AB28
Multivibrators
(Astable and Monostable)

Operating Manual

Ver.1.1

An ISO 9001 : 2000 company

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TÜV Rheinland Group

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RoHS Compliance

Scientech Products are RoHS Complied.

RoHS Directive concerns with the restrictive use of Hazardous substances (Pb, Cd, Cr, Hg, Br compounds) in electric and electronic equipments.

Scientech products are “Lead Free” and “Environment Friendly”.

It is mandatory that service engineers use lead free solder wire and use the soldering irons upto (25 W) that reach a temperature of 450°C at the tip as the melting temperature of the unleaded solder is higher than the leaded solder.

Introduction

AB28 is a compact, ready to use **Multivibrator** experimental Board. This is useful for students to understand Multivibrator in Astable and Monostable mode using IC NE 555. It can be used as stand alone unit with external DC power supply or can be used with **Scientech Analog Lab ST2612** which has built in DC power supply, AC power supply, function generator, modulation generator, continuity tester, toggle switches, and potentiometer.

List of Boards :

Model	Name
AB01	Diode characteristics (Si, Zener, LED)
AB02	Transistor characteristics (CB NPN)
AB03	Transistor characteristics (CB PNP)
AB04	Transistor characteristics (CE NPN)
AB05	Transistor characteristics (CE PNP)
AB06	Transistor characteristics (CC NPN)
AB07	Transistor characteristics (CC PNP)
AB08	FET characteristics
AB09	Rectifier Circuits
AB10	Wheatstone bridge
AB11	Maxwell's Bridge
AB12	De Sauty's Bridge
AB13	Schering Bridge
AB14	Darlington Pair
AB15	Common Emitter Amplifier
AB16	Common Collector Amplifier
AB17	Common Base Amplifier
AB18	RC-Coupled Amplifier
AB19	Cascode Amplifier
AB20	Direct Coupled Amplifier
AB21	Class A Amplifier
AB22	Class B Amplifier (push pull emitter follower)
AB23	Class C Tuned Amplifier
AB24	Transformer Coupled Amplifier
AB25	Phase Locked Loop (FM Demodulator & Frequency Divider / Multiplier)
AB26	FET Amplifier
AB27	Voltage Controlled Oscillator
AB29	F-V and V-F Converter
AB30	V-I and I-V Converter
AB31	Zener Voltage Regulator
AB32	Transistor Series Voltage Regulator
AB33	Transistor Shunt Voltage Regulator
AB35	DC Ammeter
AB37	DC Ammeter (0-2mA)
AB39	Instrumentation Amplifier

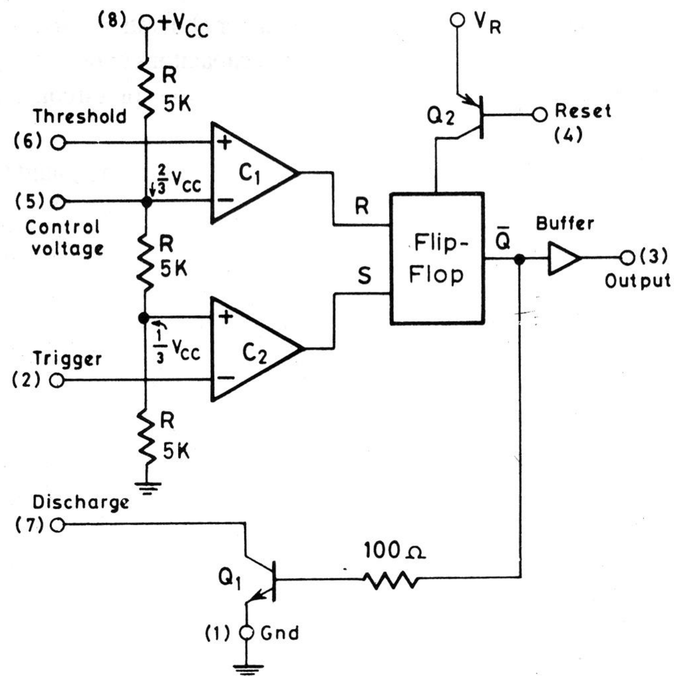
AB41	Differential Amplifier (Transistorized)
AB42	Operational Amplifier (Inverting / Non-inverting / Differentiator)
AB43	Operational Amplifier (Adder/Scalar)
AB44	Operational Amplifier (Integrator/ Differentiator)
AB45	Schmitt Trigger and Comparator
AB49	K Derived Filter
AB51	Active filters (Low Pass and High Pass)
AB52	Active Band Pass Filter
AB54	Tschebyscheff Filter
AB56	Fiber Optic Analog Link
AB57	Owen's Bridge
AB58	Anderson's Bridge
AB59	Maxwell's Inductance Bridge
AB64	RC – Coupled Amplifier with Feedback
AB66	Wien Bridge Oscillators
AB67	Colpitt Oscillator
AB68	Hartley Oscillator
AB80	RLC Series and RLC Parallel Resonance
AB82	Thevenin's and Maximum Power Transfer Theorem
AB83	Reciprocity and Superposition Theorem
AB84	Tellegen's Theorem
AB85	Norton's theorem
AB88	Diode Clipper
AB89	Diode Clampers
AB90	Two port network parameter
AB91	Optical Transducer (Photovoltaic cell)
AB92	Optical Transducer (Photoconductive cell/LDR)
AB93	Optical Transducer (Phototransistor)
AB96	Temperature Transducer (RTD & IC335)
AB97	Temperature Transducer (Thermocouple)
AB101	DSB Modulator and Demodulator
AB102	SSB Modulator and Demodulator
AB106	FM Modulator and Demodulator

and many more…………

Theory

The device 555 is a monolithic timing circuit that can produce accurate and highly stable time delays or oscillations. The 555 timer is reliable, easy to use, and economical. IC 555 has been used in number of applications, such as monostable and astable multivibrators, DC-DC converters, digital logic probes, waveform generators, analog frequency meters and tachometers, temperature measurement and control, infrared transmitters, burglar and toxic gas alarms, voltage regulators, etc.

The timer 555 is available as an 8-pin metal can, an 8-pin mini DIP, or a 14-pin DIP. Figure 1 shows the functional diagram and the pin configuration of the NE 555 timer. The NE 555 operates over a temperature range of 0° to 70°C. The important features of the NE 555 timer are as follows:



Functional Diagram

Figure 1

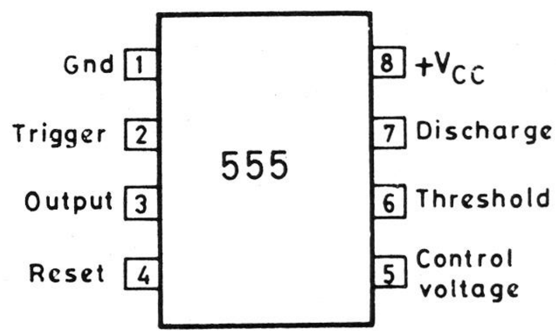
- Operation on + 5 to + 18 V supply voltage in both astable and monostable modes.
- Adjustable duty cycle.
- Timing from µ sec to hours.
- High current output.
- Capacity to source or sink current 'of 200 mA.
- Output can drive TIL.
- Temperature stability of 50 parts per million (ppm) per °C change in temperature or 0.005% per °C. - Reliable, easy to use, and low cost.

The 555 timer is highly stable device for generating accurate time delay or oscillation.

The device consists of two comparators that drive the set (S) and reset *(R)* terminals of a flip-flop, which in turn controls the *'on'* and *'off* cycles of the discharge transistor Q_1. The comparator reference voltages are fixed at 2/3 *Vcc* for comparator C_1 and *Vcc/3* for comparator C_2 by means of the voltage divider made up of three series resistors *(R).* These reference voltages are required to control the timing. The timing can be controlled externally by applying voltage to the control voltage terminal. If no such control is required then the control voltage terminal can be bypassed by a capacitor to ground. Typically the capacitor is chosen of about 0.01uF.

On a negative transition of pulse applied at the trigger terminal and when the voltage at the trigger terminal passes through *Vcc/3,* the output of comparator C_2 changes state because its positive input terminal is fixed at *Vcc/3.* This change of state sets the flip-flop, so that output of flip-flop, *Q,* goes to *low* level. On the other hand when the voltage applied at the threshold terminal of comparator C_1 goes positive and passes through the reference level *2Vcc/3,* the output of the comparator changes its state. This change of state resets the flip-flop, so that *Q* is latched into *high* level. A separate reset terminal is provided for timer which is used to reset the flip-flop externally. This reset voltage applied externally would override the effect of the output of lower comparator which sets the flip-flop. This overriding reset will be in effect whenever the reset input is less than about l0.4Volt.

Normally, when the reset terminal is not used, it should be connected to positive supply *(Vcc).* The transistor Q_2 acts as a buffer, isolating the reset terminal from the flip-flop and transistor Q_1. The output of flip-flop is *Q* which is also used as an output terminal taken through an output stage or buffer. When the flip-flop is reset the output at the output terminal is *low* and when the flip-flop is set the output is in *high* logic state. The buffer is necessary to source current as high as 200mA. A capacitor is connected between discharge terminal and ground. When Q_1 is *off the* capacitor charges and when Q_1 is *on* it discharges through Q_1.



IC 555 Pin Out

Figure 2

Pin 1 (Ground) : The ground (or common) pin is the most-negative supply potential of the device, which is normally connected to circuit common (ground) when operated from positive supply voltages.

Pin 2 (Trigger) : The output of the timer depends on the amplitude of the external trigger pulse applied to this pin. The output is low if the voltage at this pin is greater than 2/3 V_{CC}. However, when a negative going pulse of amplitude larger than 1/3 V_{CC} is applied to this pin, the comparator 2 output goes low, which in turn switches the output to the timer high. The output remains high as long as the trigger terminal is held at a low voltage.

Pin 3 (Output) : There are two ways a load can be connected to the output terminal - either between pin 3 and ground (pin 1) called as normally off load or between pin 3 and supply voltage + V_{CC} (pin 8) called as normally on load.

Pin 4 (Reset) : This pin is also used to reset the latch and return the output to a low state. The reset pin will force the output to go low no matter what state the other inputs to the flip-flop are in. When not used, it is recommended that the reset input be tied to V+ to avoid any possibility of false resetting.

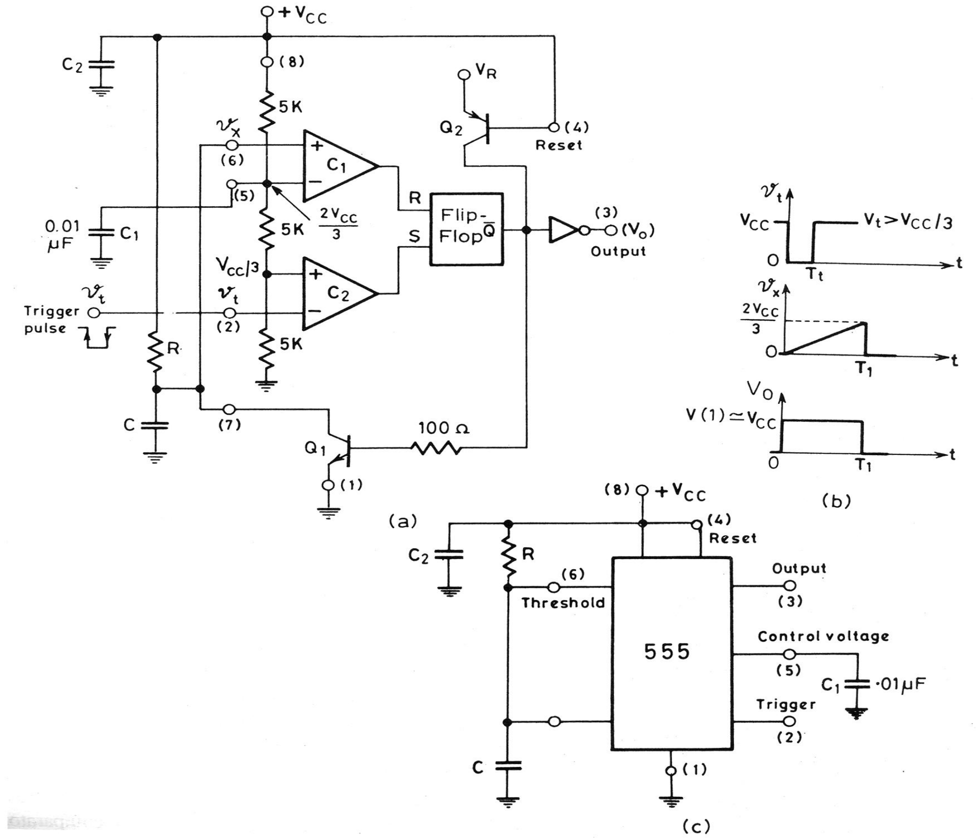
Pin 5 (Control Voltage) : An external voltage applied to this terminal changes the threshold as well as the trigger voltage. In other words, by imposing a voltage on this pin or connecting a pot between this pin and ground, the pulse width of the output waveform can be varied. When not used, the control pin should be bypassed to ground with a 0.01µF capacitor to prevent any noise problems.

Pin 6 (Threshold) : This is the non-inverting input terminal of the comparator 1, which monitors the voltage across the external capacitor. When the voltage at this pin is greater or equal to the threshold voltage 2/3 V_{CC}, the output of comparator 1 goes high, which in turn switches the output of the timer low.

Pin 7 (Discharge) : This pin is connected internally to the collector of transistor T1, as shown in figure 3. When the output is high, T1 is off and acts as an open circuit to the external capacitor C connected across it. On the other hand, when the output is low, T1 is saturated and acts as a short circuit, shorting out the external capacitor C to ground.

Pin 8 (V+) : The V+ pin (also referred to as V_{CC}) is the positive supply voltage terminal of the 555 timer IC. Supply-voltage operating range for the 555 is +4.5 volts (minimum) to +16 volts (maximum), and it is specified for operation between +5 volts and +15 volts.

IC 555 as Monostable Multivibrator :



IC 555 as Monostable multivibrator (a) Functional Diagram (b) waveform at various points (c) External Connections

Figure 3

The resistance *R* and the capacitor C are external to the chip, and their values determine the output pulse width. Before the application of the trigger pulse v_t , the voltage at the trigger input pin is ***high*** which is equal to *Vcc* [say *V (1)*]. With this high trigger input, the output of comparator C_2 will be ***low*** [say *V(0)],* causing the flip-flop output *Q* to be ***high***, ***i.e.*** *Q* = *V* (1) and *Vo* = *V* (0) = 0 (due to inverter circuit). With *Q* = *V* (1), the discharge transistor Q_1 will be saturated and the voltage across the timing capacitor C will be essentially zero, ***i.e.*** *Vx* = O. The output *Va* = 0 V is the quiescent state of the timer device.

At *t* = 0, application of trigger v_t, (negative going pulse shown in [Figure 3***(b)***] less than *Vcc/3* causes the output of comparator C2 to be ***high***, i.e. *V* (1). This will set the flip-flop with *Q* now ***low. i.e,*** *Q* = *V (0).* This makes *Vo* = *V* (1). Due to *Q* = *V(0),* discharge transistor will be turned 'off'. Note that after termination of the trigger pulse the flip-flop will remain in the *Q* = *V* (0) state. Now, the timing capacitor charges up towards ***Vcc via*** resistor *R,* with a time constant ***t = RC.*** The charging up expression is

$$v_x = V_{CC}\,(1 - e^{-t/RC}) \qquad \ldots\ldots\ldots\ldots..(1)$$

where v_x is the voltage across C at any time ***t.***

When v_x reaches the threshold voltage level of 2*Vcc/3,* comparator C_1 will switch states and its output voltage will now be ***high.*** This causes the flip-flop to reset so that *Q* will go ***high.*** i.e. *V (1),* and *Vo* returns to original level *V (0)*. The high value of *Q* turns on the discharge transistor Q_1 . The low saturation resistance of Q_1 discharges C quickly.

The end of the output pulse occurs at time T_1, at which point v_x =2 *Vcc/3.* Thus the pulse width T_1 is determined by the time required for the capacitor voltage v_x to charge from zero to 2*Vcc/3.* This period can be obtained by putting v_x = *2Vcc/3* at ***t= T,*** Thus from eq.1

$$2\,V_{CC}/3 = V_{CC}\,(1 - e^{-T_1/RC})$$

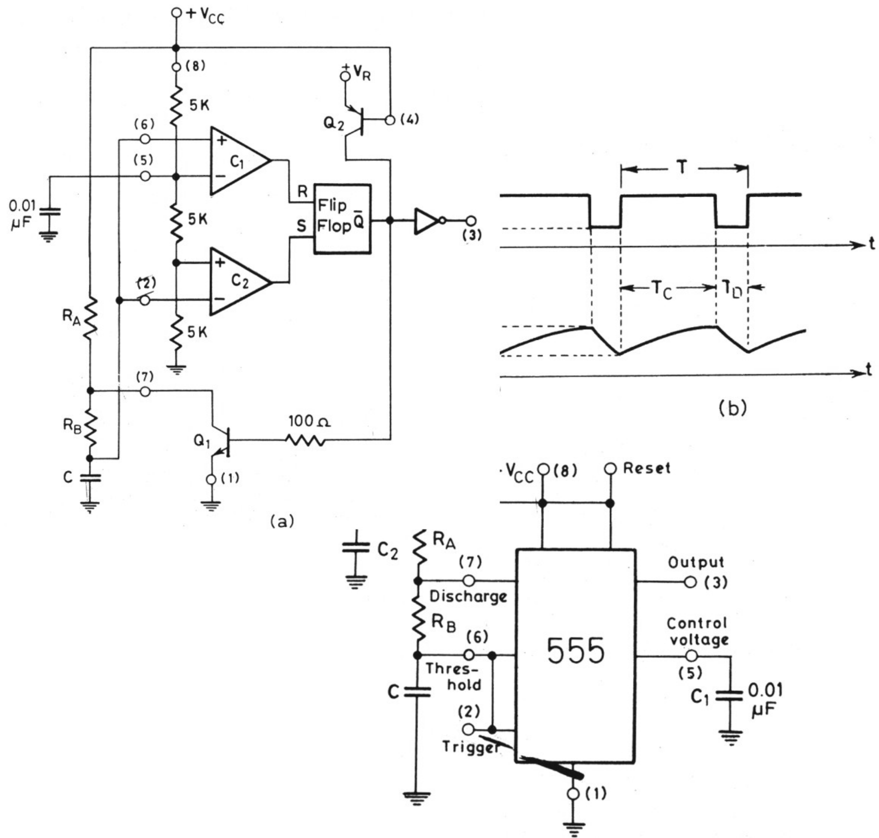
$$T_1 = RC \ln \frac{V_{CC}}{V_{CC} - \frac{2}{3} V_{CC}}$$

$$T_1 \cong 1.1\,RC \qquad \ldots\ldots\ldots\ldots(2)$$

Note that the pulse duration is independent of the supply voltage *Vcc.* The trigger pulse width must be shorter in duration than T_1 for proper operation of the timer. In Eq.2 we have assumed *V (0)* = 0.

The timing cycle may be interrupted by connecting the reset terminal (pin 4). This turns on transistor Q_1 and the capacitor is prevented from charging.

IC 555 as Astable Multivibrator :



Astable Multivibrator (a) Functional Diagram (b) Waveform at various points (c) external connection diagram

Figure 4

In this mode of operation, the timing capacitor charges up toward *Vcc* (assuming V_O is ***high*** initially) through $(R_A + R_B)$ until the voltage across the capacitor reaches the threshold level of 2 *Vcc/3.* At this point comparator C_1 switches state causing the flip-flop output *Q* to go ***high*** i.e., $Q = V(1)$. This turns on the discharge transistor Q_1 and the timing capacitor C then discharges through R_B and *Q1* (pin 7). The discharging continues until the capacitance voltage drops to *Vcc/3,* at which point comparator C_2 switches states causing the flip-flop output *Q* to go *low,* i.e., $Q = V(0)$, turning off the discharge transistor Q_1. At this point the capacitor starts to charge again, thus completing the cycle.

The output voltage and capacitor voltage waveforms are shown in Figure 4(b) As shown here, the capacitor is periodically charged and discharged between 2 *Vcc/3* and *Vcc/3,* respectively.

The charging time is given by,

$$T_c = (R_A + R_B)\ C\ \text{In}\ 2$$

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

The discharging time is given by,

$$T_D = R_B\ C\ \text{In}\ 2$$

$$= 0.639\ R_B\ C$$

The total period $T = T_C + T_D$

$$T = 0.693\ (R_A + 2R_B)\ C$$

And the frequency of oscillations will be

$$fo = \frac{1}{T} = \frac{1}{0.693(R_A + 2R_B)C}$$

$$fo = \frac{1.44}{(R_A + 2R_B)C}$$

Experiment 1

Objective :
Study of IC 555 as a mono stable (one shot) Multivibrator

Equipments Needed :

1. Analog board of **AB28.**
2. DC power supplies + 5V, from external source or **ST2612 Analog Lab**.
3. 2 mm patch cords.
4. Ohm meter.
5. Function generator [for pulse signal (**Scientech** Function Generator **ST4062**, **ST4063** etc.)]

Circuit diagram :

Circuit used to study monostable multivibrator is shown in Figure 5.

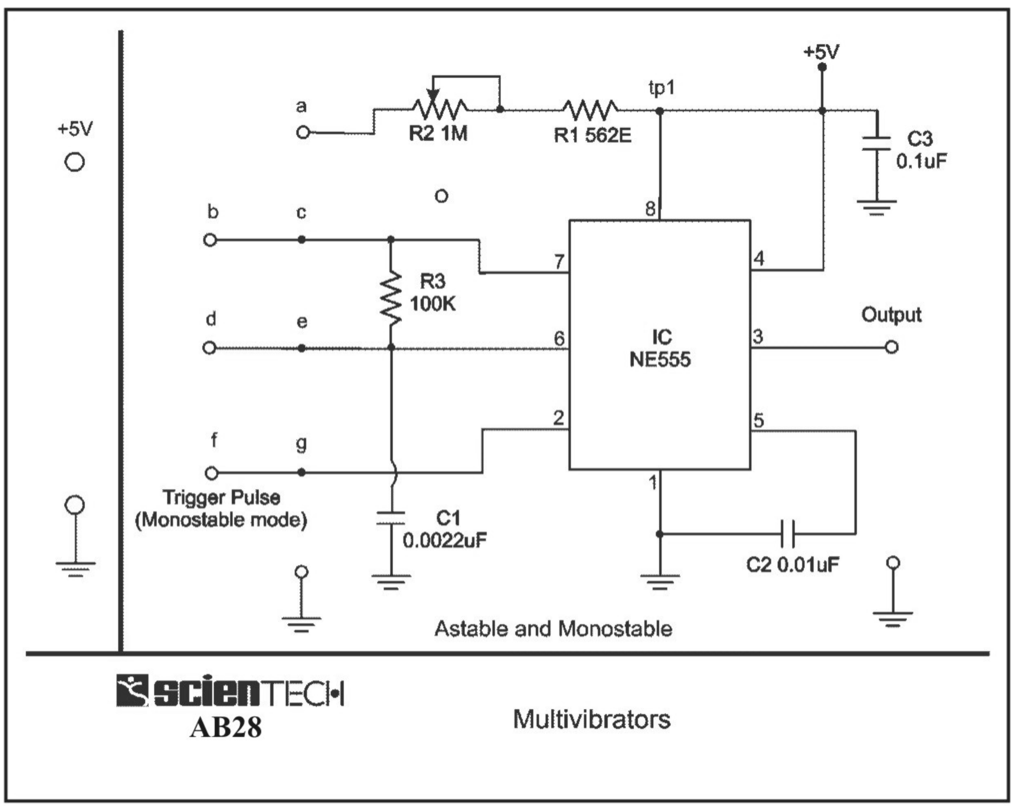


Figure 5

Procedure :

- Connect power supply + 5V from **ST2612** or any external source.

1. Connect point a to point b using a 2mm patch cord.
2. Connect point c to point d/e using a 2mm patch cord.
3. Keep the pot (R2 1M) to fully anticlockwise direction.
4. Apply a pulse signal of 5Vpp and 1 KHz (keep duty cycle of pulse 50%) at pin 2 of IC 555 i.e. to the point e/g on **AB28** board. Observe the same on oscilloscope CHI.
5. Connect pin 3 of IC55 i.e. output socket to the oscilloscope CHII.
6. Vary the pot and observe the variation of output pulse duty cycle with the change in resistance R (where, R=R1+R2).
7. For any value of R measure the ON time of output pulse.
8. Calculate the same by following equation for theoretically calculating the output pulse 'On' time.

   $$T_P = 1.1 * R_1C_1$$

   Note : For calculating the value of R, disconnect the +5V supply and connection between point a and b. Connect ohmmeter between point a and TP1. The ohmmeter will read the value of R.
9. Verify theoretical and practical values of T_P.

   Note : The two values of T_P (theoretical and practical values) will match only for time for which input pulse is High i.e. only for 'On' 'time of input pulse. To verify this vary the duty cycle of input signal and check the output pulse duty cycle by varying R (R=R1+R2).
10. Repeat above procedure for different values of R.

Experiment 2

Objective :

Study of IC 555 as an Astable (free running) Multivibrator

Equipments Needed :

1. Analog board **AB28.**
2. DC power supplies +5V from external source or **ST2612 Analog Lab**.
3. 2 mm. patch cords.

Circuit diagram :

Circuit used to study Astable Multivibrator is shown in Figure 6.

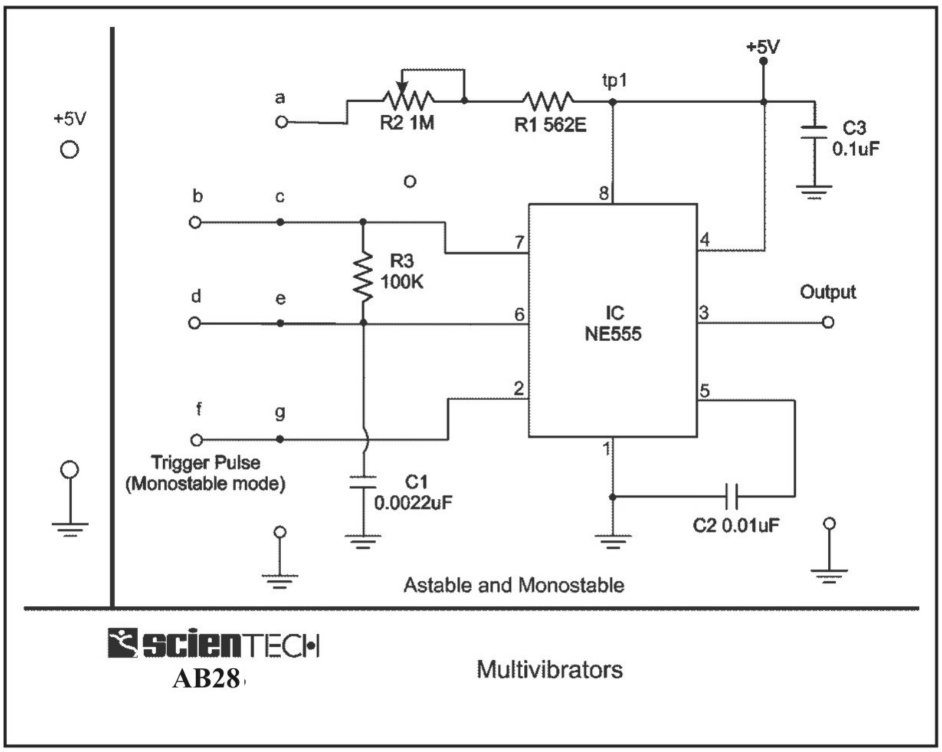


Figure 6

Procedure :

- Connect power supply +5V from **ST2612** or any external source.

1. Connect point a to point b using a 2mm patch cord.

2. Connect point d to point f/g using a 2mm patch cord.

3. Keep the pot (R2 1M) to fully anticlockwise direction.

4. Connect pin 3 of IC55 i.e. output socket to the oscilloscope.

5. Vary the pot and observe the variation of output signal's frequency with the change in resistance R (where, R=R1+R2).

6. To verify the above calculate the frequency of output signal using following equation

$$fout = \frac{1.44}{C1(R + 2R3)}$$

Note : For calculating the value of R, disconnect the +5V supply and connection between point a and b. Connect ohmmeter between point a and TP1. The ohmmeter will read the value of R.

7. Trace the waveforms of the voltage across capacitor C1 and ground.

8. Repeat above procedure for different values of R.

Data Sheet

LM555/NE555/SA555

Single Timer

Features

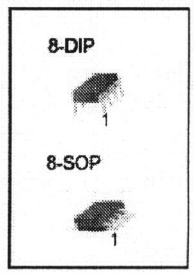
- High Current Drive Capability (200mA)
- Adjustable Duty Cycle
- Temperature Stability of 0.005%/°C
- Timing From µSec to Hours
- Turn off Time Less Than 2µSec

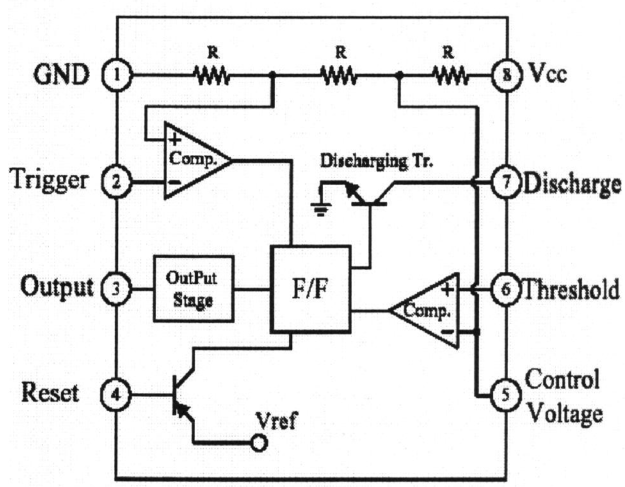
Applications

- Precision Timing
- Pulse Generation
- Time Delay Generation
- Sequential Timing

Description

The LM555/NE555/SA555 is a highly stable controller capable of producing accurate timing pulses. With a monostable operation, the time delay is controlled by one external resistor and one capacitor. With an astable operation, the frequency and duty cycle are accurately controlled by two external resistors and one capacitor.





Warranty

1. We guarantee the product against all manufacturing defects for 24 months from the date of sale by us or through our dealers. Consumables like dry cell etc. are not covered under warranty.
2. The guarantee will become void, if
   - **a)** The product is not operated as per the instruction given in the operating manual.
   - **b)** The agreed payment terms and other conditions of sale are not followed.
   - **c)** The customer resells the instrument to another party.
   - **d)** Any attempt is made to service and modify the instrument.
3. The non-working of the product is to be communicated to us immediately giving full details of the complaints and defects noticed specifically mentioning the type, serial number of the product and date of purchase etc.
4. The repair work will be carried out, provided the product is dispatched securely packed and insured. The transportation charges shall be borne by the customer.

For any Technical Problem Please Contact us at **service@scientech.bz**

List of Accessories

1. 2 mm Patch Cords (Red) ....1 No.
2. 2 mm Patch Cord (Blue) .... 4 Nos.
3. 2 mm Patch Cord (Black) .... 3 Nos.
4. e-Manual...1 No.

Updated 25-03-2009