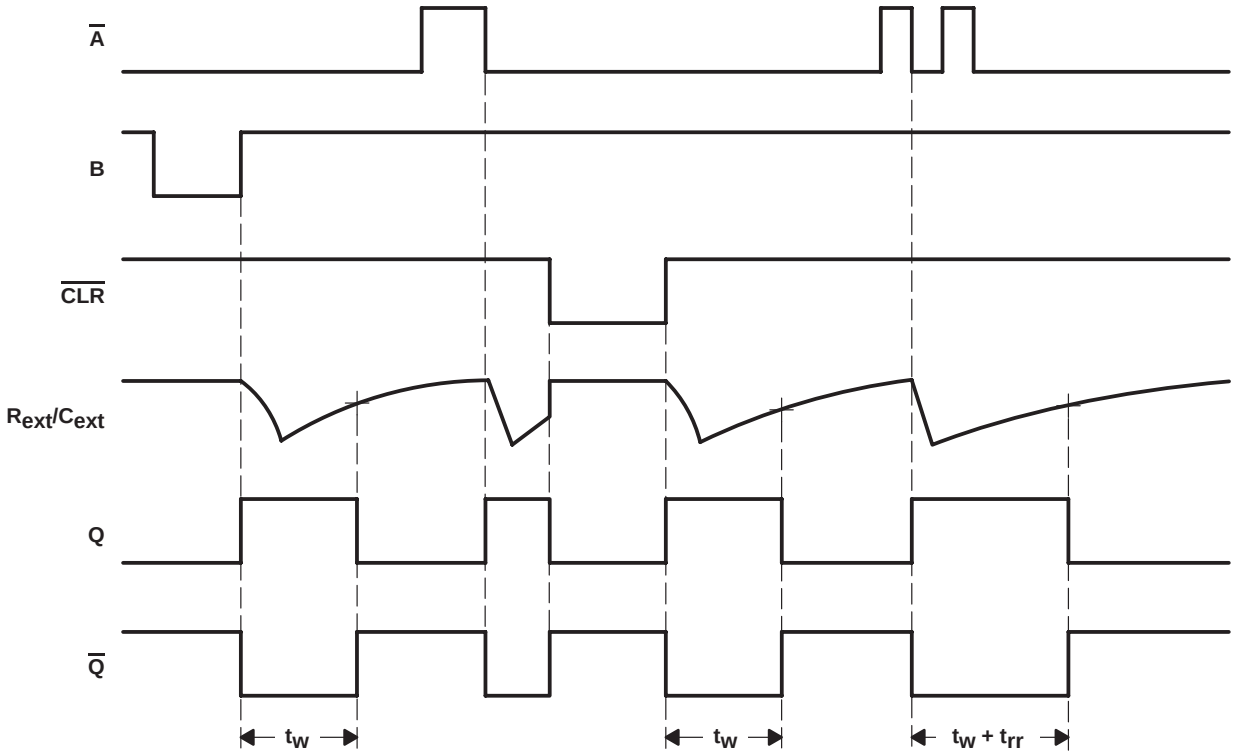


† This symbol is in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.
Pin numbers shown are for the D, DB, DGV, J, NS, PW, and W packages.

logic diagram, each multivibrator (positive logic)



input/output timing diagram



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

Supply voltage range, V_{CC} . . . . . –0.5 V to 7 V
Input voltage range, V_I (see Note 1) . . . . . –0.5 V to 7 V
Output voltage range in high or low state, V_O (see Notes 1 and 2) . . . . . –0.5 V to V_{CC} + 0.5 V
Output voltage range in power-off state, V_O (see Note 1) . . . . . –0.5 V to 7 V
Input clamp current, I_{IK} (V_I < 0) . . . . . –20 mA
Output clamp current, I_{OK} (V_O < 0 or V_O > V_{CC}) . . . . . ±50 mA
Continuous output current, I_O (V_O = 0 to V_{CC}) . . . . . ±25 mA
Continuous current through V_{CC} or GND . . . . . ±50 mA
Package thermal impedance, θ_{JA} (see Note 3): D package . . . . . 73°C/W
DB package . . . . . 82°C/W
DGV package . . . . . 120°C/W
NS package . . . . . 64°C/W
PW package . . . . . 108°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. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.
2. This value is limited to 7 V maximum.
3. The package thermal impedance is calculated in accordance with JESD 51.

recommended operating conditions (see Note 4)

			SN54LV221A		SN74LV221A		UNIT
			MIN	MAX	MIN	MAX	
V_{CC}	Supply voltage		2	5.5	2	5.5	V
V_{IH}	High-level input voltage	V_{CC} = 2 V	1.5		1.5		V
		V_{CC} = 2.3 V to 2.7 V	$V_{CC} \times 0.7$		$V_{CC} \times 0.7$		
		V_{CC} = 3 V to 3.6 V	$V_{CC} \times 0.7$		$V_{CC} \times 0.7$		
		V_{CC} = 4.5 V to 5.5 V	$V_{CC} \times 0.7$		$V_{CC} \times 0.7$		
V_{IL}	Low-level input voltage	V_{CC} = 2 V		0.5		0.5	V
		V_{CC} = 2.3 V to 2.7 V		$V_{CC} \times 0.3$		$V_{CC} \times 0.3$	
		V_{CC} = 3 V to 3.6 V		$V_{CC} \times 0.3$		$V_{CC} \times 0.3$	
		V_{CC} = 4.5 V to 5.5 V		$V_{CC} \times 0.3$		$V_{CC} \times 0.3$	
V_I	Input voltage		0	5.5	0	5.5	V
V_O	Output voltage		0	V_{CC}	0	V_{CC}	V
I_{OH}	High-level output current	V_{CC} = 2 V		–50		–50	μA
		V_{CC} = 2.3 V to 2.7 V		–2		–2	mA
		V_{CC} = 3 V to 3.6 V		–6		–6	
		V_{CC} = 4.5 V to 5.5 V		–12		–12	
I_{OL}	Low-level output current	V_{CC} = 2 V		50		50	μA
		V_{CC} = 2.3 V to 2.7 V		2		2	mA
		V_{CC} = 3 V to 3.6 V		6		6	
		V_{CC} = 4.5 V to 5.5 V		12		12	
R_{ext}	External timing resistance	V_{CC} = 2 V	5k		5k		Ω
		$V_{CC} \geq$ 3 V	1k		1k		
C_{ext}	External timing capacitance		No restriction		No restriction		pF
$\Delta t/\Delta V_{CC}$	Power-up ramp rate		1		1		ms/V
T_A	Operating free-air temperature		–55	125	–40	85	°C

NOTE 4: All unused inputs of the device must be held at V_{CC} or GND to ensure proper device operation. Refer to the TI application report, *Implications of Slow or Floating CMOS Inputs*, literature number SCBA004.

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

PARAMETER		TEST CONDITIONS	V_{CC}	SN54LV221A			SN74LV221A			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
V_{OH}		I_{OH} = –50 µA	2 V to 5.5 V	V_{CC}–0.1			V_{CC}–0.1			V
		I_{OH} = –2 mA	2.3 V	2			2			
		I_{OH} = –6 mA	3 V	2.48			2.48			
		I_{OH} = –12 mA	4.5 V	3.8			3.8			
V_{OL}		I_{OL} = 50 µA	2 V to 5.5 V			0.1			0.1	V
		I_{OL} = 2 mA	2.3 V			0.4			0.4	
		I_{OL} = 6 mA	3 V			0.44			0.44	
		I_{OL} = 12 mA	4.5 V			0.55			0.55	
I_I	R_{ext}/C_{ext}†	V_I = V_{CC} or GND	2 V to 5.5 V			±2.5			±2.5	µA
	$\overline{A}$, B, and $\overline{CLR}$	V_I = V_{CC} or GND	0 V			±1			±1	
			5.5 V			±1			±1	
I_{CC}	Quiescent	V_I = V_{CC} or GND, I_O = 0	5.5 V			20			20	µA
I_{CC}	Active state (per circuit)	V_I = V_{CC} or GND, R_{ext}/C_{ext} = 0.5 V_{CC}	2.3 V			220			220	µA
			3 V			280			280	
			4.5 V			650			650	
			5.5 V			975			975	
I_{off}		V_I or V_O = 0 to 5.5 V	0 V						5	µA
C_i		V_I = V_{CC} or GND	3.3 V		1.9			1.9		pF
			5 V		1.9			1.9		

† This test is performed with the terminal in the off-state condition.

timing requirements over recommended operating free-air temperature range, V_{CC} = 2.5 V ± 0.2 V (unless otherwise noted) (see Figure 1)

			TEST CONDITIONS	T_A = 25°C			SN54LV221A	SN74LV221A		UNIT
				MIN	TYP	MAX	MIN MAX	MIN	MAX	
t_w	Pulse duration	$\overline{CLR}$		6			6.5	6.5		ns
		$\overline{A}$ or B trigger		6			6.5	6.5		

timing requirements over recommended operating free-air temperature range, V_{CC} = 3.3 V ± 0.3 V (unless otherwise noted) (see Figure 1)

			TEST CONDITIONS	T_A = 25°C			SN54LV221A	SN74LV221A		UNIT
				MIN	TYP	MAX	MIN MAX	MIN	MAX	
t_w	Pulse duration	$\overline{CLR}$		5			5	5		ns
		$\overline{A}$ or B trigger		5			5	5		

timing requirements over recommended operating free-air temperature range, V_{CC} = 5 V ± 0.5 V (unless otherwise noted) (see Figure 1)

			TEST CONDITIONS	T_A = 25°C			SN54LV221A	SN74LV221A		UNIT
				MIN	TYP	MAX	MIN MAX	MIN	MAX	
t_w	Pulse duration	$\overline{CLR}$		5			5	5		ns
		$\overline{A}$ or B trigger		5			5	5		

switching characteristics over recommended operating free-air temperature range, V_{CC} = 2.5 V ± 0.2 V (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	T_A = 25°C			SN54LV221A		SN74LV221A		UNIT
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
t_{pd}	$\overline{A}$ or B	Q or $\overline{Q}$	C_L = 15 pF		14.6*	31.4*	1*	37*	1	37	ns
	$\overline{CLR}$	Q or $\overline{Q}$			13.2*	25*	1*	29.5*	1	29.5	
	$\overline{CLR}$ trigger	Q or $\overline{Q}$			15.2*	33.4*	1*	39*	1	39	
t_{pd}	$\overline{A}$ or B	Q or $\overline{Q}$	C_L = 50 pF		16.7	36	1	42	1	42	ns
	$\overline{CLR}$	Q or $\overline{Q}$			15	32.8	1	34.5	1	34.5	
	$\overline{CLR}$ trigger	Q or $\overline{Q}$			17.4	38	1	44	1	44	
t_w†		Q or $\overline{Q}$	C_L = 50 pF, C_{ext} = 28 pF, R_{ext} = 2 kΩ		203	260		320		320	ns
			C_L = 50 pF, C_{ext} = 0.01 μF, R_{ext} = 10 kΩ	90	100	110	90	110	90	110	μs
			C_L = 50 pF, C_{ext} = 0.1 μF, R_{ext} = 10 kΩ	0.9	1	1.1	0.9	1.1	0.9	1.1	ms
Δt_w‡			C_L = 50 pF		±1						%

* On products compliant to MIL-PRF-38535, this parameter is not production tested.
† t_w = Duration of pulse at Q and $\overline{Q}$ outputs
‡ Δt_w = Output pulse duration variation (Q and $\overline{Q}$) between circuits in same package

switching characteristics over recommended operating free-air temperature range, V_{CC} = 3.3 V ± 0.3 V (unless otherwise noted) (see Figure 1)

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	T_A = 25°C			SN54LV221A		SN74LV221A		UNIT
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
t_{pd}	$\overline{A}$ or B	Q or $\overline{Q}$	C_L = 15 pF		10.2*	20.6*	1*	24*	1	24	ns
	$\overline{CLR}$	Q or $\overline{Q}$			9.3*	15.8*	1*	18.5*	1	18.5	
	$\overline{CLR}$ trigger	Q or $\overline{Q}$			10.6*	22.4*	1*	26*	1	26	
t_{pd}	$\overline{A}$ or B	Q or $\overline{Q}$	C_L = 50 pF		11.8	24.1	1	27.5	1	27.5	ns
	$\overline{CLR}$	Q or $\overline{Q}$			10.6	19.3	1	22	1	22	
	$\overline{CLR}$ trigger	Q or $\overline{Q}$			12.3	25.9	1	29.5	1	29.5	
t_w†		Q or $\overline{Q}$	C_L = 50 pF, C_{ext} = 28 pF, R_{ext} = 2 kΩ		186	240		300		300	ns
			C_L = 50 pF, C_{ext} = 0.01 μF, R_{ext} = 10 kΩ	90	100	110	90	110	90	110	μs
			C_L = 50 pF, C_{ext} = 0.1 μF, R_{ext} = 10 kΩ	0.9	1	1.1	0.9	1.1	0.9	1.1	ms
Δt_w‡			C_L = 50 pF		±1						%

* On products compliant to MIL-PRF-38535, this parameter is not production tested.
† t_w = Duration of pulse at Q and $\overline{Q}$ outputs
‡ Δt_w = Output pulse duration variation (Q and $\overline{Q}$) between circuits in same package

switching characteristics over recommended operating free-air temperature range, V_{CC} = 5 V ± 0.5 V (unless otherwise noted) (see Figure 1)

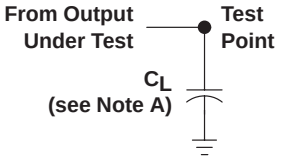
PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	T_A = 25°C			SN54LV221A		SN74LV221A		UNIT
				MIN	TYP	MAX	MIN	MAX	MIN	MAX	
t_{pd}	$\overline{A}$ or B	Q or $\overline{Q}$	C_L = 15 pF		7.1*	12*	1*	14*	1	14	ns
	$\overline{CLR}$	Q or $\overline{Q}$			6.5*	9.4*	1*	11*	1	11	
	$\overline{CLR}$ trigger	Q or $\overline{Q}$			7.3*	12.9*	1*	15*	1	15	
t_{pd}	$\overline{A}$ or B	Q or $\overline{Q}$	C_L = 50 pF		8.2	14	1	16	1	16	ns
	$\overline{CLR}$	Q or $\overline{Q}$			7.4	11.4	1	13	1	13	
	$\overline{CLR}$ trigger	Q or $\overline{Q}$			8.6	14.9	1	17	1	17	
t_w†		Q or $\overline{Q}$	C_L = 50 pF, C_{ext} = 28 pF, R_{ext} = 2 kΩ		171	200		240		240	ns
			C_L = 50 pF, C_{ext} = 0.01 µF, R_{ext} = 10 kΩ	90	100	110	90	110	90	110	µs
			C_L = 50 pF, C_{ext} = 0.1 µF, R_{ext} = 10 kΩ	0.9	1	1.1	0.9	1.1	0.9	1.1	ms
Δt_w‡			C_L = 50 pF		±1						%

* On products compliant to MIL-PRF-38535, this parameter is not production tested.
† t_w = Duration of pulse at Q and $\overline{Q}$ outputs
‡ Δt_w = Output pulse duration variation (Q and $\overline{Q}$) between circuits in same package

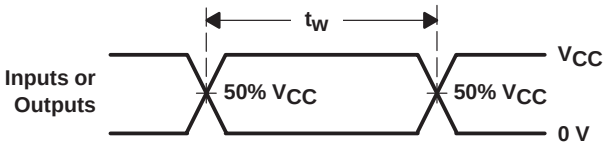
operating characteristics, T_A = 25°C

PARAMETER		TEST CONDITIONS		V_{CC}	TYP	UNIT
C_{pd}	Power dissipation capacitance	C_L = 50 pF,	f = 10 MHz	3.3 V	50	pF
				5 V	51	

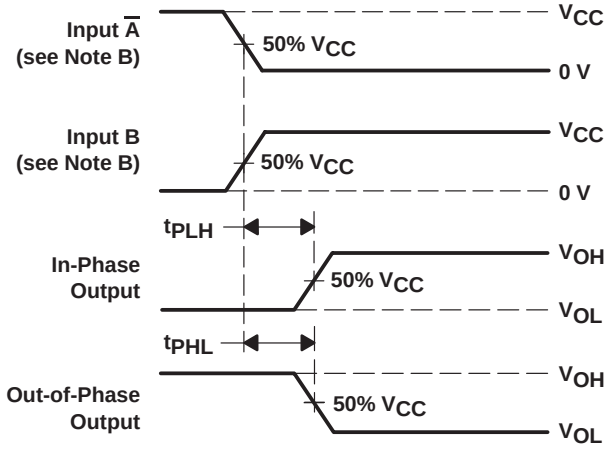
PARAMETER MEASUREMENT INFORMATION



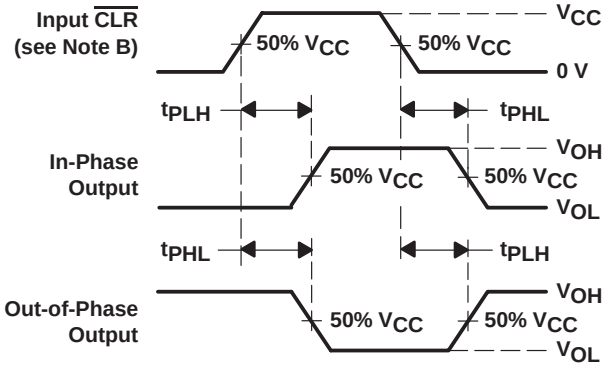
LOAD CIRCUIT



VOLTAGE WAVEFORMS
PULSE DURATION



VOLTAGE WAVEFORMS
DELAY TIMES



VOLTAGE WAVEFORMS
DELAY TIMES

NOTES: A. C_L includes probe and jig capacitance.
B. All input pulses are supplied by generators having the following characteristics: PRR ≤ 1 MHz, Z_O = 50 Ω, t_r = 3 ns, t_f = 3 ns.
C. The outputs are measured one at a time with one input transition per measurement.

Figure 1. Load Circuit and Voltage Waveforms

APPLICATION INFORMATION

caution in use

To prevent malfunctions due to noise, connect a high-frequency capacitor between V_{CC} and GND, and keep the wiring between the external components and C_{ext} and R_{ext}/C_{ext} terminals as short as possible.

power-down considerations

Large values of C_{ext} can cause problems when powering down the ’LV221A because of the amount of energy stored in the capacitor. When a system containing this device is powered down, the capacitor can discharge from V_{CC} through the protection diodes at pin 2 or pin 14. Current through the input protection diodes must be limited to 30 mA; therefore, the turn-off time of the V_{CC} power supply must not be faster than $t = V_{CC} \times C_{ext}/30$ mA. For example, if V_{CC} = 5 V and C_{ext} = 15 pF, the V_{CC} supply must turn off no faster than $t = (5\ V) \times (15\ pF)/30\ mA = 2.5$ ms. Usually, this is not a problem because power supplies are heavily filtered and cannot discharge at this rate. When a more rapid decrease of V_{CC} to zero occurs, the ’LV221A can sustain damage. To avoid this possibility, use external clamping diodes.

output pulse duration

The output pulse duration, t_W, is determined primarily by the values of the external capacitance (C_T) and timing resistance (R_T). The timing components are connected as shown in Figure 2.

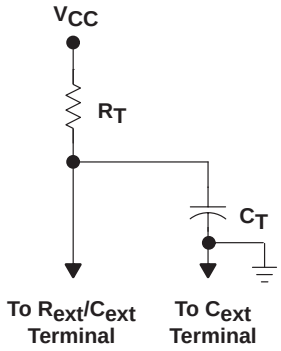


Figure 2. Timing-Component Connections

The pulse duration is given by:

$$t_w = K \times R_T \times C_T \quad (1)$$

if C_T is ≥ 1000 pF, K = 1.0

or

if C_T is < 1000 pF, K can be determined from Figure 7

where:

t_W = pulse duration in ns
R_T = external timing resistance in kΩ
C_T = external capacitance in pF
K = multiplier factor

Equation 1 and Figure 3 or 4 can be used to determine values for pulse duration, external resistance, and external capacitance.

APPLICATION INFORMATION†

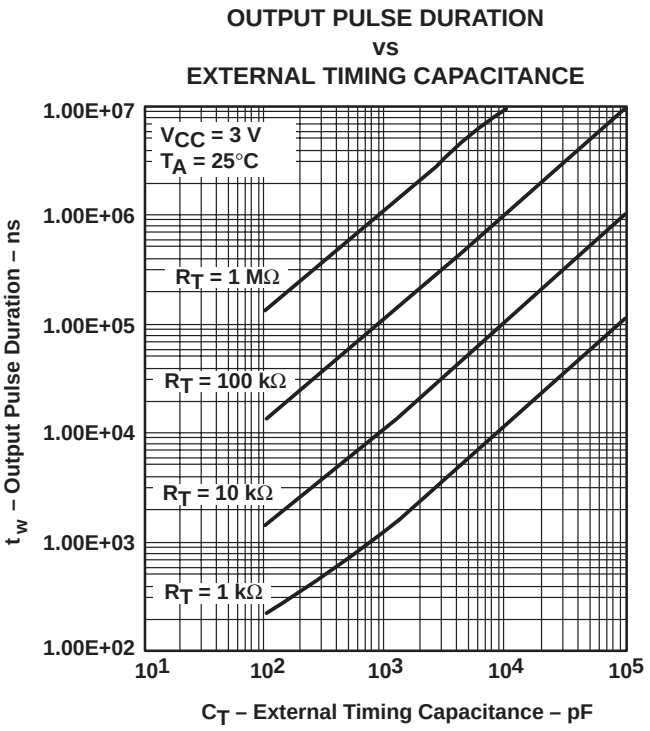


Figure 3

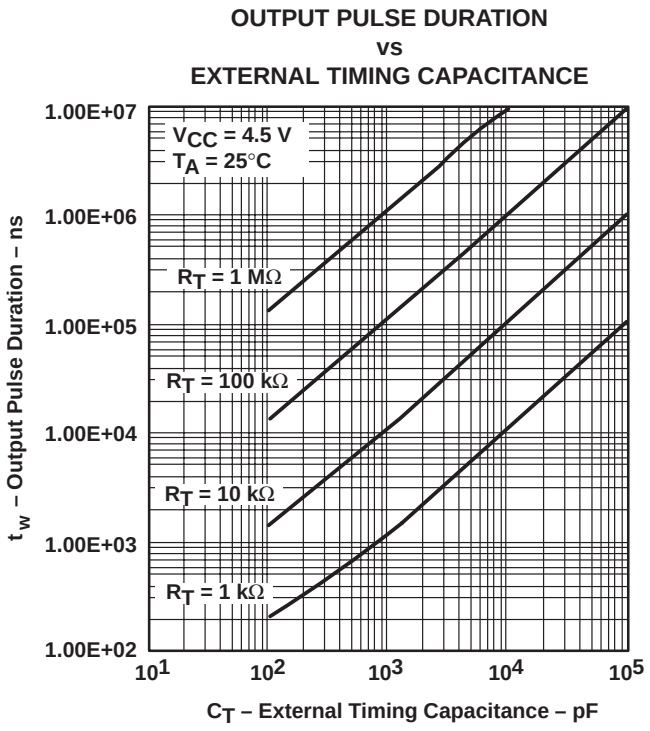


Figure 4

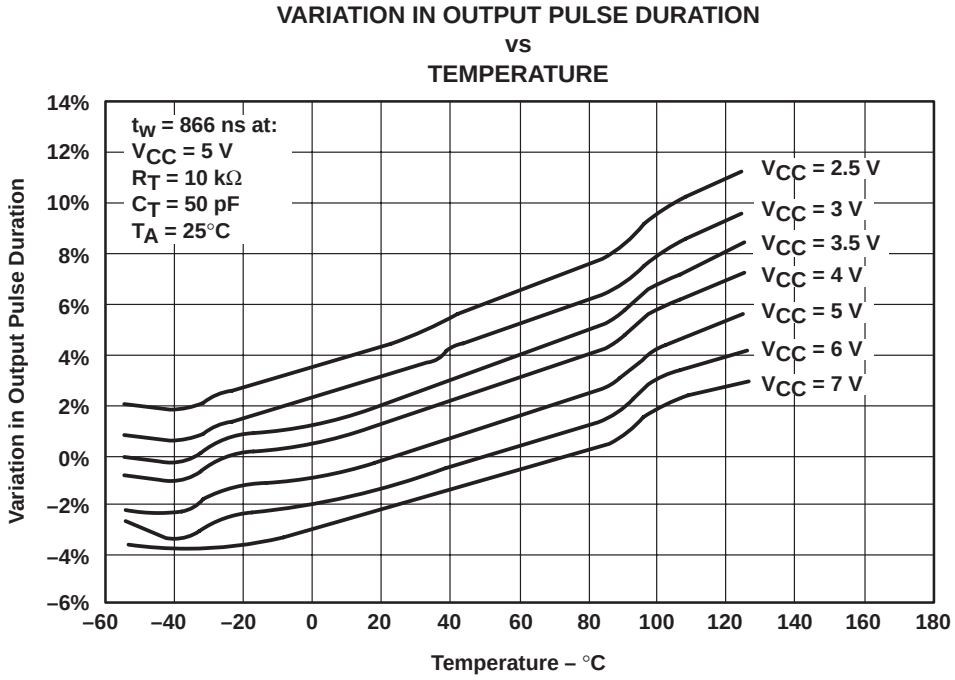


Figure 5

† Operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied.

APPLICATION INFORMATION†

EXTERNAL CAPACITANCE vs MULTIPLIER FACTOR

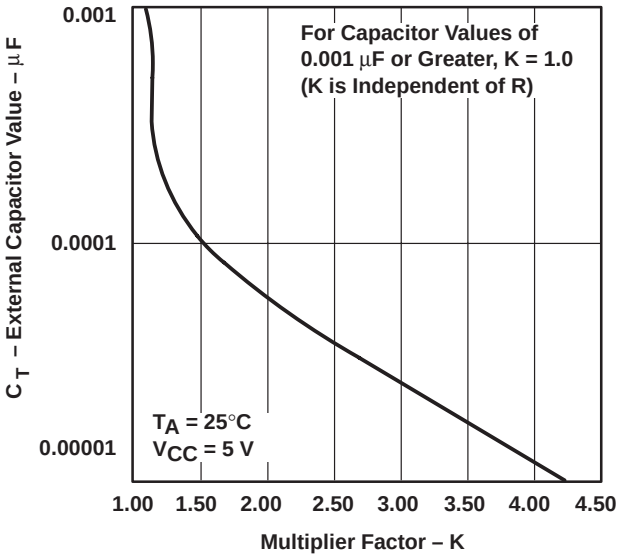


Figure 6

OUTPUT PULSE DURATION CONSTANT vs SUPPLY VOLTAGE

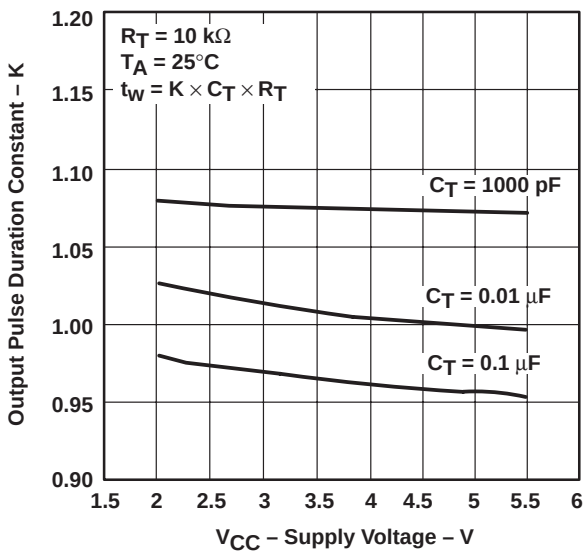


Figure 7

DISTRIBUTION OF UNITS vs OUTPUT PULSE DURATION

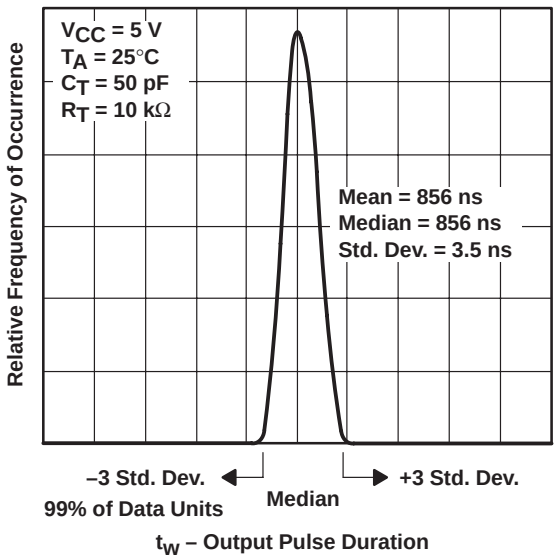


Figure 8

† Operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied.

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