

SEE ORDER OF DATA FOR ERRATA INFORMATION

D1669, SEPTEMBER 1973—REVISED OCTOBER 1988

- Timing from Microseconds to Hours
- Astable or Monostable Operation
- Adjustable Duty Cycle
- TTL-Compatible Output Can Sink or Source Up to 200 mA
- Functionally Interchangeable with the Signetics SE555, SE555C, SA555, NE555; Have Same Pinout

SE555C FROM TI IS NOT RECOMMENDED FOR NEW DESIGNS**description TEXAS INSTR (LIN/INTFC)**

These devices are monolithic timing circuits capable of producing accurate time delays or oscillation. In the time-delay or monostable mode of operation, the timed interval is controlled by a single external resistor and capacitor network. In the astable mode of operation, the frequency and duty cycle may be independently controlled with two external resistors and a single external capacitor.

The threshold and trigger levels are normally two-thirds and one-third, respectively, of V_{CC}. These levels can be altered by use of the control voltage terminal. When the trigger input falls below the trigger level, the flip-flop is set and the output goes high. If the trigger input is above the threshold level and the threshold input is above the threshold level, the flip-flop is reset and the output is low. The reset input can override all other inputs and can be used to initiate a new timing cycle. When the reset input goes low, the flip-flop is reset and the output goes low. Whenever the output is low, a low-impedance path is provided between the discharge terminal and ground.

The output circuit is capable of sinking or sourcing current up to 200 mA. Operation is specified for supplies of 5 to 15 V. With a 5-V supply, output levels are compatible with TTL inputs.

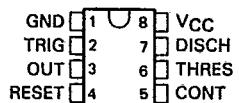
The SE555 and SE555C are characterized for operation over the full military range of -55°C to 125°C. The SA555 is characterized for operation from -40°C to 85°C, and the NE555 is characterized for operation from 0°C to 70°C.

SE555, SE555C . . . JG PACKAGE

SA555, NE555 . . . D, JG, OR P PACKAGE

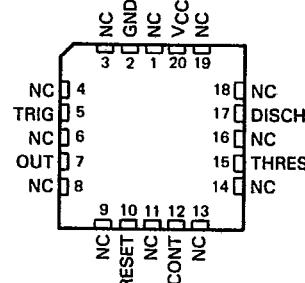
(TOP VIEW)

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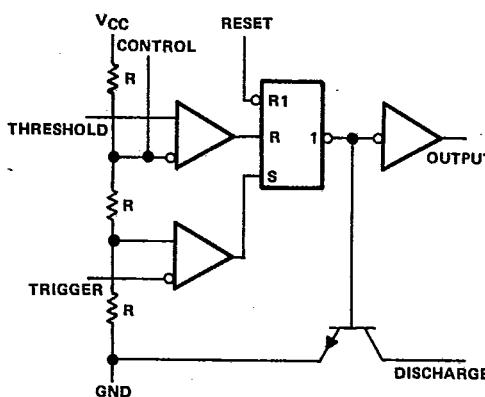


SE555, SE555C . . . FK PACKAGE

(TOP VIEW)



NC—No internal connection

functional block diagram

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Special Functions

Reset can override Trigger, which can override Threshold.

PRODUCTION DATA documents contain information 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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AVAILABLE OPTIONS

TA RANGE	V _{thres} MAX V _{CC} = 15 V	PACKAGE			
		SMALL OUTLINE (D)	CHIP CARRIER (FK)	CERAMIC DIP (JG)	PLASTIC DIP (P)
0°C to 70°C	11.2 V	NE555D		NE555JG	NE555P
-40°C to 85°C	11.2 V	SA655D		SA555JG	SA655P
-55°C to 125°C	10.6 V 11.2 V		SE555FK SE555CFK	SE555JG SE555CJG	

The D package is available taped and reeled. Add the suffix R to the device type (e.g., NE555DR).

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

Supply voltage, V _{CC} (See Note 1)	18 V	V _{CC}
Input voltage (control, reset, threshold, and trigger)	±225 mA	see Dissipation Rating Table
Output current	±225 mA	see Dissipation Rating Table
Continuous total dissipation	-55°C to 125°C	
Operating free-air temperature range: SE555, SE555C	-40°C to 85°C	
SA555	0°C to 70°C	
NE555	-65°C to 150°C	
Storage temperature range	260°C	
Case temperature for 60 seconds: FK package	300°C	
Lead temperature 1.6 mm (1/16 inch) from case for 60 seconds: JG package	260°C	
Lead temperature 1.6 mm (1/16 inch) from case for 10 seconds: D or P package	260°C	

NOTE 1: All voltage values are with respect to network ground terminal.

DISSIPATION RATING TABLE

PACKAGE	TA ≤ 25°C POWER RATING	DERATING FACTOR ABOVE TA = 25°C	TA = 70°C	TA = 85°C	TA = 125°C
			POWER RATING	POWER RATING	POWER RATING
D	726 mW	5.8 mW/°C	464 mW	377 mW	N/A
FK	1376 mW	11.0 mW/°C	880 mW	716 mW	275 mW
JG (SE555, SE555C)	1050 mW	8.4 mW/°C	672 mW	546 mW	210 mW
JG (SA555, NE555)	825 mW	8.6 mW/°C	528 mW	429 mW	N/A
P	1000 mW	8.0 mW/°C	640 mW	520 mW	N/A

recommended operating conditions

	SE555	SE555C	SA655	NE555	UNIT	
	MIN	MAX	MIN	MAX		
Supply voltage, V _{CC}	4.5	18	4.5	16	4.5	18
Input voltage (control, reset, threshold, and trigger)	V _{CC}	V _{CC}	V _{CC}	V _{CC}	V	
Output current	±200		±200	±200	mA	
Operating free-air temperature, TA	-55	125	-55	125	-40	85
				0	70	°C

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electrical characteristics at 25°C free-air temperature, V_{CC} = 5 V to 15 V (unless otherwise noted)

PARAMETER	TEST CONDITIONS	SE555			SE555C, SA555, NE555			UNIT
		MIN	TYP	MAX	MIN	TYP	MAX	
Threshold voltage level	V _{CC} = 15 V	9.4	10	10.6	8.8	10	11.2	V
	V _{CC} = 5 V	2.7	3.3	4	2.4	3.3	4.2	
Threshold current (see Note 2)			30	250		30	250	nA
Trigger voltage level	V _{CC} = 15 V	4.8	5	5.2	4.5	5	5.6	V
	V _{CC} = 5 V	1.45	1.67	1.9	1.1	1.67	2.2	
Trigger current	Trigger at 0 V		0.5	0.9		0.5	2	μA
Reset voltage level		0.3	0.7	1	0.3	0.7	1	V
Reset current	Reset at V _{CC}		0.1	0.4		0.1	0.4	mA
	Reset at 0 V		-0.4	-1		-0.4	-1.5	
Discharge switch off-state current		20	100		20	100		nA
Control voltage (open circuit)	V _{CC} = 15 V	9.6	10	10.4	9	10	11	V
	V _{CC} = 5 V	2.9	3.3	3.8	2.6	3.3	4	
Low-level output voltage	V _{CC} = 15 V	I _{OL} = 10 mA	0.1	0.15	0.1	0.25		V
		I _{OL} = 50 mA	0.4	0.5	0.4	0.75		
		I _{OL} = 100 mA	2	2.2	2	2.5		
	V _{CC} = 5 V	I _{OL} = 200 mA	2.5		2.5			
		I _{OL} = 5 mA	0.1	0.2	0.1	0.35		
High-level output voltage	V _{CC} = 15 V	I _{OH} = -100 mA	13	13.3	12.75	13.3		V
	V _{CC} = 5 V	I _{OH} = -200 mA		12.5		12.5		
		I _{OH} = -100 mA	3	3.3	2.75	3.3		
Supply current	V _{CC} = 15 V	Output low, No load	10	12	10	15		mA
		V _{CC} = 5 V	3	5	3	6		
	V _{CC} = 15 V	Output high, No load	9	10	9	13		
		V _{CC} = 5 V	2	4	2	5		

NOTE 2: This parameter influences the maximum value of the timing resistors R_A and R_B in the circuit of Figure 12. For example, when V_{CC} = 5 V, the maximum value is R = R_A + R_B ≈ 3.4 MΩ, and for V_{CC} = 15 V, the maximum value is 10 MΩ.

operating characteristics, V_{CC} = 5 V and 15 V

PARAMETER	TEST CONDITIONS [†]	TA = 25°C	SE555			SE555C, SA555, NE555			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
Initial error of timing interval [‡]	Each timer, monostable [§]	TA = 25°C	0.5	1.5		1	3		%
	Each timer, astable [¶]		1.5		2.25				
Temperature coefficient of timing interval	Each timer, monostable [§]	TA = MIN to MAX	30	100		50			ppm/°C
	Each timer, astable [¶]		90		150				
Supply voltage sensitivity of timing interval	Each timer, monostable [§]	TA = 25°C	0.05	0.2		0.1	0.5		%/V
	Each timer, astable [¶]		0.15		0.3				
Output pulse rise time	C _L = 15 pF,	100	200		100	300			ns
	TA = 25°C	100	200		100	300			

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

[‡]Timing interval error is defined as the difference between the measured value and the average value of a random sample from each process run.

[§]Values specified are for a device in a monostable circuit similar to Figure 9, with component values as follow: R_A = 2 kΩ to 100 kΩ, C = 0.1 μF.

[¶]Values specified are for a device in an astable circuit similar to Figure 12, with component values as follow: R_A = 1 kΩ to 100 kΩ, C = 0.1 μF.

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Special Functions

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TYPICAL CHARACTERISTICS[†]

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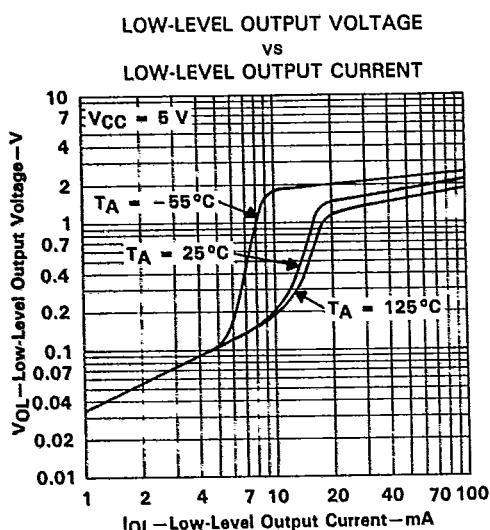


FIGURE 1

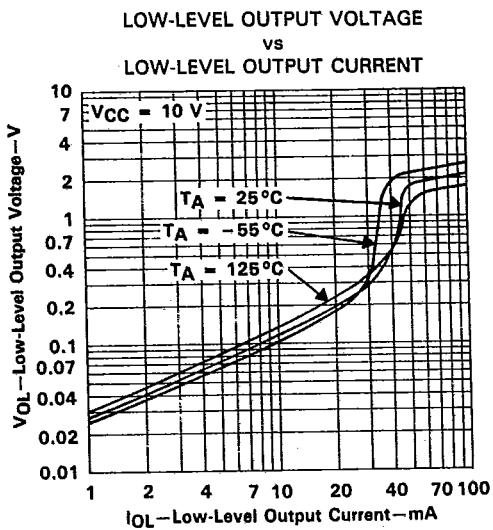


FIGURE 2

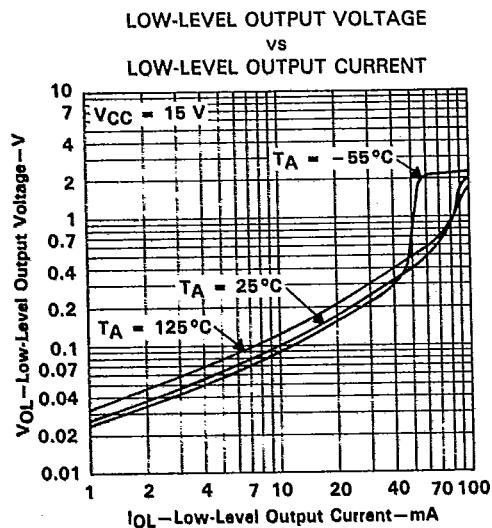


FIGURE 3

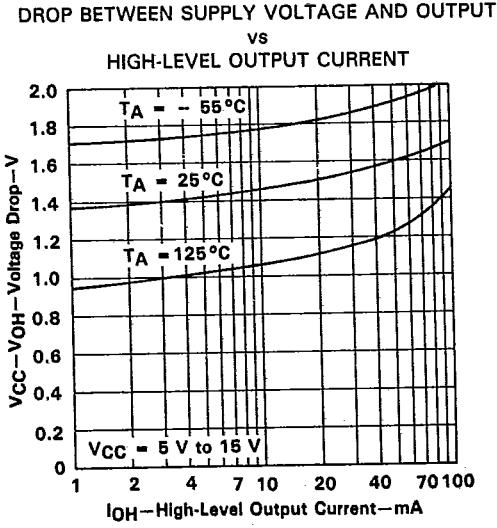


FIGURE 4

[†]Data for temperatures below 0°C and above 70°C are applicable for SE555 circuits only.

TEXAS INSTR (LIN/INTFC)

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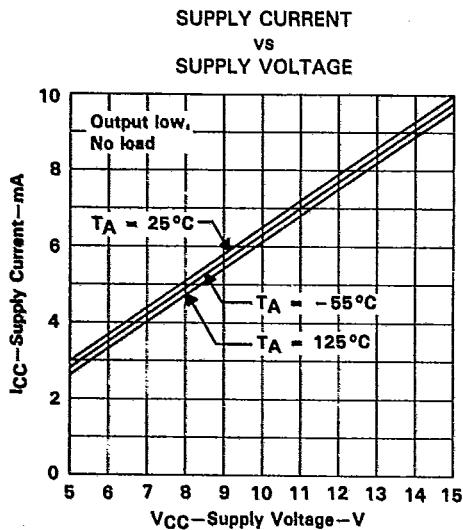
TYPICAL CHARACTERISTICS[†]

FIGURE 5

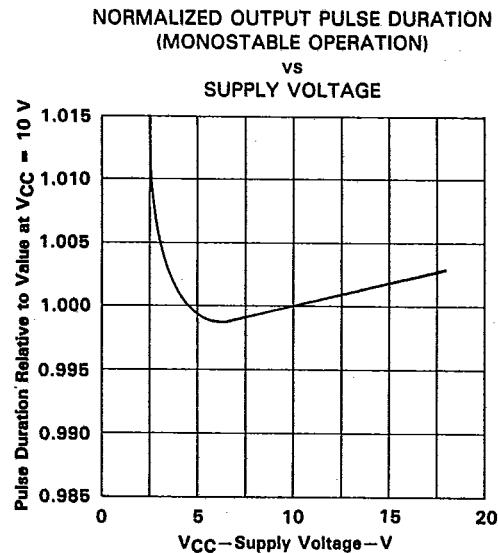


FIGURE 6

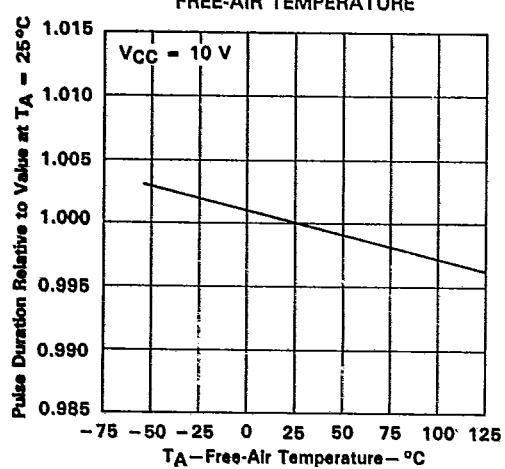


FIGURE 7

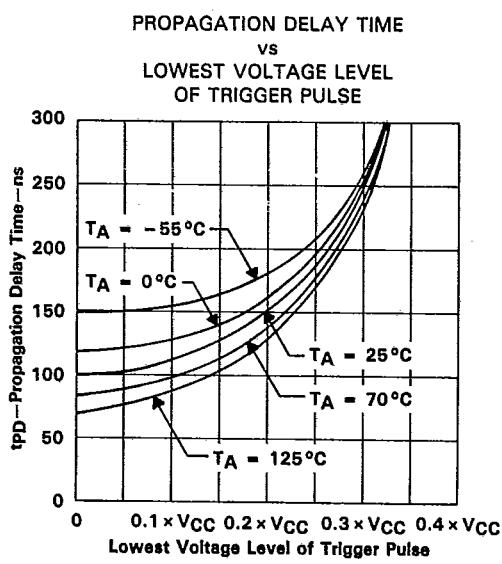


FIGURE 8

[†]Data for temperatures below 0°C and above 70°C are applicable for SE555 circuits only.

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Special Functions

TEXAS INSTR (LIN/INTFC)

TYPICAL APPLICATION DATA

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monostable operation

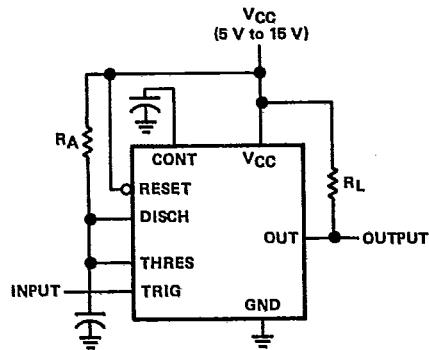


FIGURE 9. CIRCUIT FOR MONOSTABLE OPERATION

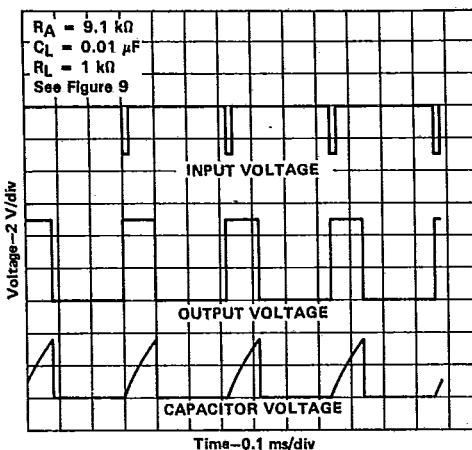


FIGURE 10. TYPICAL MONOSTABLE WAVEFORMS

For monostable operation, any of these timers may be connected as shown in Figure 9. If the output is low, application of a negative-going pulse to the trigger input sets the flip-flop (Q goes low), drives the output high, and turns off Q1. Capacitor C is then charged through RA until the voltage across the capacitor reaches the threshold voltage of the threshold input. If the trigger input has returned to a high level, the output of the threshold comparator will reset the flip-flop (Q goes high), drive the output low, and discharge C through Q1.

Monostable operation is initiated when the trigger input voltage falls below the trigger threshold. Once initiated, the sequence ends only if the trigger input is high at the end of the timing interval. Because of the threshold level and saturation voltage of Q1, the output pulse duration is approximately $t_W = 1.1 R_A C$. Figure 11 is a plot of the time constant for various values of R_A and C. The threshold levels and charge rates are both directly proportional to the supply voltage, V_{CC} . The timing interval is therefore independent of the supply voltage, so long as the supply voltage is constant during the time interval.

Applying a negative-going trigger pulse simultaneously to the reset and trigger terminals during the timing interval discharges C and re-initiates the cycle, commencing on the positive edge of the reset pulse. The output is held low as long as the reset pulse is low. To prevent false triggering, when the reset input is not used, it should be connected to V_{CC} .

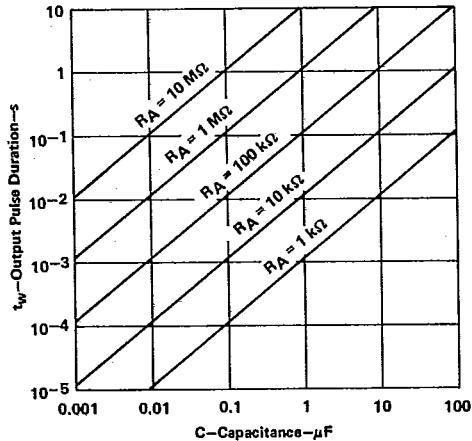


FIGURE 11. OUTPUT PULSE DURATION vs CAPACITANCE

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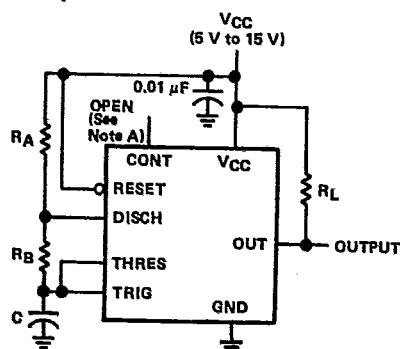
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TEXAS INSTR (LIN/INTFC)

TYPICAL APPLICATION DATA

T-51-19

astable operation



NOTE A: Decoupling the control voltage input to ground with a capacitor may improve operation. This should be evaluated for individual applications.

FIGURE 12. CIRCUIT FOR ASTABLE OPERATION

As shown in Figure 12, adding a second resistor, R_B , to the circuit of Figure 9 and connecting the trigger input to the threshold input causes the timer to self-trigger and run as a multivibrator. The capacitor C will charge through R_A and R_B and then discharge through R_B only. The duty cycle may be controlled, therefore, by the values of R_A and R_B .

This astable connection results in capacitor C charging and discharging between the threshold-voltage level ($\approx 0.67 \cdot V_{CC}$) and the trigger-voltage level ($\approx 0.33 \cdot V_{CC}$). As in the monostable circuit, charge and discharge times (and therefore the frequency and duty cycle) are independent of the supply voltage.

Figure 13 shows typical waveforms generated during astable operation. The output high-level duration t_H and low-level duration t_L may be calculated as follows:

$$t_H = 0.693 (R_A + R_B) C$$

$$t_L = 0.693 R_B C$$

Other useful relationships are shown below.

$$\text{period} = t_H + t_L = 0.693 (R_A + 2R_B) C$$

$$\text{frequency} \approx \frac{1.44}{(R_A + 2R_B) C}$$

$$\text{Output driver duty cycle} = \frac{t_L}{t_H + t_L} = \frac{R_B}{R_A + 2R_B}$$

$$\text{Output waveform duty cycle} = \frac{t_H}{t_H + t_L} = 1 - \frac{R_B}{R_A + 2R_B}$$

$$\text{Low-to-high ratio} = \frac{t_L}{t_H} = \frac{R_B}{R_A + R_B}$$

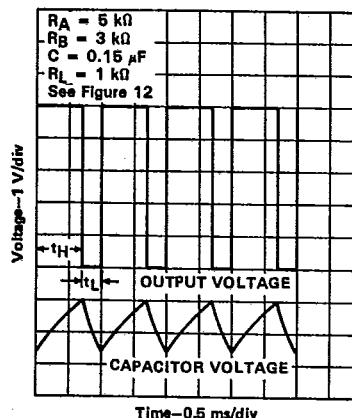


FIGURE 13. TYPICAL ASTABLE WAVEFORMS

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Special Functions

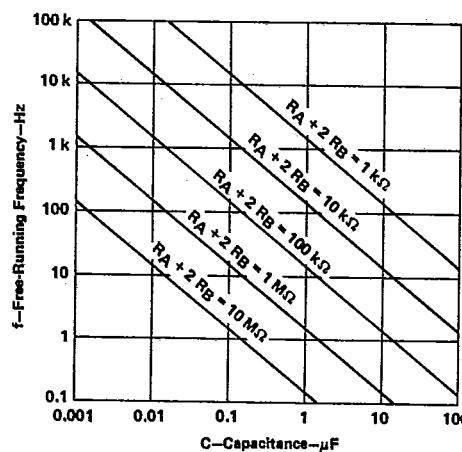


FIGURE 14. FREE-RUNNING FREQUENCY

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TYPICAL APPLICATION DATA

missing-pulse detector

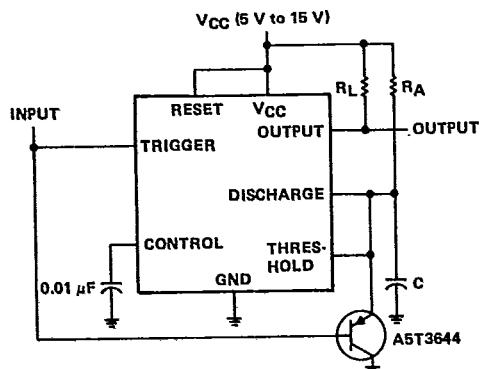


FIGURE 15. CIRCUIT FOR MISSING-PULSE DETECTOR

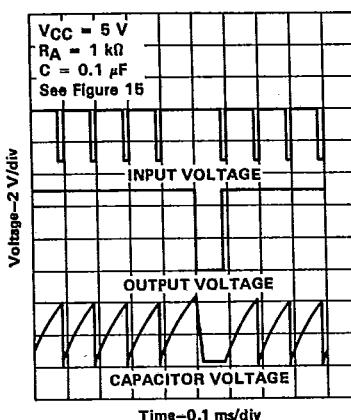


FIGURE 16. MISSING-PULSE DETECTOR WAVEFORMS

The circuit shown in Figure 15 may be used to detect a missing pulse or abnormally long spacing between consecutive pulses in a train of pulses. The timing interval of the monostable circuit is continuously retriggered by the input pulse train as long as the pulse spacing is less than the timing interval. A longer pulse spacing, missing pulse, or terminated pulse train permits the timing interval to be completed, thereby generating an output pulse as illustrated in Figure 16.

4

Special Functions

frequency divider

By adjusting the length of the timing cycle, the basic circuit of Figure 9 can be made to operate as a frequency divider. Figure 17 illustrates a divide-by-3 circuit that makes use of the fact that retriggering cannot occur during the timing cycle.

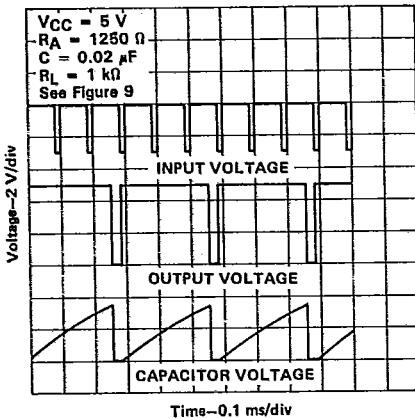
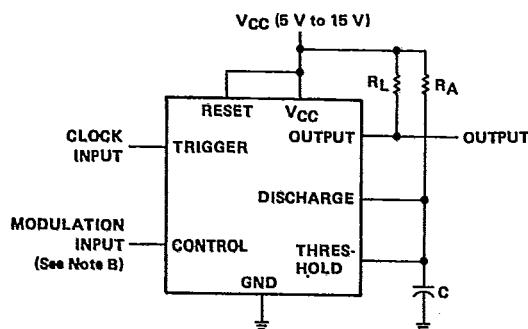


FIGURE 17. DIVIDE-BY-THREE CIRCUIT WAVEFORMS

TYPICAL APPLICATION DATA

T-51-19

pulse-width modulation



NOTE B: The modulating signal may be direct or capacitively coupled to the control terminal. For direct coupling, the effects of modulation source voltage and impedance on the bias of the timer should be considered.

FIGURE 18. CIRCUIT FOR PULSE-WIDTH MODULATION

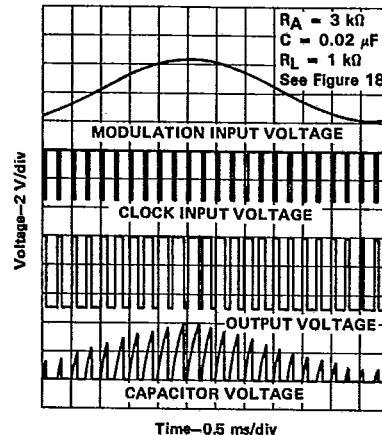


FIGURE 19. PULSE-WIDTH MODULATION WAVEFORMS

The operation of the timer may be modified by modulating the internal threshold and trigger voltages, which is accomplished by applying an external voltage (or current) to the control pin. Figure 18 shows a circuit for pulse-width modulation. A continuous input pulse train triggers the monostable circuit, and a control signal modulates the threshold voltage. Figure 19 illustrates the resulting output pulse-width modulation. While a sine-wave modulation signal is illustrated, any wave shape could be used.

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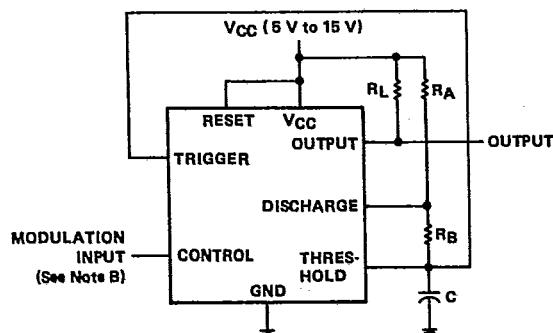
Special Functions

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TYPICAL APPLICATION DATA

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pulse-position modulation



NOTE B: The modulating signal may be direct or capacitively coupled to the control terminal. For direct coupling, the effects of modulation source voltage and impedance on the bias of the timer should be considered.

FIGURE 20. CIRCUIT FOR PULSE-POSITION MODULATION

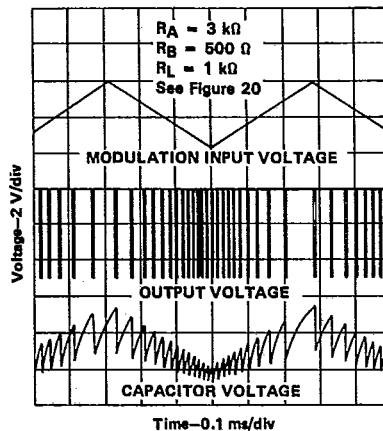


FIGURE 21. PULSE POSITION-MODULATION WAVEFORMS

As shown in Figure 20, any of these timers may be used as a pulse-position modulator. This application modulates the threshold voltage, and thereby the time delay, of a free-running oscillator. Figure 21 illustrates a triangular-wave modulation signal for such a circuit; however, any wave shape could be used.

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TYPICAL APPLICATION DATA

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sequential timer

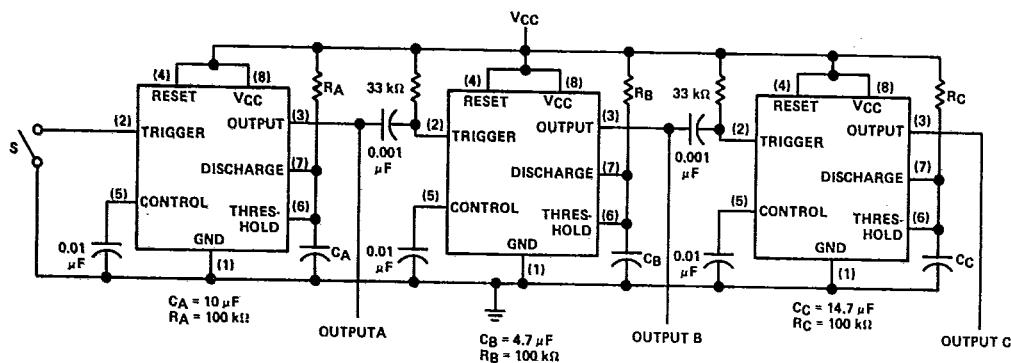
S closes momentarily at $t = 0$.

FIGURE 22. SEQUENTIAL TIMER CIRCUIT

Many applications, such as computers, require signals for initializing conditions during start-up. Other applications, such as test equipment, require activation of test signals in sequence. These timing circuits may be connected to provide such sequential control. The timers may be used in various combinations of astable or monostable circuit connections, with or without modulation, for extremely flexible waveform control. Figure 22 illustrates a sequencer circuit with possible applications in many systems, and Figure 23 shows the output waveforms.

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Special Functions

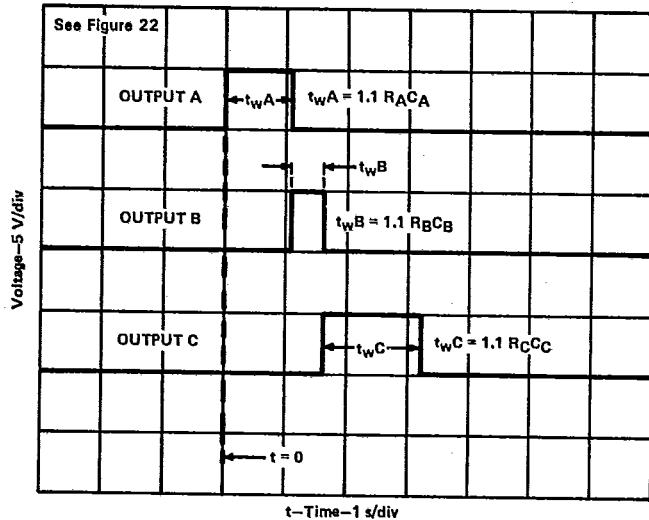


FIGURE 23. SEQUENTIAL TIMER WAVEFORMS