1.Description

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

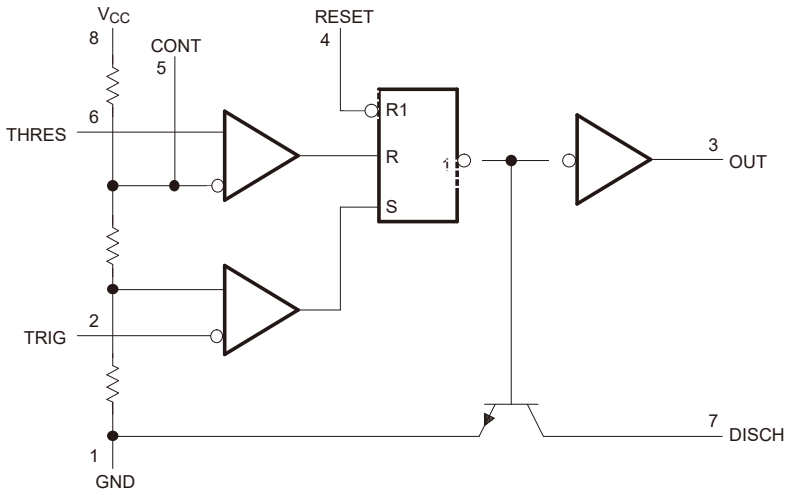
2.Features

- Timing From Microseconds to Hours
- Astable or Monostable Operation
- Adjustable Duty Cycle
- TTL-Compatible Output Can Sink or Source Up to 200 mA

3.Applications

- Fingerprint Biometrics
- Iris Biometrics
- RFID Reader

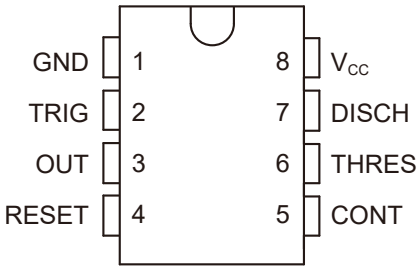
4.Simplified Schematic



5.Device Information

Device Model	Working Temperature	Package
NE555	T_A=0°C to 70°C	DR (SOP-8)
		P (DIP-8)
SA555	T_A=-40°C to 85°C	DR (SOP-8)
		P (DIP-8)

6.Pinning Information



NE555... DR PACKAGE
SA555...P PACKAGE

Pin Functions

Pin		I/O	Description
Name	DR/P		
CONT	5	I/O	Controls comparator thresholds, Outputs 2/3 VCC, allows bypass capacitor connection
DISCH	7	O	Open collector output to discharge timing capacitor
GND	1	-	Ground
OUT	3	O	High current timer output signal
RESET	4	I	Active low reset input forces output and discharge low
THRES	6	I	End of timing input. THRES > CONT sets output low and discharge low
TRIG	2	I	Start of timing input. TRIG< ½CONT sets output high and discharge open
V_{CC}	8	-	Input supply voltage, 4.5V to 16V.(SA555 maximum is 18V)

7.Absolute Maximum Ratings

Over operating free-air temperature range (unless otherwise noted)

Condition		Symbol	Min	Max	Unit
Supply voltage (2)		V_{CC}		18	V
Input voltage (CONT, RESET, THRES, TRIG)		V_I		V_{CC}	V
Output current		I_O		±225	mA
Package thermal impedance (3)(4)	DR package	θ_{JA}		97	°C
	P package			85	°C
Operating virtual junction temperature		T_J		150	°C

(1) 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.

(2) All voltage values are with respect to GND.

(3) Maximum power dissipation is a function of $T_{J(max)}$, θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_{J(max)} - T_A) / \theta_{JA}$. Operating at the absolute maximum T_J of 150°C can affect reliability.

(4) The package thermal impedance is calculated in accordance with JESD 51-7.

(5) Maximum power dissipation is a function of $T_{J(max)}$, θ_{JC}, and T_C. The maximum allowable power dissipation at any allowable case temperature is $P_D = (T_{J(max)} - T_C) / \theta_{JC}$. Operating at the absolute maximum T_J of 150°C can affect reliability.

(6) The package thermal impedance is calculated in accordance with MIL-STD-883.

8.Handling Ratings

Parameter	Symbol	Min	Max	Units
Storage temperature range	T_{STG}	-65	150	°C

9.Recommended Operating Conditions

Over operating free-air temperature range (unless otherwise noted)

Condition		Symbol	Min	Max	Unit
Supply voltage	NE555, SA555	V_{CC}	4.5	16	V
Input voltage	CONT, RESET, THRES, and TRIG	V_I		V_{CC}	V
Output current		I_O		±200	mA
Operating free-air temperature	NE555	T_A	0	70	°C
	SA555		-40	85	°C

10.Electrical Characteristics

V_{CC}=5V to 15V, T_A=25°C (unless otherwise noted)

Parameter	Conditions	NE/SA555			Units
		Min	Typ	Max	
THRES voltage level	V_{CC}=15V	8.8	10	11.2	V
	V_{CC}=5V	2.4	3.3	4.2	V
THRES current (1)			30	250	nA
TRIG voltage level	V_{CC}=15V	4.5	5	5.6	V
	V_{CC}=5V	1.1	1.67	2.2	V
TRIG current	TRIG at 0V		0.5	2	μA
RESET voltage level		0.3	0.7	1	V
	T_A=-55°C to 125°C				V
RESET current	RESET at V_{CC}		0.1	0.4	mA
	RESET at 0 V		-0.4	-1.5	mA
DISCH switch off-state current			20	100	nA
DISCH switch on-state voltage	V_{CC}=5V, I_O=8mA		0.15	0.4	V
CONT voltage (open circuit)	V_{CC}=15V	9	10	11	V
	V_{CC}=5V	2.6	3.3	4	V
High-level output voltage	V_{CC}=15V, I_{OH}=-100mA	12.75	13.3		V
	V_{CC}=15V, I_{OH}=-200mA		12.5		V
	V_{CC}=15V, I_{OH}=-100mA	2.75	3.3		V
Low-level output voltage	V_{CC}=15V, I_{OL}=10mA		0.1	0.25	V
	V_{CC}=15V, I_{OL}=50mA		0.4	0.75	V
	V_{CC}=15V, I_{OL}=100mA		2	2.5	V
	V_{CC}=15V, I_{OL}=200mA		2.5		V
	V_{CC}=5V, I_{OL}=3.5mA				V
	V_{CC}=5V, I_{OL}=5mA		0.1	0.35	V
	V_{CC}=5V, I_{OL}=8mA		0.15	0.4	V

Parameter	Conditions		NE/SA555			Units
			Min	Typ	Max	
Supply current	Output low, No load	V_{CC}=15V		10	15	mA
		V_{CC}=5V		3	6	mA
	Output high, No load	V_{CC}=15V		9	13	mA
		V_{CC}=5V		2	5	mA

(1) 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}=5V, the maximum value is R = R_A + R_A≒3.4MΩ, and for V_{CC}=15V, the maximum value is 10MΩ.

11.Operating Characteristics

V_{CC}=5V to 15V, T_A=25°C (unless otherwise noted)

Parameter		Conditions (1)	NE/SA555			Units
			Min	Typ	Max	
Initial error of timing interval (2)	Each timer, monostable (3)	T_A=25°C		1	3	%
	Each timer, astable (5)			2.25		%
Temperature coefficient of timing interval	Each timer, monostable (3)	T_A=MIN to MAX		50		ppm/°C
	Each timer, astable (5)			150		
Supply-voltage sensitivity of timing interval	Each timer, monostable (3)	T_A=25°C		0.1	0.5	%/V
	Each timer, astable (5)			0.3		%/V
Output-pulse rise time		C_L=15pF, T_A=25°C		100	300	ns
Output-pulse fall time		C_L=15pF, T_A=25°C		100	300	ns

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

(2) Timing interval error is defined as the difference between the measured value and the average value of a random sample from each process run.

(3) Values specified are for a device in a monostable circuit similar to Figure 9, with the following component values: R_A=2kΩ to 100 kΩ, C=0.1μF.

(4) On products compliant to MIL-PRF-38535, this parameter is not production tested.

(5) Values specified are for a device in an astable circuit similar to Figure 12, with the following component values: R_A=1kΩ to 100 kΩ, C=0.1μF.

12.1 Typical Characteristic

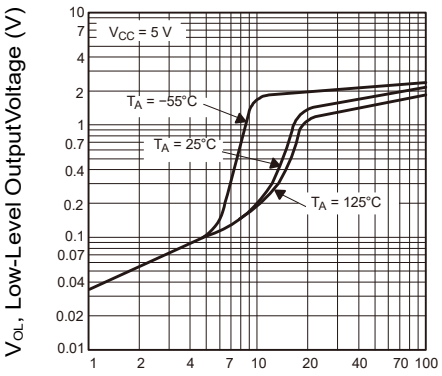


Figure 1: Low-Level Output Voltage vs Low-Level Output Current

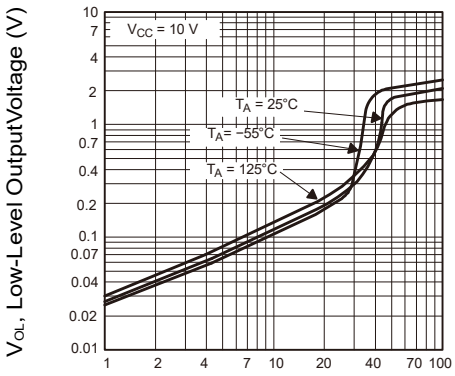


Figure 2: Low-Level Output Voltage vs Low-Level Output Current

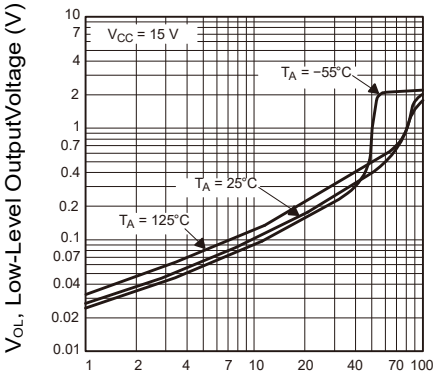


Figure 3: Low-Level Output Voltage vs Low-Level Output Current

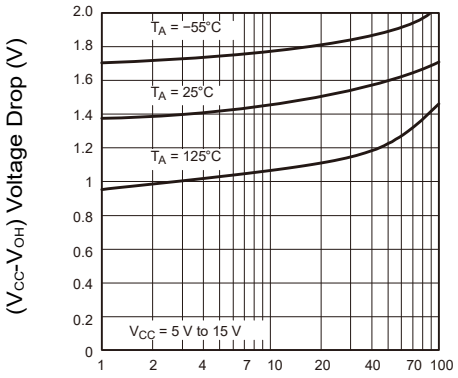


Figure 4: Drop Between Supply Voltage and Output vs High-Level Output Current

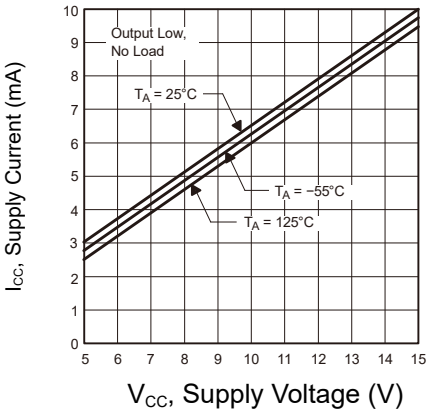


Figure 5: Supply Current vs Supply Voltage

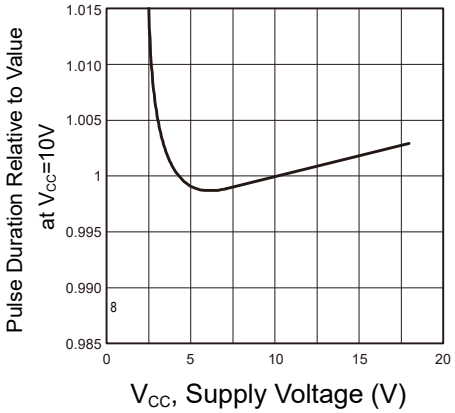


Figure 6: Normalized Output Pulse Duration (Monostable Operation) vs Supply Voltage

12.2 Typical Characteristic

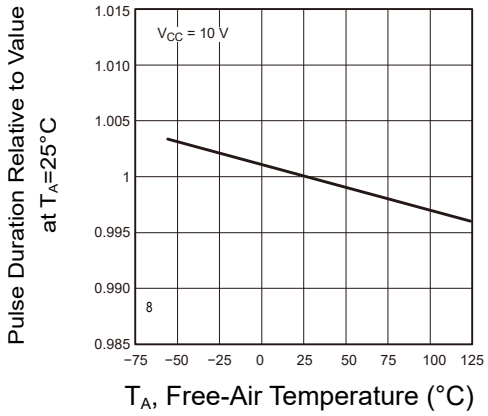


Figure 7: Normalized Output Pulse Duration (Monostable Operation) vs Free-Air Temperature

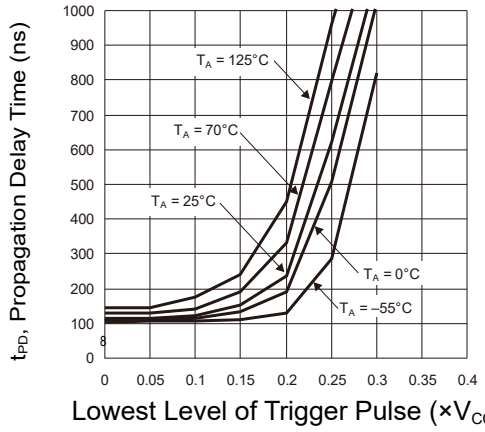


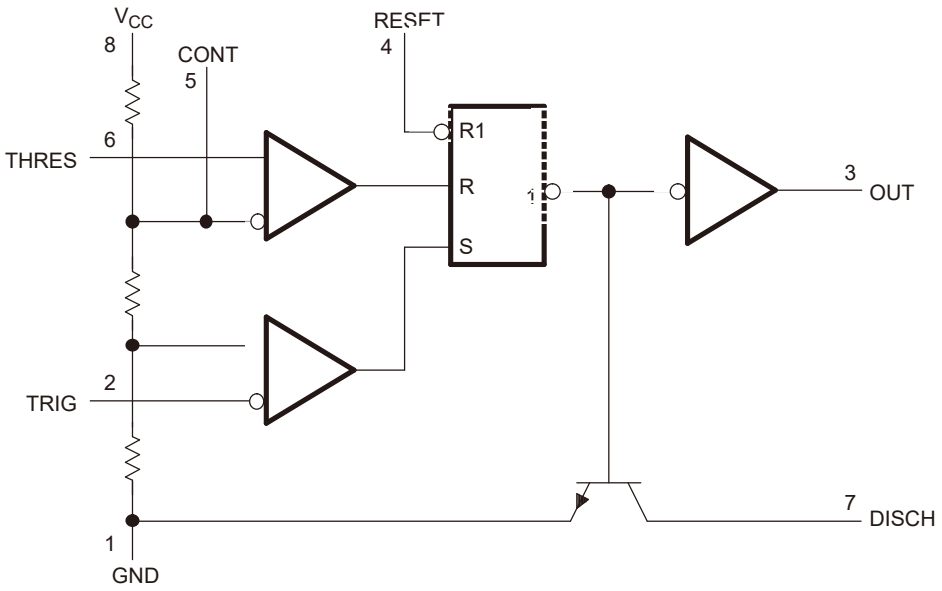
Figure 8: Propagation Delay Time vs Lowest Voltage Level of Trigger Pulse

13.Detailed Description

Overview

The xx555 timer is a popular and easy to use for general purpose timing applications from 10μs to hours or from <1mHz to 100 kHz. In the time-delay or mono-stable mode of operation, the timed interval is controlled by a single external resistor and capacitor network. In the a-stable mode of operation, the frequency and duty cycle can be controlled independently with two external resistors and a single external capacitor. Maximum output sink and discharge sink current is greater for higher VCC and less for lower VCC.

Functional Block Diagram



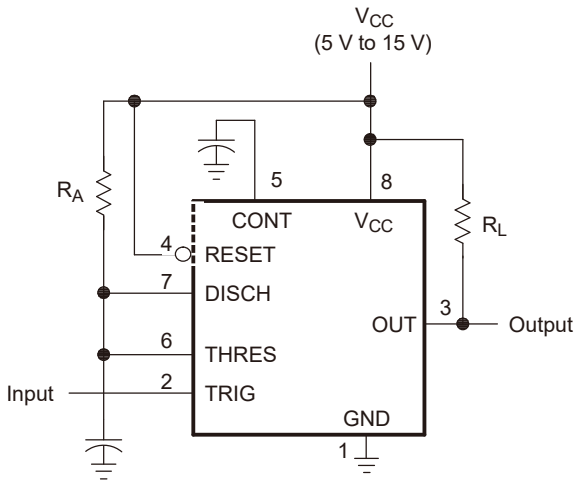
A. Pin numbers shown are for the D, JG, P, PS, and PW packages.

B. RESET can override TRIG, which can override THRES.

14.Feature Description

Mono-stable Operation

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



Pin numbers shown are for the D, JG, P, PS, and PW packages.

Figure 9. Circuit for Monostable Operation

Monostable operation is initiated when TRIG voltage falls below the trigger threshold. Once initiated, the sequence ends only if TRIG is high for at least 10 μs before the end of the timing interval. When the trigger is grounded, the comparator storage time can be as long as 10 μs, which limits the minimum monostable pulse width to 10μs. Because of the threshold level and saturation voltage of Q1, the output pulse duration is approximately $t_w=1.1R_AC$. Figure 11 is a plot of the time constant for various values of R_A and C. The threshold levels and charge rates both are 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 RESET and TRIG during the timing interval discharges C and reinitiates 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 RESET is not used, it should be connected to V_{CC}.

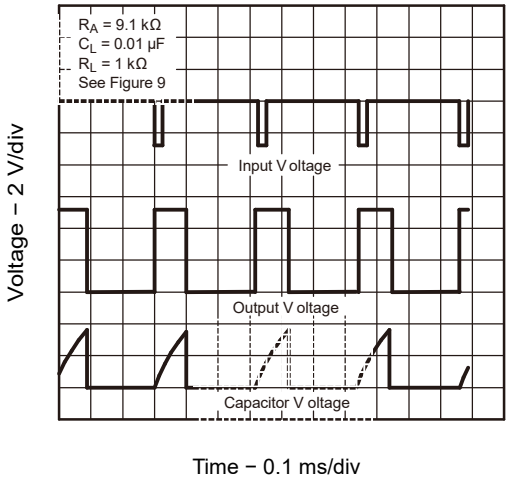


Figure 10: Typical Monostable Waveforms

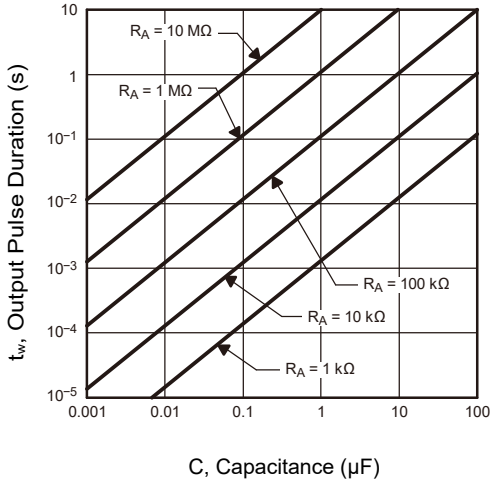
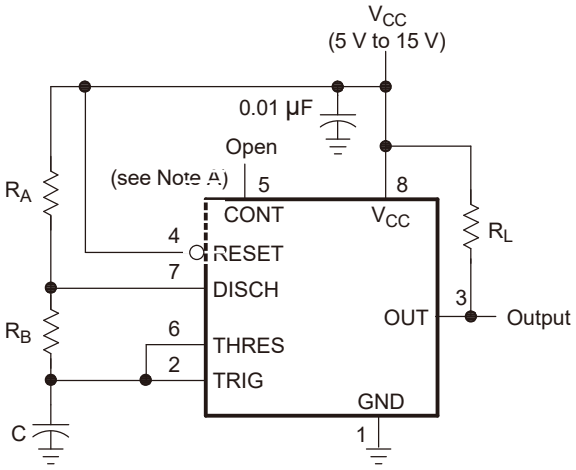


Figure 11: Output Pulse Duration vs Capacitance

A-stable 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 multi-vibrator. The capacitor C charges through R_A and R_B and then discharges through RB only. Therefore, the duty cycle is controlled by the values of R_A and R_B.

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



Pin numbers shown are for the D, JG, P, PS, and PW packages.
NOTE A: Decoupling CONT voltage to ground with a capacitor can improve operation. This should be evaluated for individual applications.

Figure 12: Circuit for Astable Operation

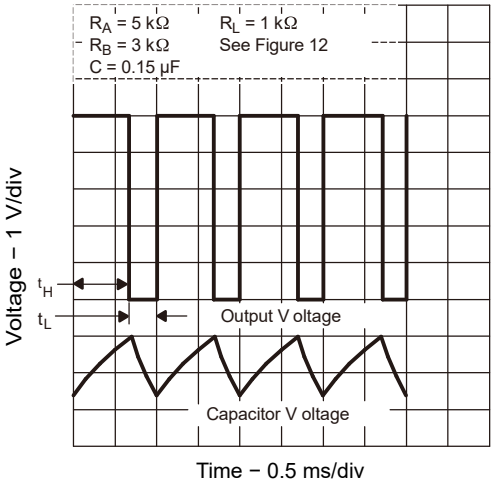


Figure 13: Typical Astable Waveforms

Figure 12 shows typical waveforms generated during astable operation. The output high-level duration t_H and low-level duration t_L can be calculated as follows:

$t_H=0.693\ (R_A + R_B)\ C$ (1)

$t_L=0.693\ (R_B)\ C$ (2)

Other useful relationships are shown below:

period $t_H + t_L=0.693\ (R_A + 2R_B)\ C$ (3)

$$\text{frequency} \approx \frac{1.44}{(R_A + 2R_B)C} \quad (4)$$

$$\text{Output driver duty cycle} = \frac{t_L}{t_H + t_L} = \frac{R_B}{R_A + 2R_B} \quad (5)$$

$$\text{Output waveform duty cycle} = \frac{t_H}{t_H + t_L} = 1 - \frac{R_B}{R_A + 2R_B} \quad (6)$$

$$\text{Low-to-high ratio} = \frac{t_L}{t_H} = \frac{R_B}{R_A + R_B} \quad (7)$$

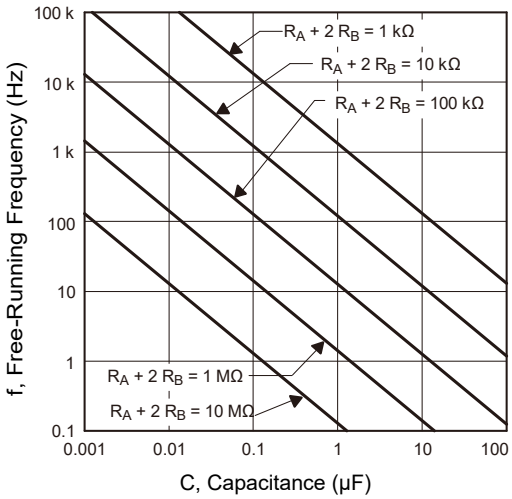


Figure 14: Free-Running Frequency

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 15 shows a divide-by-three circuit that makes use of the fact that re-triggering cannot occur during the timing cycle.

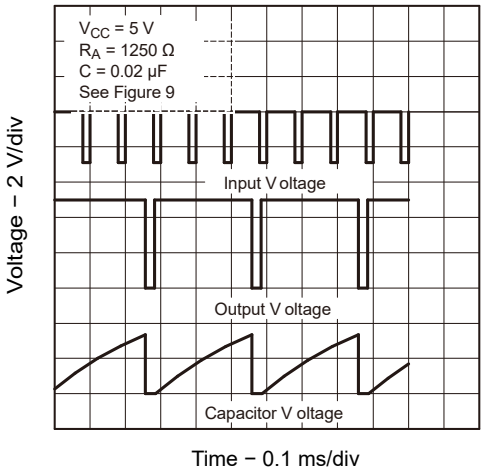


Figure 15: Divide-by-Three Circuit Waveforms

15.Device Functional Modes

Table 1. Function Table

Reset	Trigger Voltage(1)	Threshold Voltage(1)	Output	Discharge Switch
Low	Irrelevant	Irrelevant	Low	On
High	<1/3 V_{CC}	Irrelevant	High	Off
High	>1/3 V_{CC}	>1/3 V_{CC}	Low	On
High	>1/3 V_{CC}	<1/3 V_{CC}	As previously established	

(1) Voltage levels shown are nominal.

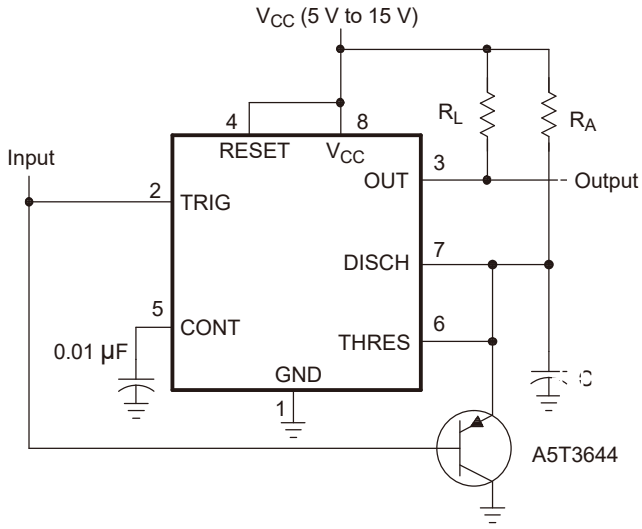
Application Information

The xx555 timer devices use resistor and capacitor charging delay to provide a programmable time delay or operating frequency. This section presents a simplified discussion of the design process.

16.Typical Applications

Missing-Pulse Detector

The circuit shown in Figure 16 can 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 re-triggered continuously 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 shown in Figure 17.



Pin numbers shown are shown for the D, JG, P, PS, and PW packages.

Figure 16: Circuit for Missing-Pulse Detector

Design Requirements

Input fault (missing pulses) must be input high. Input stuck low will not be detected because timing capacitor "C" will remain discharged.

Detailed Design Procedure

Choose R_A and C so that R_A× C > [maximum normal input high time]. R_L improves V_{OH}, but it is not required for TTL compatibility.

Application Curves

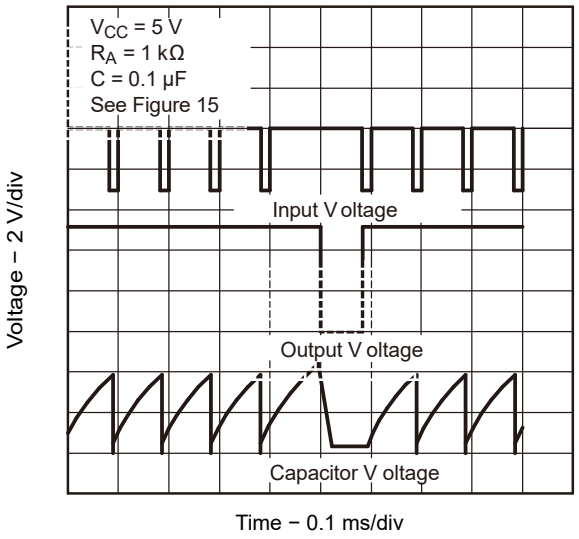
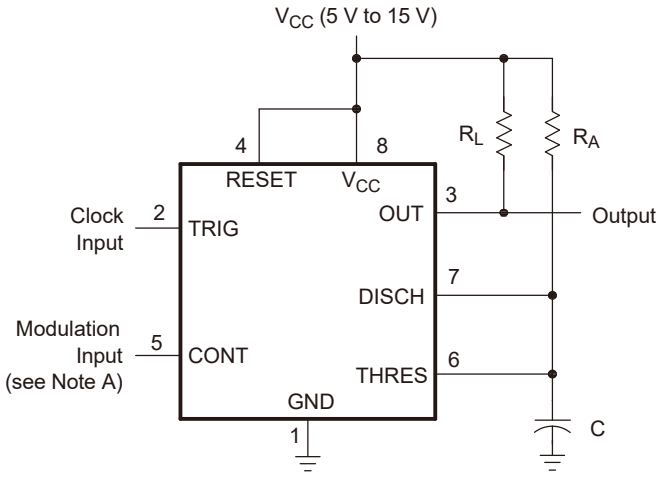


Figure 17: Completed Timing Waveforms for Missing-Pulse Detector

Pulse-Width Modulation

The operation of the timer can be modified by modulating the internal threshold and trigger voltages, which is accomplished by applying an external voltage (or current) to CONT. 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 shows the resulting output pulse-width modulation. While a sine-wave modulation signal is shown, any wave shape could be used.



Pin numbers shown are for the D, JG, P, PS, and PW packages.

NOTE A: The modulating signal can be direct or capacitively coupled to CONT. 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

Design Requirements

Clock input must have V_{OL} and V_{OH} levels that are less than and greater than 1/3 VCC. Modulation input can vary from ground to VCC. The application must be tolerant of a nonlinear transfer function; the relationship between modulation input and pulse width is not linear because the capacitor charge is based RC on an negative exponential curve.

Detailed Design Procedure

Choose R_A and C so that $R_A \times C = 1/4$ [clock input period].R_L improves V_{OH}, but it is not required for TTL compatibility.

Application Curves

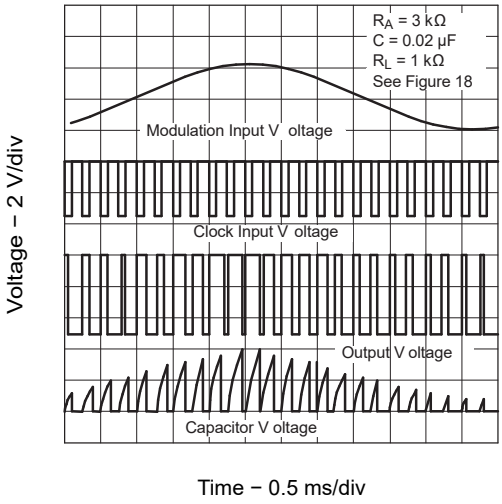
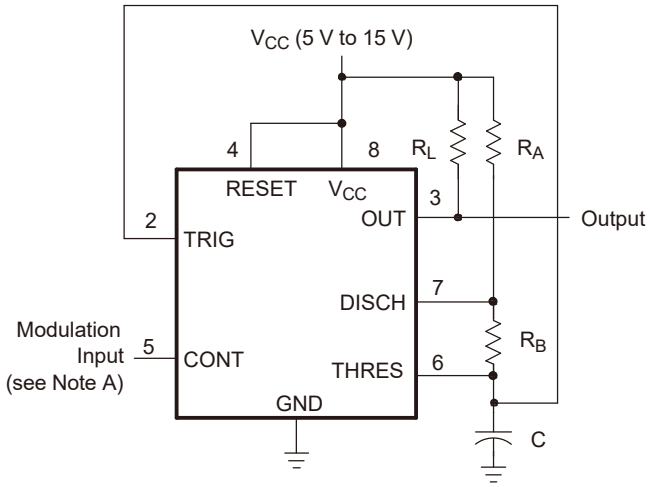


Figure 19: Pulse-Width-Modulation Waveforms

Pulse-Position Modulation

As shown in Figure 20, any of these timers can 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 shows a triangular-wave modulation signal for such a circuit; however, any wave shape could be used.



Pin numbers shown are for the D, JG, P, PS, and PW packages.

NOTE A: The modulating signal can be direct or capacitively coupled to CONT. 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

Design Requirements

Both DC and AC coupled modulation input will change the upper and lower voltage thresholds for the timing capacitor. Both frequency and duty cycle will vary with the modulation voltage.

Detailed Design Procedure

The nominal output frequency and duty cycle can be determined using formulas in A-stable Operation section. R_L improves V_{OH}, but it is not required for TTL compatibility.

Application Curves

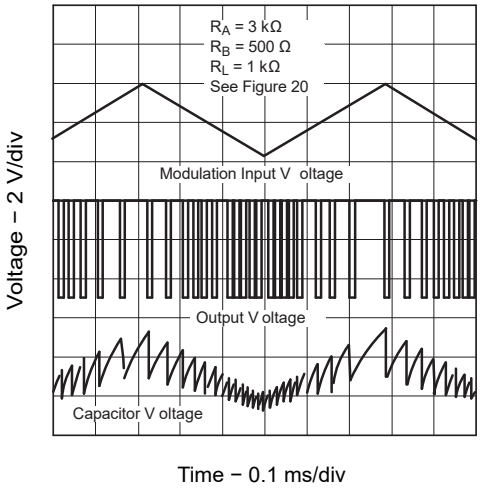
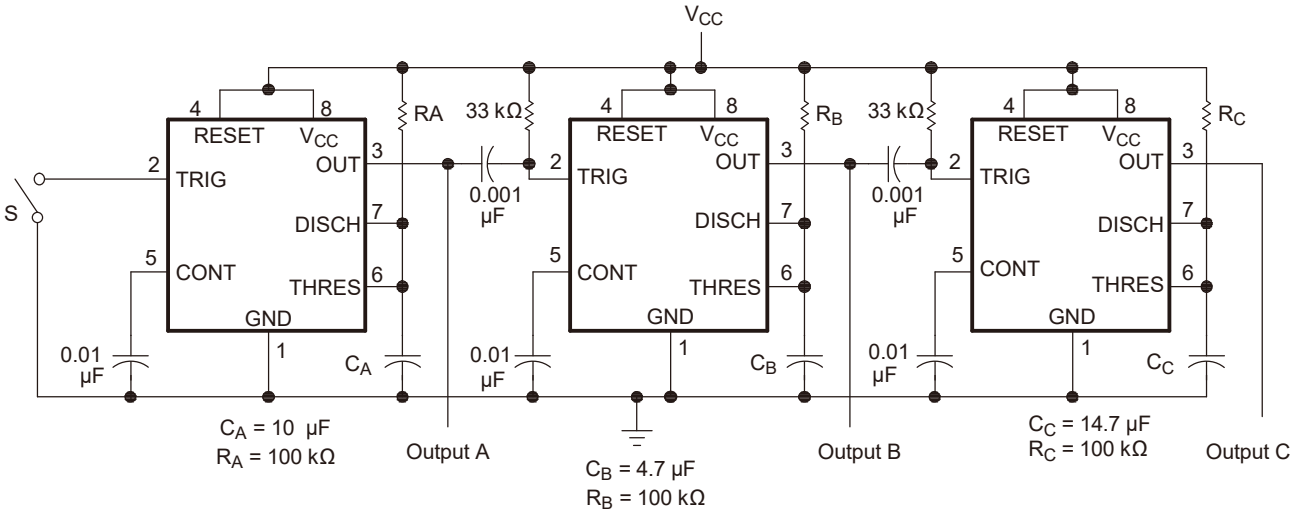


Figure 21: Pulse-Position-Modulation Waveforms

Sequential Timer

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 can be connected to provide such sequential control. The timers can be used in various combinations of astable or monostable circuit connections, with or without modulation, for extremely flexible waveform control. Figure 22 shows a sequencer circuit with possible applications in many systems, and Figure 23 shows the output waveforms.



Pin numbers shown are for the D, JG, P, PS, and PW packages.
NOTE A: S closes momentarily at t = 0.

Figure 22: Sequential Timer Circuit

Design Requirements

The sequential timer application chains together multiple mono-stable timers. The joining components are the 33kΩ resistors and 0.001-μF capacitors. The output high to low edge passes a 10-μs start pulse to the next monostable.

Detailed Design Procedure

The timing resistors and capacitors can be chosen using this formula. $t_w = 1.1 \times R \times C$.

Application Curves

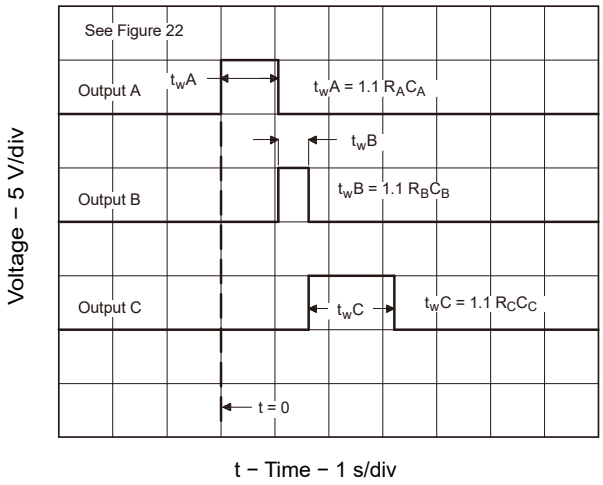


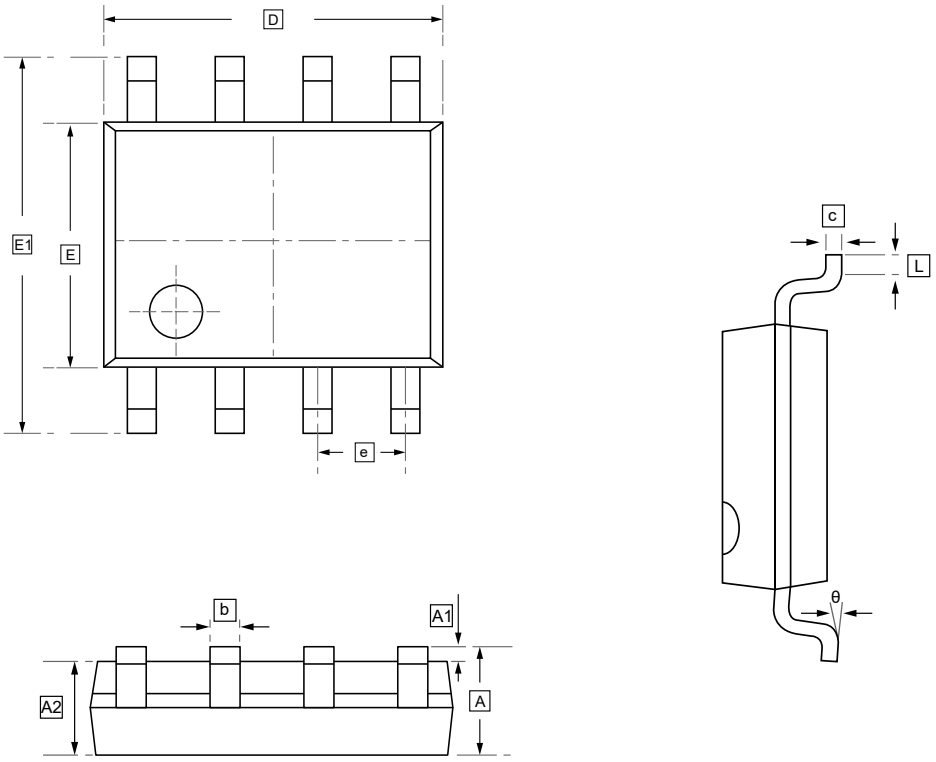
Figure 23: Sequential Timer Waveforms

Power Supply Recommendations

The devices are designed to operate from an input voltage supply range between 4.5 V and 16 V. (18 V for SE555).

A bypass capacitor is highly recommended from VCC to ground pin; ceramic 0.1 μF capacitor is sufficient.

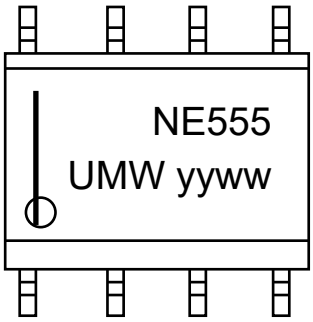
17.SOP-8 Package Outline Dimensions



DIMENSIONS (mm are the original dimensions)

Symbol	A	A1	A2	b	c	D	E	E1	e	L	θ
Min	1.350	0.000	1.350	0.330	0.170	4.700	3.800	5.800	1.270	0.400	0°
Max	1.750	0.100	1.550	0.510	0.250	5.100	4.000	6.200	BSC	1.270	8°

18.Ordering Information



yy: Year Code
ww: Week Code

Order Code	Marking	Package	Base QTY	Delivery Mode
UMW NE555DR	NE555	SOP-8	2500	Tape and reel
UMW SA555DR	SA555	SOP-8	2500	Tape and reel

19.Disclaimer

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