# 555 Monostable 30.1

# Key Facts

* When triggered, the monostable produces a single accurately timed pulse. The output goes high for the timed period and then goes low again.
* The monostable has one stable state and one unstable state.
* In the circuit below, the 10k pull-up resistor pulls pin 2 high.
* Pressing the switch sends a LOW trigger pulse to pin 2.
* This turns on the output for a time T = 1.1 R C
* The duration of the output pulse is called its period.
* The reset switch can be pressed to end the timing earlier than normal.

## How it Works - Exam Answer

* The timer starts when the trigger voltage drops below Vs / 3.#
* The output goes high and the discharge transistor turns off. Trigger pulses are ignored.
* C charges through R towards Vs.
* When the voltage across C reaches 2/3 of Vs, the timer resets. This takes 1.1 R C Seconds.
* The output goes low.
* The discharge transistor turns on and quickly discharges C to zero volts.

## 555 Monostable Circuit Diagram



## Pulse Time

The square wave output is high for the following period ...

T = 1.1 R C

## 555 Monostable Timing Diagram



* The trigger pulse (a) turns on the output for a fixed time.
* Trigger pulse (b) turns the output on again.
* Trigger pulse (c) is IGNORED because the output is already on.

# 555 Astable

## Key Facts

* This is an oscillator circuit providing a square wave output.
* The astable has zero stable states.
* Whichever state it is in (high or low), it will soon switch to the other state.
* The 555 chip CAN NOT drive a normal 8 Ohm loudspeaker.
* Piezoelectric sounders can be plugged straight in.
* A DC blocking capacitor may be needed with a resistor in series to limit the output current to less that 200 mA. 27 Ohms should be suitable for a 12 Volt circuit.
* The DC Blocking capacitor (if used) should have a low reactance at the operating frequency.
* The astable frequency depends on C1.

## How it Works - Exam Answer

* If the output is high, the discharge transistor is off.
* C1 charges towards Vs through Ra and Rb until the threshold rises above 2/3 of the supply voltage.
* The output goes low and the discharge transistor turns on.
* C1 discharges towards 0 Volts through Rb until the threshold drops below 1/3 of the supply voltage.
* The output goes high again and the steps above repeat.





## 555 Astable Formulas

**Frequency F = 1.44 / ((Ra + 2Rb) C1)**

**Low Time tL = 0.7 RbC1**

**High Time tH = 0.7 (Ra + Rb) C1**

## Symmetrical Square Wave

* To get a fairly symmetrical square wave, Ra should be a lot smaller then Rb.
* For adjustable frequencies, Rb can be a variable resistor.
* Try using an LDR for Rb. The frequency will depend on the light level.

## Mark Space Ratio

The mark space ratio is a measure of the proportion of the time the output is high. For example if the output was high 80% of the time and low for 20% of the time, the mark space ratio would be 4 or 4:1

**Mark Space Ratio = tH / tL**

# 555 Timer Insides

Inside the 555 timer you will find ...

* **Voltage Divider consisting of three 5kΩ resistors.**
* These three 5k resistors may explain the name of this device.
* The threshold comparator goes high if the threshold input goes above 2/3 of the supply voltage.
* The trigger comparator goes high if the trigger input voltage drops below 1/3 of the supply voltage.
* **Threshold Comparator.**
* If the threshold input is greater than 2/3 Vs, the latch resets and the output goes low.
* The discharge transistor turns on and this pulls pin 7 (discharge) low too.
* **Trigger comparator.**
* If the trigger input is less than 1/3 Vs, the latch is set and the output goes high.
* The discharge transistor turns off and pin 7 (discharge) is controlled by components external to the 555 chip.
* **Data Latch.**
* This RS Flip Flop is set if the trigger input is less than 1/3 Vs.
* It is reset if the threshold input is greater than 2/3 Vs.
* **Output Buffer.**
* This is able to source or sink up to 200mA to the output.
* **Reset (pin 4).**
* If pin 4 is low, this resets or disables the timer and the other inputs have no effect.
* **Discharge.**
* This pin is held low by an NPN transistor used as a switch.
* This happens when the 555 output is low.
* If the 555 output is high, this transistor turns off and it has no effect on the rest of the circuit.
* (This arrangement is called "open collector").

**The internal modules include ...**

* The three 5k resistors used as voltage dividers
* Two Op' Amp' Comparators
* The RS Flip Flop / Bistable Latch
* The Output Buffer / Driver
* NPN Transistor used as a switch.

