CEBEK®

EDUCATIONAL MODULES

For LEARNING and to PRACTICE the ELECTRONICS

www.cebek.com

EDU-013. Monostable Ne555

EDU-013

The EDU-013 is a mini composed by two NE555 in monostable configuration with the necessary components to experiment without external elements the different variables and concepts indicated in the documentation and the practices.
The EDU-013 exhibits the accurate timer based on the "555". Experimenting through the practices, the description of its internal structure, operating answer and characteristics of its monostable configuration. Shot answer, timing, reset, etc.

Practice 1. Description of the monostable NE555. The shoting circuit, PCS and PCI, switching levels, process description and timing result in the monostable configuration step by step.

Practice 2. Timing. Resolution of values on RC network according to pre-established timing on the circuit. Combination according to resistors and capacitors commercial values.

Practice 3. Reset. Reset Control and operating answer. Shot and inhibition levels.

EDU-013

EDU-013. Monostable NE555

Warranty and Do not forget.

Cebek educational modules included in the EDU serial offer several practices to analyse, experiment and to learn basic knowledge on the studied theme. Nevertheless, their function is not to make a mini-class on each theme, but to complete and to be used as basis, as well as to allow to experiment on the theoretical theme evocated by the teacher. For this reason, we suggest you to use modules form the EDU serial under the supervision and the direction of a teacher.
Cebek doesn't offer a consulting service as concern the theoretical or the operating principles concerning the theme deal with the module. It only offers a technical assistance regarding questions and problems coming from the circuit's internal operating mode.
All Cebek modules included in the EDU serial have a warranty of 3 years as concerning components and labour man. All damages provoked by external causes (from the circuit), as well as wrong connections or installations or due to an operating mode no indicated into the module's documentation won't be covered by the warranty. More over, all wrong or incorrect handling won't be excluded from the warranty. For any claim, you have to present the corresponding invoice.
To contact our technical department, you can send a message to sat@cebek.com, or a fax :Nº+34.93.432.29.95 or a mail to the following address: CEBEK, c/Quetzal, 17-21, 08014 Barcelona (SPAIN).

Rules and Identification of the EDU serial elements.

To make easier the identification and for a single rule as concern different practices and educational Cebek modules, all common elements will answer to colour code and to a shape.

Test Point. (TP).
It allows to connect oscilloscope's or multimeter extremities to read parameters relating to the practice. According to its colour, it will indicate that the Test Point (TP) is connected to the positive or to the negative of the circuit, as well as reads concerning current, voltage, load, etc….

TP. ⊕ circuit Red
TP. ⊖ circuit Black
TP. Voltage Yellow
TP. Current Blue
TP Without current or TP AC. White
Union terminal between points Aluminium, without colour

Conmutator / Switch.
According to the colour of the switch, you can control the voltage, the current or
Power supply Red
Current Blue
Voltage Yellow
Logical Green

Jumper.
It allows to close or open a signal or an electrical ›circuit

Important Point.
Point with special importance,
To remember.

EDU-013. Monostable NE555

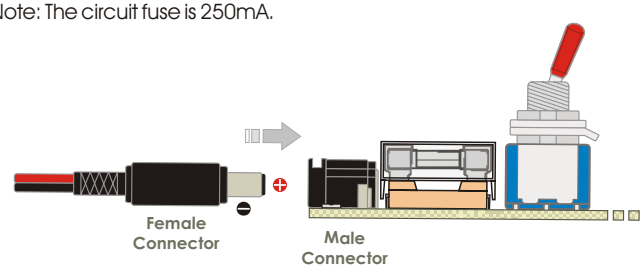
Before to start...

Before to start a practice,
Before to start a practice, it is very important to carefully read its instructions manual as well as corresponding indications.
You have to correctly make connections concerning indicated contact points, otherwise measures depending on these connections will be confuses or incorrects.
Do not make any connection or short-circuits no specified in this manual, to avoid to damage the module.
If the illumination Led indicated as "PWR" doesn't light on or if its function is suddenly stopped, you have to immediately disconnect the devise from the power supply and to check if there is no short-circuit as well as the fuse state.
Even if you can make this practice following instructions described into this manual, we suggest you to make this practice under the supervision of a teacher allowing to consult, to increase or to help regarding concepts described herewith.
On the circuit, each practice will be delimited by a rectangle with the corresponding number. One or several experiments could be reported to this practice.

Module's power supply.

The module is supplied at 12 V DC. You have to use a laboratory stabilised power supply like our Cebek FE-113. The circuit's feeding is done through the male connector inserted on the board, do not inject signal on any other terminal placed on the circuit. Once supplied, the circuit offers necessaries voltages to make experiments with each practice. To connect the power supply, the module includes a cable with a male connector at one extremity and wires at the other extremity.

Respecting the connector polarity, you have to connect each terminal to the corresponding and respective terminal of the power supply. Then, you could insert it on the module.
Note: The circuit fuse is 250mA.



Required Material.

You won't need any additional material or components to experiment with this module. You only need basis measure instruments to obtain and to compare obtained values from this practice. For this module, you will need one or several multimeters with their voltmeter, ammeter or ohmmeter functions. If you have an oscilloscope, you could also use it to substitute the voltmeter.

Bibliography.

- With Google: NE555
- With Google: Ne555 Fairchild
- Electronics Principles, (Mc Graw Hill)

EDU-013

EDU-013. Monostable NE555

Practice 0. The "555"

The "555" is probably one of the most popular integrated circuits, and the most used, it maintain today several characteristics that make it ideal in innumerable applications, mainly as accurate timer.
Distributed by different manufacturers, according to its origin it is denominated NE555, LM555, CA555, MC555, etc. It is also available the version which encapsulates in a same integrated two NE 555, the NE 556

Among its characteristics it emphasizes its high accuracy which it can reach as timer, even if it is submitted to voltage and temperature variations. It can be
supplied with voltages between 4.5 and 18 V.D.C and its stability in frequency by each Celsius degree os of 0.005%.
More over, it requires the use of few external components and it can supply a maximum output current up to 200 mA. Which allow in the no necessity to extend with more components, like current drivers, the control of superior loads.

The NE 555 can operate mainly in two different configurations, like monostable multivibrator or astable multivibrator. In Monoestable mode, the NE 555 produces a single accurate impulse which can be established from microseconds up to hours. In Astable mode, it generates a constant square signal, composed by a impulse at high level followed by another one at low level, where the width of the pulse at high level can be adjusted as well as the part of the cycle at low level.

NE 555's pins

Practice 0. 555's Internal structure and description

Internally, the NE 555 is basically structured by a voltage division with three resistors of the same value, two comparators, a RS flip-flop, a NPN and a Reset control

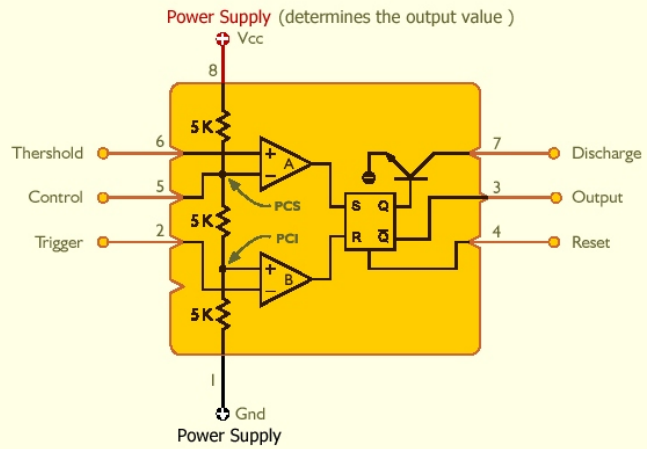
The resistor which constitutes two levels that determine the switching points on the comparators, the superior, (PCS = 2/3 Vdc), and the inferior, (PCI = 1/3 Vdc).
Trigger. The Pin 2, the trigger. When the applied voltage is inferior to the PCI, the comparator B goes to high level. In the monostable configuration, the Trigger voltage is the shot voltage.
Thershold. The Pin 6, the threshold. It also acts on the comparators, in this case on the A. When the applied voltage is superior to PCS, the comparator goes to high level.

Fixes switching levels.

PCS (superior switching point = **2/3 Vcc**)
PCI (inferior switching point = **1/3 Vcc**)

Practice 0. 555's Internal structure and description,(Part II)

NE 555 Internal structure



Output. Pin 3 goes to high level during the output impulse.
Reset. Pin 4. When it is connected to the ground, it reset the output, (Output) and prevents the shot.
Control. Pin 5 is connected to the ground through a capacitor and it avoids voltage fluctuations. In other 555's configurations, like the impulse modulation, it acts as corrector of PCS allowing the modification of the impulse width.
Discharge. Pin 7 executes the capacitor discharge, (which will be used in timing), to ground.

Practice 1. NE555 Monoestable operation mode

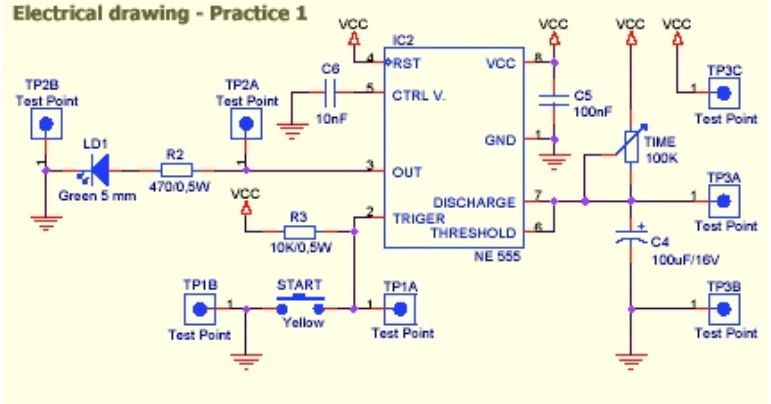
The NE 555 acting in monostable mode is in summary a timer that generates a single output impulse, whose duration will be established by the load time of an external capacitor and the internal PCS.
The capacitor loading time will depend on its capacity as well as of the limiter resistor for the load and the PCS of the 555's feeding value the, (Vcc).
Practice 1 shows the operating mode and the relation of the NE 555's internal structure in monostable configuration. When each element take part, the starting shot for the timing development, the relevance of the external components, the end of the impulse in the output and the constant for the calculation of the impulse duration.

The practice, the circuit operating mode starts when the EDU-013's power supplied is activated. At this moment, the internal NPN, forced by the high level of the flip-flop Q output, is saturated, discharging to the ground the external C4 capacitor. This operation is almost instantaneous and after it, the circuit remains in quiescent, that is in fact the starting point for the practice.

Practice 1. NE555 Monoestable operation mode

The shot and activation of the timing start when the voltage in pin 2, (trigger) decreases below the PCI. Having established that internally PCI corresponds to 1/3 of Vcc, (9 V.), the pin shot will be fixed for any voltage inferior to 3 V.
In the drawing of the practice it is used the Start push button and the R3 resistor to establish the shot. With the open push button, pin 2 is forced to Vcc.
In order to provoke the shot you only have to close the push button, which will connect pin 2 to ground, guarantying a voltage inferior to the PCI.

Electrical drawing - Practice 1



If the B comparator input is inferior to PCI, the comparator output changes and provokes the Reset of the flip-flop which also switch the state of Q at low level. Therefore, Q goes to high level, (output = Vcc and Ld1 is lighted on). With Q at low level, NPN goes to cuts, unblocking the load of C4 through the Time resistor.
When the capacitor voltage overpasses the threshold one, PCS, it will be the A comparator which will change the output, returning to activate the flip-flop and restoring Q at high level to allow the NPN leads and quickly discharge the capacitor. Automatically Q is at low level, (output = zero, Ld1 remains in off).
Consequently, the width of the output impulse will correspond to the time required by the capacitor load to overpass PCS. If it is considered that 2/3 Vcc = 66.7% of Vcc and the load takes place exponentially, the established formula is: Duration of the impulse at On = the product of 1.1 by the Time resistor and the C4 capacitor.

Formula : Monoestable NE 555.

(Time = seconds, R in Ohms and C in Farades). Time = 1,1 RC

Choose a channel from the oscilloscope between the TP1A and TP1B test points and another between the TP3A and TP3B test points. Whereas the first channel shows each shooting action, the channel about TP3 will visualize the capacitor voltage load.
Check that until the capacitor does not reach 2/3 Vcc the A internal comparator does not allow the change of the flip-flop, and the NE 555 will not respond to any shooting action after the first.
Note that the internal logical maintains the output at On if the timing has finished but it remains activated the shot.
The output activation can be displayed through Ld1 LED or through TP2A and TP2B test points.

EDU-013. Monostable NE555

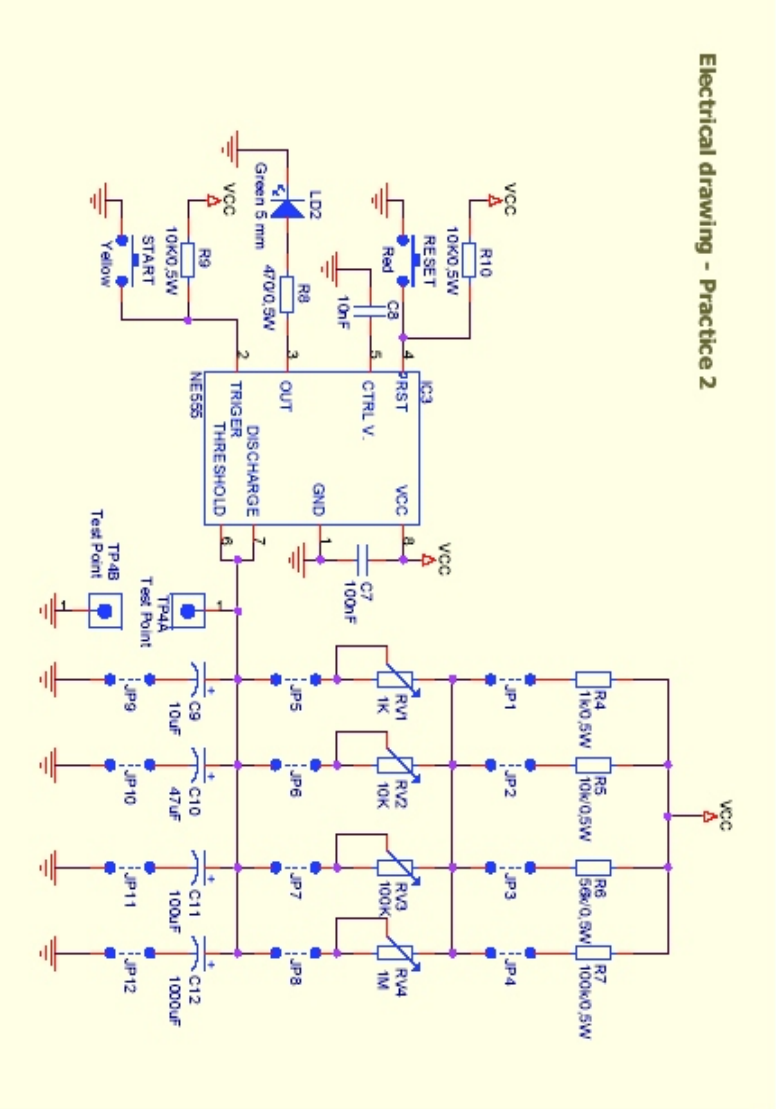
Practice 2. Timing and Reset

The description of the internal operating mode for the NE 555's monostable configuration reflects that the time constant of the output impulse width depends on the capacity of the capacitor and the load resistor.

This practice allows to experiment with different combinations and values change between both components, as well as their extrapolation on the formula with the consequent repercussion in the output.

This practice also introduce and experiment on the pin 4's function : The Reset.

Note: Probably there will have some small result discrepancies between the formula and the real transfer on the circuit due to the capacitors and resistors minimum tolerances.



EDU-013

EDU-013. Monostable NE555

Practice 2. Timing and Reset, (Part II)

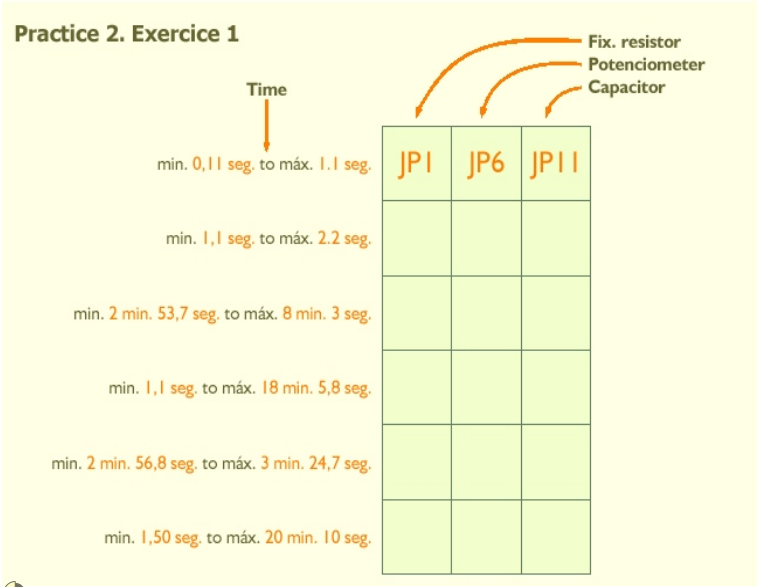
Exercise 1. The RC Network of the practice subdivides the resistance in two components, a potentiometer and a fix resistor. The resistor function is to assure a minimum timing value when the potentiometer is equal to zero and a maximum value equal to the sum of both components.

In order to configure a combination of a fix Resistor plus a potentiometer plus a capacitor, you have to close the corresponding jumpers. Seeing the drawing it can be easily to deduce that the JP1, JP6 and JP11 closure will configure a RC of R4 more RV2 with C11.

The exercise will consist in indicating in each square the jumpers combination that would configure the necessary RC to obtain the required timing.

Finally you have to verify that this combination offers the set out timing.

Also, monitoring through an oscilloscope the TP4A and TP4B test points you can see that the duration of the impulse is equal to the corresponding capacitor time in reaching 2/3 Vcc, (6 V.).



Exercise 2. The pin 4, (Reset), inhibits the integrated circuit's function and placing the output to zero. In the circuit of this practice, the pin 4 is forced to Vdc through R10.

The white push button (Reset), when it is closed, connects pin 4 to negative activating the Reset.

R10, limits the pin input current, prevents the short circuit with Vdc, each time the push button is closed.

In order to do the experimentation of this exercise you have to select a RC configuration that assures a long timing.

Then, you have to momentarily press start. In normal conditions, the output will only return to zero when the timing is finished. Nevertheless, before the end of the timing, if you briefly press Reset, the output will change to zero, stopping the timing and leaving to the integrated circuit awaiting a new shot.

In order to verify the inhibition action, before to start a new shooting action, you have to close the Reset push button, and check that even if you do different shot, the circuit will not respond until Reset is released.