A

MINI PROJECT REPORT ON:

DESIGN & SIMULATION OF METAL DETECTOR USING IC 555

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This is to certify that Mr. Benade Shubham Mahadev, Mr. More Atharv Pravin , Mr. Patil Aniket Bhimrao & Mr. Patil Atharv Rajendra students of TY E&TC engineering has successfully completed the Mini Project Report on "Design & Simulation Of Metal Detector Using IC 555" in partial fulfillment of the award of degree, Bachelor of E & TC Engineering as laid down by Shivaji University, Kolhapur during academic year 2022-23

Date:

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We extend our deepest thanks to all the teaching and non-teaching staff of the Department of E&TC Engineering of TKIET for their assistance and cooperation.

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Table *of Contents:*

Title:

Design & Simulation of Metal Detector using IC 555.

1. Introduction:

In our daily life. we have got used to witness many detectors that detect metallic devices like guns, bombs, etc. To prevent any unlawful entry of guns and bombs in public places, a security system is developed by designing various electronics projects by using a proximity sensor. So, a metal detector is used to sense any existing metal which is nearby.

A Metal detector is an electronic device which is used in many places like theatres, shopping malls, hotels, etc., lo detect any metallic objects like knives, gums or any other explosives kept hidden within the baggage of person carrying them with bad intentions; such metal detectors are especially useful to detect the presence of hidden items within objects.

A metal detector is an electronics device that includes an oscillator which produces AC current that passes through a coil producing an alternating magnetic field. If a part of the metal is near to the coil, eddy current will be induced in the metal and this produces a magnetic field of its own. Il another coil is used do measure the magnetic field, the change in the magnetics field, the change in the magnetic field due to the metallic object can be detected

The first industrial metal detector was developed in the year 1960 and was used for mineral prospecting and other industrial applications. A metal detector is an electronic device that includes an oscillator which produces AC that passes through a coil producing an alternating magnetic field. If a part of the metal is near to the coil, eddy current will be induced in the metal and this produces a magnetic field of its own. If another coil is used to measure the magnetic field, the change in the magnetic field, the change in the magnetic field due to the metallic object can be detected.

The metal detectors are used to detect the weapons like guns, knives in the airports, and also used in the construction industry to detect steel reinforcing bars in wires, concrete, pipes buried in floors and walls.

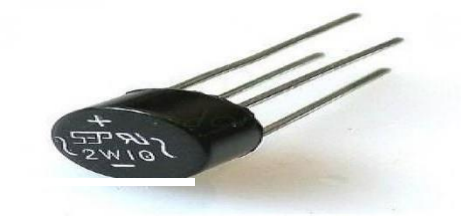
2. Specification and Requirement:

SR.NO	COMPONENT	VALUE	QUANTITY
1.	Transformer	12v,1A	1
2.	Bridge Rectifier	15V,1.5A	1
3.	Voltage Regulator (IC 7812)	12v	1
4.	IC 555	15v,200mA	1
5.	Capacitors	2.2 uf,10uf	2,1
6.	Resistor	47k	1
7.	Buzzer	8 ohms	1
8.	Inductor (coil)	10mH (150 turns)	1

1. TRANSFORMER

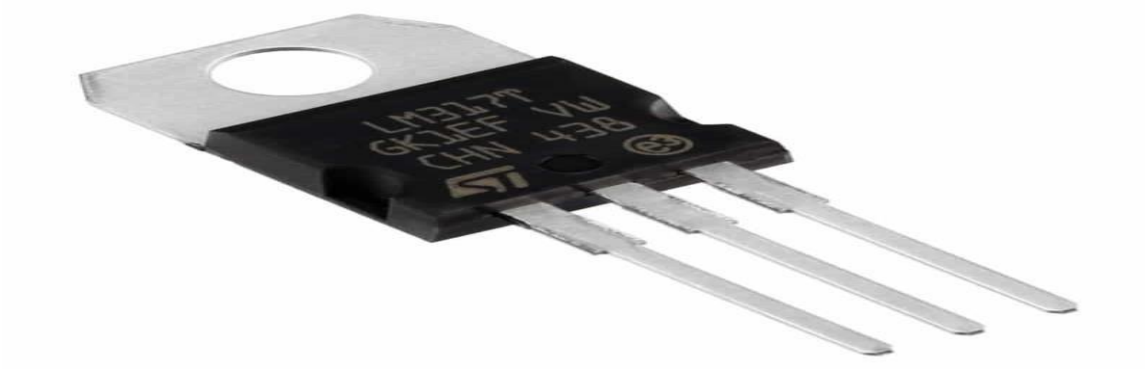
• Input Voltage: 230V AC.
• Output Voltage: 12V.
• Output Current: 1A.
• Mounting: Vertical mount type.
• Winding: Copper.
• Features of 12V & 1A Step Down Transformer: -
I Soft Iron Core.
II 1A Current Drain.
III) 100% Copper Winding.
• Applications of 12V & 1A Step Down Transformer : -
I) DIY projects Requiring In-Application High current drain.
On chassis AC/DC converter.

2.RECTIFIER:



•O/p DC current is 1.5A
• The maximum peak reverse voltage is 800V
• Output Voltage: (V2xVRMS) - 2 Volt
• The maximum input voltage is 560V
• Voltage drop for each bridge is IV @, 1A
• The surge current is 50A

3.VOLTAGE REGULATOR IC:

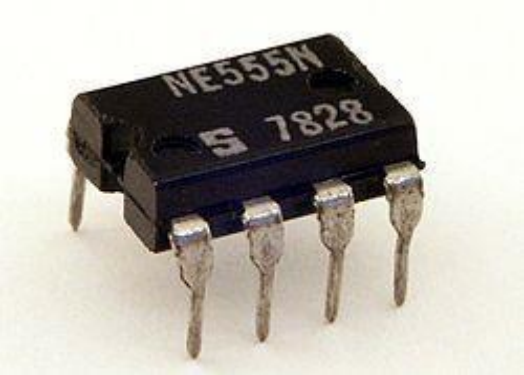


The LM7812 series of three terminal positive regulators are available in the TO-220 package and with several fixed output voltages, making them useful in a wide range of applications. Each type employs internal current limiting, thermal shut down and safe operating area protection, making it essentially indestructible. If adequate heat sinking is provided, they can deliver over 1A output current. Although designed primarily as fixed voltage regulators, these devices can be used with external components to obtain adjustable voltages and currents.

Features: -

- Output Current up to 1A
- Output Voltages of 5, 6, 8, 9, 12, 15, 18, 24
- Thermal Overload Protection
- Short Circuit Protection
- Output Transistor Safe Operating Area Protection

4. IC555:



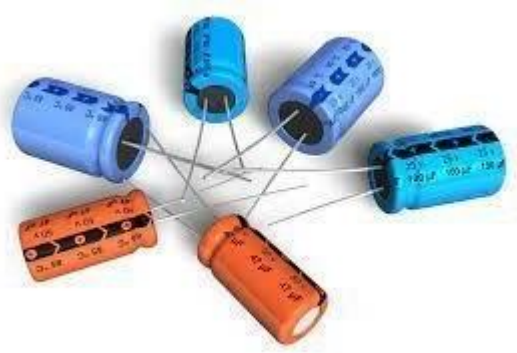
The NE555 IC devices are precision timing circuits capable of producing accurate time delays or oscillation. In the time delay or monostable mode of operation, the timed interval is controlled by a single external resistor and capacitor network. In a stable mode of operation, the frequency and duty cycle can be controlled independently with two external resistors and a single external capacitor. The threshold and trigger levels normally are two-thirds and one-third, respectively, of VCC. 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 trigger level and the threshold input is above the threshold level, the flip-flop is reset and the output is low. The reset (RESET) input can override all other inputs and can be used to initiate a new timing cycle. When RESET goes low, the flip-flop is reset, and the output goes low. When the output is low, a low impedance path is provided between discharge (DISCH) and ground. The output circuit is capable of sinking or sourcing current up to 200 mA. Operation is specified for supplies of 5V to 15V. With a 5-V supply, output levels are compatible with TTL inputs.

Features: -

- Timing from microseconds to hours
- A stable or monostable operation
- Adjustable duty cycle
- TTL compatible output can source or sink up to 200 mA
- “Green” Molding Compound (No Br, Sb)
- Lead Free Finish/ RoHS Compliant

Symbol	Parameter	Rating	Unit
VCC	Supply voltage	18	V
VI	Input voltage	VCC	V
IO	Output current	±225	mA
Θja	Package thermal resistance Junction-to-Ambient	130	°C/W
θJC	Package thermal resistance Junction-to-Case	15	°C/W
TJ	Junction temperature	150	°C
TSTG	Storage temperature	-65 to 150	°C

5. Capacitor :-



An electrolytic capacitor is a polarized capacitor whose anode or positive plate is made of a metal that forms an insulating oxide layer through anodization. This oxide layer acts as the dielectric of the capacitor.

6. Resistor :-

A **resistor** is a passive two-terminal electrical component that implements electrical resistance as a circuit element.

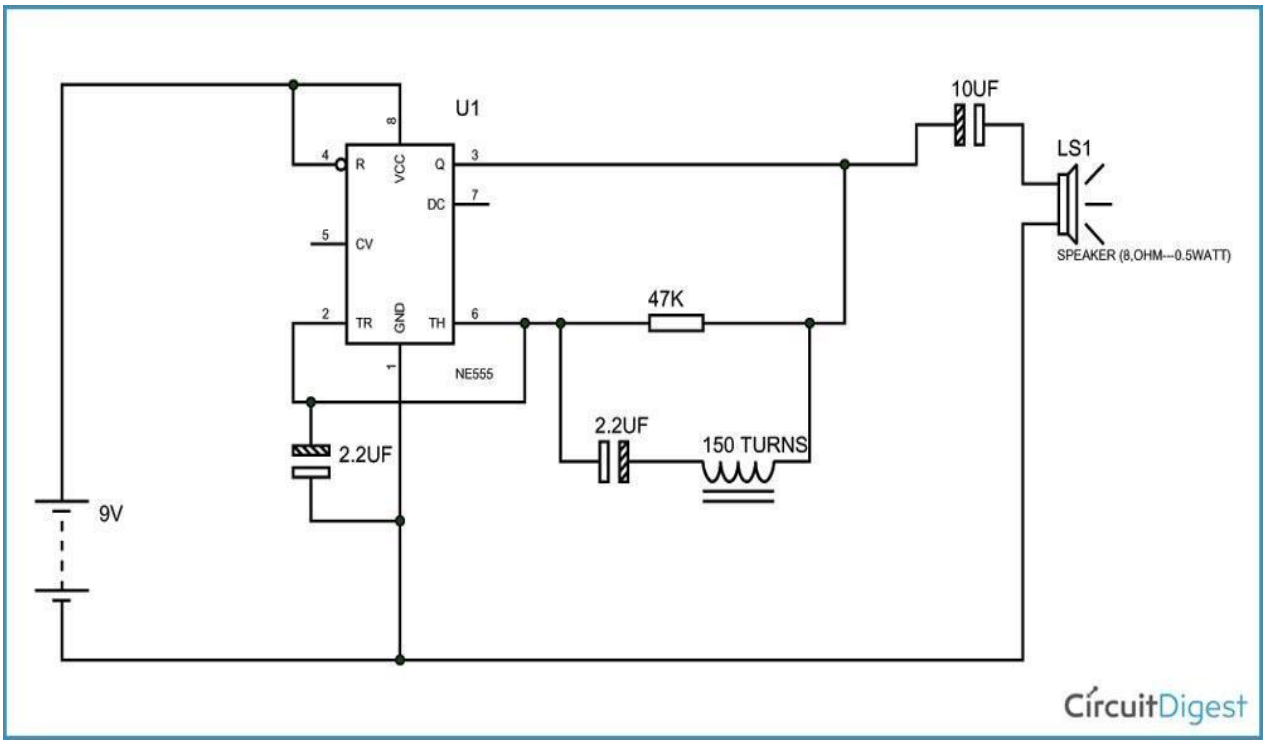
7. Buzzer :-

The purpose of Buzzer is to produce audio output that can be heard by the listeners. Buzzer are the transducers that used to convert the electromagnetic waves into sound waves.

8. Inductor (Coil) :-

The air core inductor's basic construction is, it consists of coils with a number of wire turns that are wounded on ordinary cardboard. So, ceramics or plastic former may be utilized as an insulating material. In this inductor, the gap in a paper or plastic former works like a core. So this gap has nothing but it has air inside of the former, so known as the air core inductor. Therefore, air works as a core.

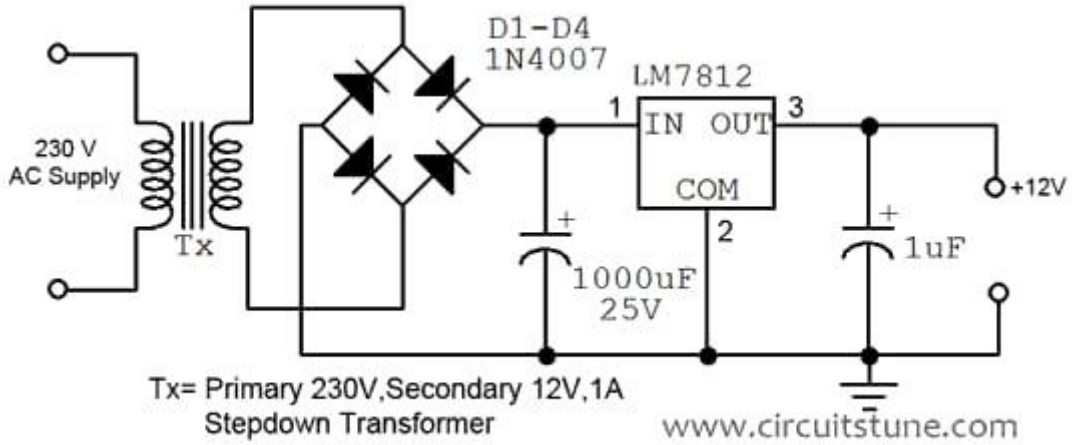
3. System Design:



COMPONENTS LIST:

1. IC = NE 555
2. 47KΩ resistor
3. 2.2µF capacitor (2 pieces)
4. Speaker (8Ω)
5. 150Turns of 10cm diameter coil (any gauge would work).
6. Power supply.
    1. Transformer
    2. Bridge rectifier
    3. Voltage regulator (7812)

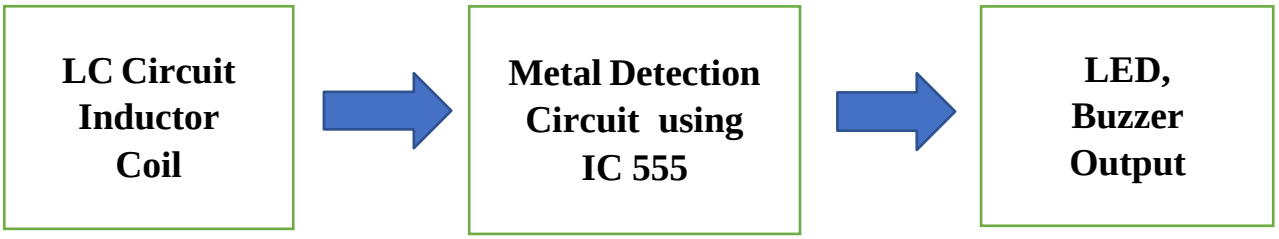
4. Power Supply Design :



Here this circuit diagram is for +12V regulated (fixed voltage) DC power supply. This power supply circuit diagram is ideal for an average current requirement of 1Amp. This circuit is based on IC LM7812. It is a 3-terminal (+ve) voltage regulator IC. It has short circuit protection , thermal overload protection. LM7812 IC is from LM78XX series. The LM78XX series IC is positive voltage regulator IC for different voltage requirements, for example LM7805 IC is made for 5 volt fixed output voltage . There is LM79XX IC series for negative voltage

A transformer (Tx =Primary 230 Volt, Secondary 12 Volt , 1Amp step down transformer) is used to covert 230V to 12V from mains. Here used a bridge rectifier made by four 1N4007 or 1N4003 diode to convert AC to DC . The filtering capacitor 1000uF,25V is used to reduce the ripple and get a smooth DC voltage. This circuit is very easy to build. For good performance input voltage should be greater than 12Volt in pin-1 of IC LM7812. Use a heat sink to IC LM7812 for safeguarding it from overheating.

5. Working:



Block Diagram

The figure shows the circuit diagram of metal detector. The 555 IC timer here acts as a square wave generator and it generate pulses with frequencies audible to human. The capacitor between pin2 and pin1 should not be changed as it is need to generate audible frequencies.

In the circuit there is an RLC circuit formed by 47K resistor, 2.2µF capacitor, and 150turn inductor. This RLC circuit is the metal detection part. Now as mentioned earlier in previous section, a metal core inductor has a high inductance value over a air cored one.

Remember the coil wound here is a air cored one, so when a metal piece is brought near the coil, the metal piece acts as a core for the air cored inductor. By this metal acting as a core, the inductance of the coil changes or increases considerably. With this sudden increase in inductance of coil the overall reactance or impedance of the RLC circuit changes by a considerable amount when compared without the metal piece.

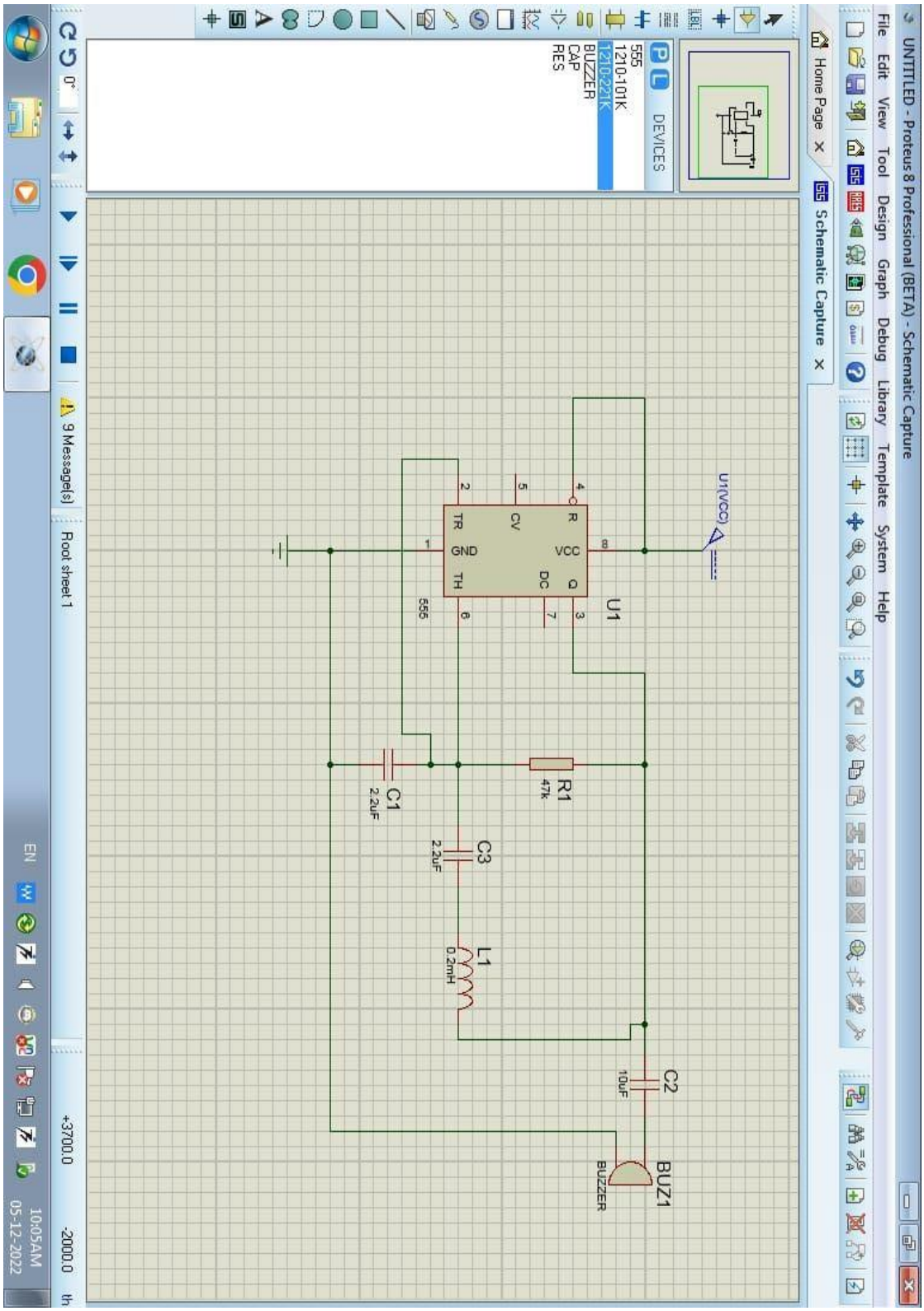
At first when there is no metal piece the signal fed to speaker causes some audible sound. Now with the reactance change around the RLC circuit the signal sent to speaker will no longer be the same as before, because of this the sound produced by the speaker will be of different to the first one.

So whenever a metal is brought near the coil, the impedance of RLC changes making the signal to change resulting in variation to sound generated in speaker.

Common Tips: -

- Enamel should be removed at the tips of coil for soldering connections.
- With different gauge we will have different RLC impedance, so one should experiment with resistance in RLC circuit for sensitive metal detection.
- The speaker can be of any type. But with resistance less than 8Ω, the timer might get heated.
- Use supply voltage higher than 5V.

6. Testing & Simulation:



7. Applications & Conclusion :

Applications:

Airport and Building Security Metal detectors are used for airport and building security to determine whether guns, knives, or other weapons are being transported onto aircraftor into public buildings.

- Construction Industry

Metal detectors are also used in the construction industry to locate steel reinforcementbars embedded in concrete, and to pinpoint metal pipes and wires in floors and walls. This is useful in avoiding unnecessary damage when replacing plumbing or wiring in a building or house.

- Civil Engineering

In Civil Engineering, metal detector are used to locate rebar (strengthen steel used as rod in concrete) .Rebar detectors are less sophisticated. Detectors can only locate metallic objects below the surface.

- Land Mine Detection

Land mine detector can sense as little as 0.5 grams of metal. So, now-a-days militariesare using land mine detector to identify the land mine. Military has used metal detectorto pinpoint buried land mines since world war1.

Conclusion:

- This project has been developed considering the need for low cost.
- The equipment is compact, simple in design and can be used practicallyanywhere needs.

After designing, simulating, assembling and testing the circuit, we came to the conclusion that our circuit of the metal detector is working satisfactorily and has negligible amount of unexpected functioning.

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