GOVT. MODEL ENGINEERING COLLEGE THRIKKAKARA

DEPARTMENT OF ELECTRONICS AND COMMUNICATION

PROJECT REPORT

ON

CRYSTAL TESTER

PRESENTED BY

EC4B

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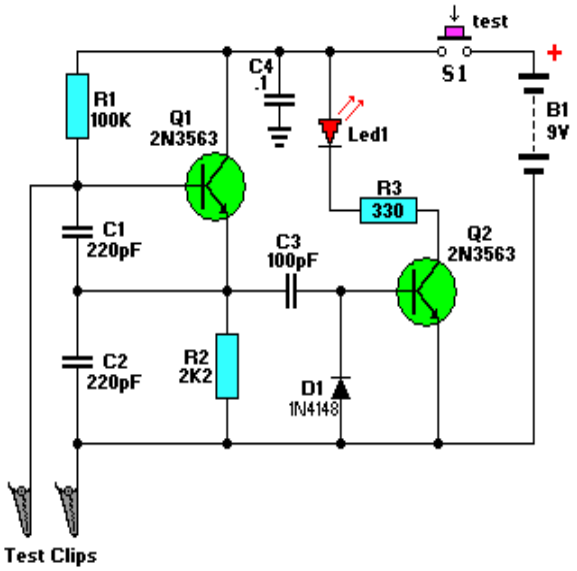
Introduction

Quartz crystals are widely used in electronic circuits for precise frequency generation, especially in oscillators, microcontrollers, and communication systems. A faulty crystal can lead to incorrect timing, circuit malfunctions, or complete failure of the system.



To ensure reliability, it is essential to test crystals before use. This project focuses on designing and developing a crystal tester using discrete components such as a transistor, resistors, and capacitors to verify the functionality of quartz crystals. The circuit works by forming an oscillator, where a working crystal will generate oscillations, which can be detected using an LED indicator or an oscilloscope.

Key Components:

1. Transistors: It used as an oscillator amplifier, ensuring that oscillations are sustained if the crystal is functional. It also acts as a signal amplifier and LED driver, enhancing the oscillation signal and switching the LED indicator.
2. Quartz Crystal (X1): The main component being tested; it vibrates at its natural resonant frequency when placed in an oscillating circuit. If the crystal is faulty, no oscillations occur, and the circuit will not function as expected.

Components Used

The components used in the project are given below:

Transistors

- Q1 (BC547BP) – Acts as an oscillator amplifier, ensuring that oscillations are sustained when the crystal is working.
- Q2 (BC547BP) – Functions as a signal amplifier and LED driver, boosting the oscillation signal to drive the LED indicator.

Diodes

D2 (1N4148) and D3 (1N4148) – Help in rectifying and shaping the oscillation signal while also protecting the transistors from unwanted voltage spikes.

Resistors

- R1 (100KΩ) – Provides biasing to Q1, keeping it in an active state for oscillations to start.
- R2 (1KΩ) and R4 (1KΩ) – Help in stabilizing the signal and controlling transistor current.

- R3 (470Ω) – Limits the current to the LED to prevent damage due to excessive voltage.

Quartz Crystal

This is the main component being tested. When placed in the circuit, it vibrates at its natural resonant frequency. If the crystal is functional, oscillations occur; otherwise, the circuit remains inactive.

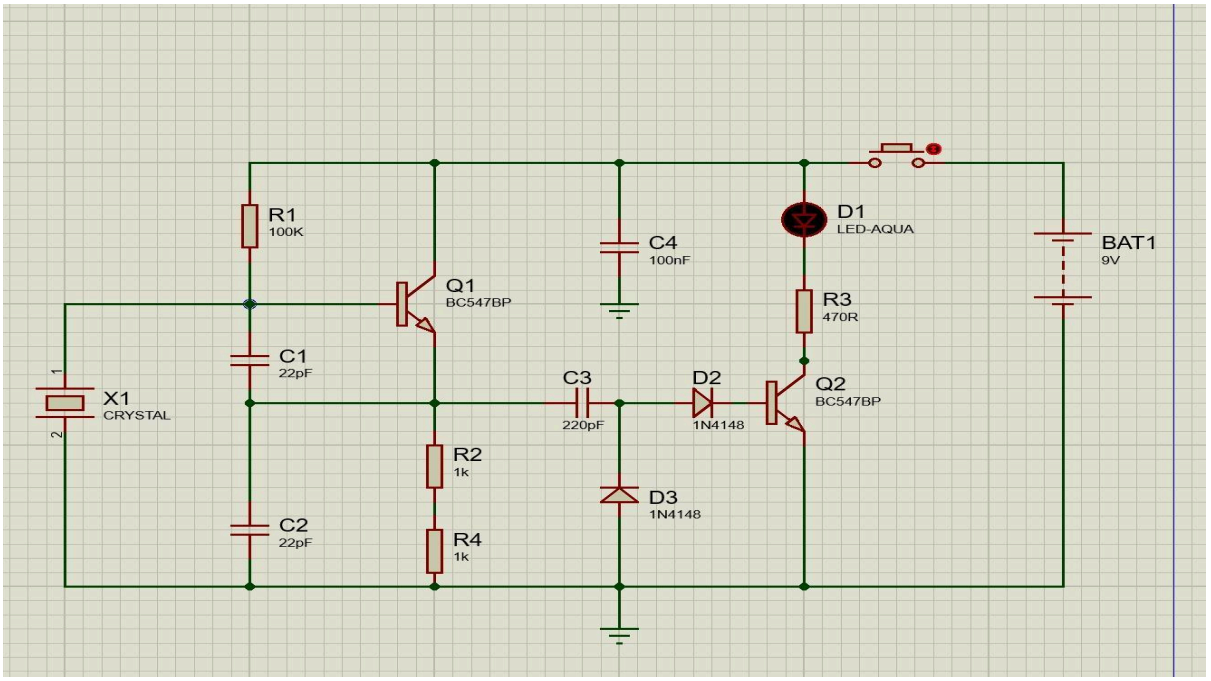
Capacitors

- C1 (22pF) and C2 (22pF) – Work as load capacitors, ensuring that the crystal oscillates at its correct frequency.
- C3 (220pF) – Helps in coupling and processing the oscillation signal.
- C4 (100nF) – Acts as a filter capacitor, reducing noise and improving circuit stability.

LED

- Provides a visual indication of crystal oscillation. If the LED glows, the crystal is working, if the LED remains off, the crystal is faulty.

Working



Working of the Circuit

(a) When power is given to circuit

1. When the switch is turned ON, the 9V battery (BAT1) supplies power to the circuit.

2. The transistors (Q1 and Q2) receive biasing voltages through the resistors (R1, R2, R3, and R4).

(b) Crystal Oscillation Begins

1. The quartz crystal (X1) is connected in a feedback loop with Q1 (BC547BP).
2. The capacitors (C1, C2 - 22pF each) help in tuning the crystal and stabilizing oscillations.
3. If the crystal is working, it starts vibrating at its natural resonant frequency, generating an AC signal.

(c) Signal Amplification by Q1

- The weak oscillating signal from the crystal is amplified by Q1 (acting as an oscillator amplifier).
- The output is passed through C3 (220pF capacitor) to remove unwanted noise.

(d) Signal Rectification and Processing

- The diodes (D2 and D3 - 1N4148) rectify and shape the oscillation signal.
- The signal is further stabilized by resistors R2 (1KΩ) and R4 (1KΩ).

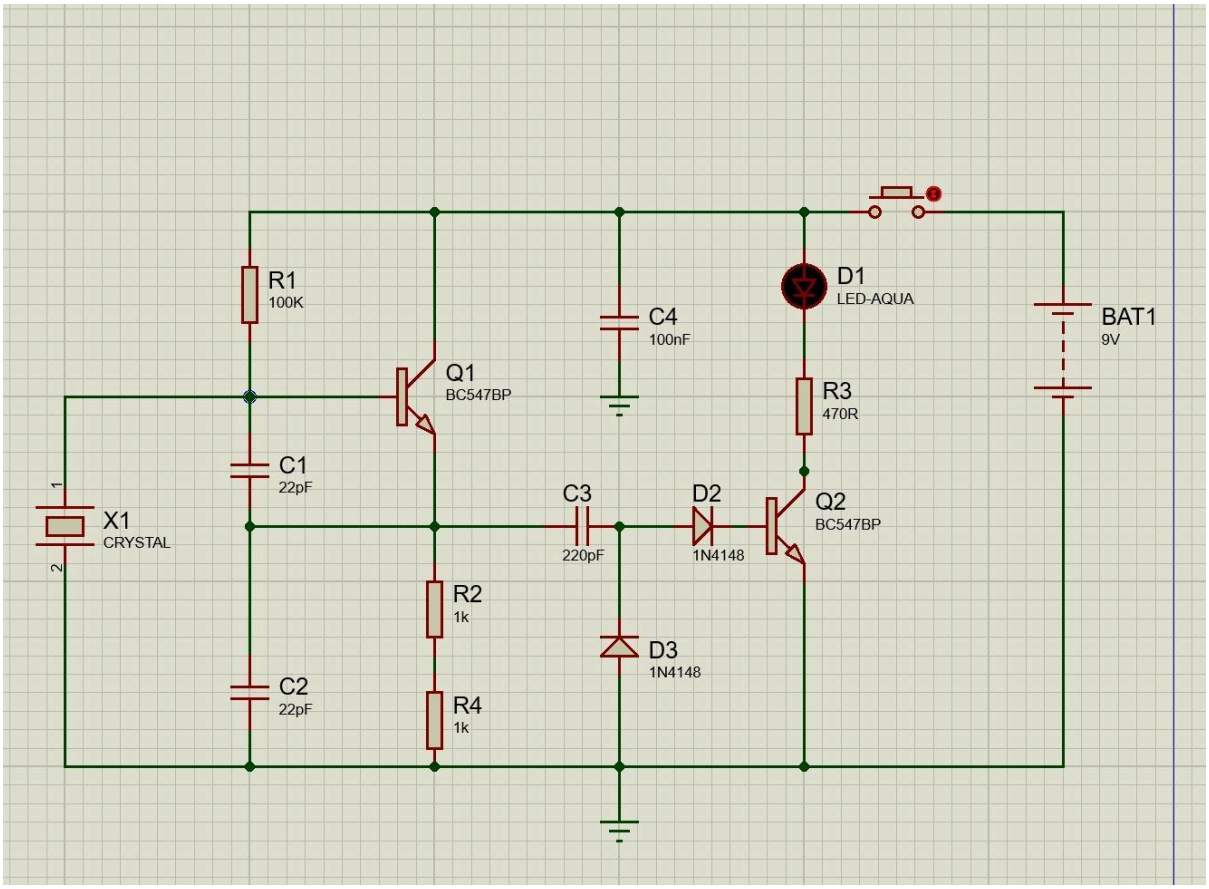
(e) Second Amplification Stage (Q2 - BC547BP)

- The processed signal is fed to Q2, which acts as a switching transistor.
- If oscillations are present, Q2 turns ON and conducts.

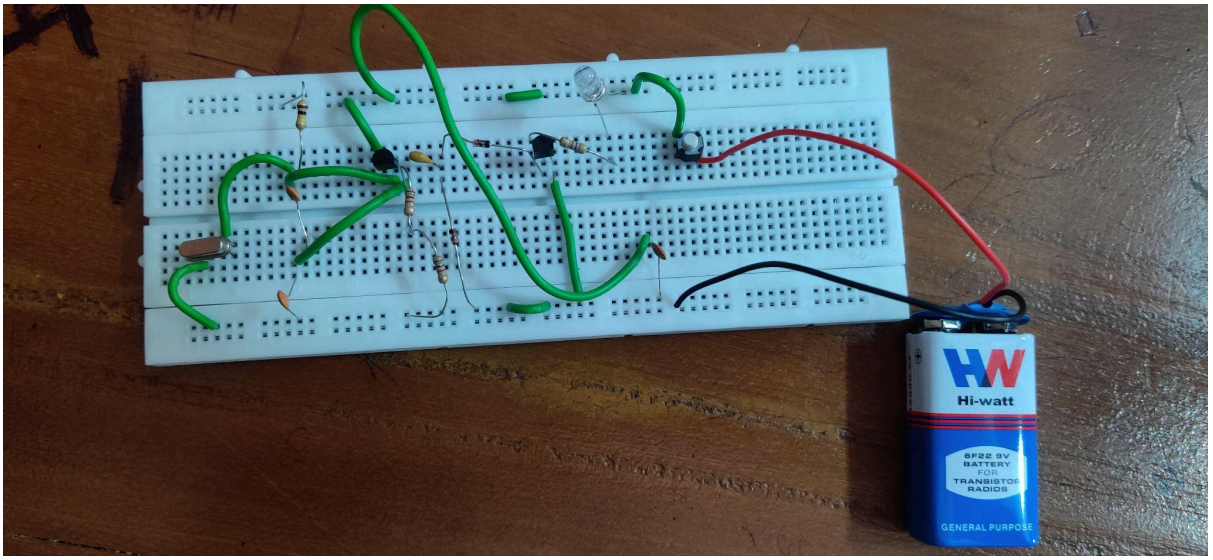
(f) LED Indication

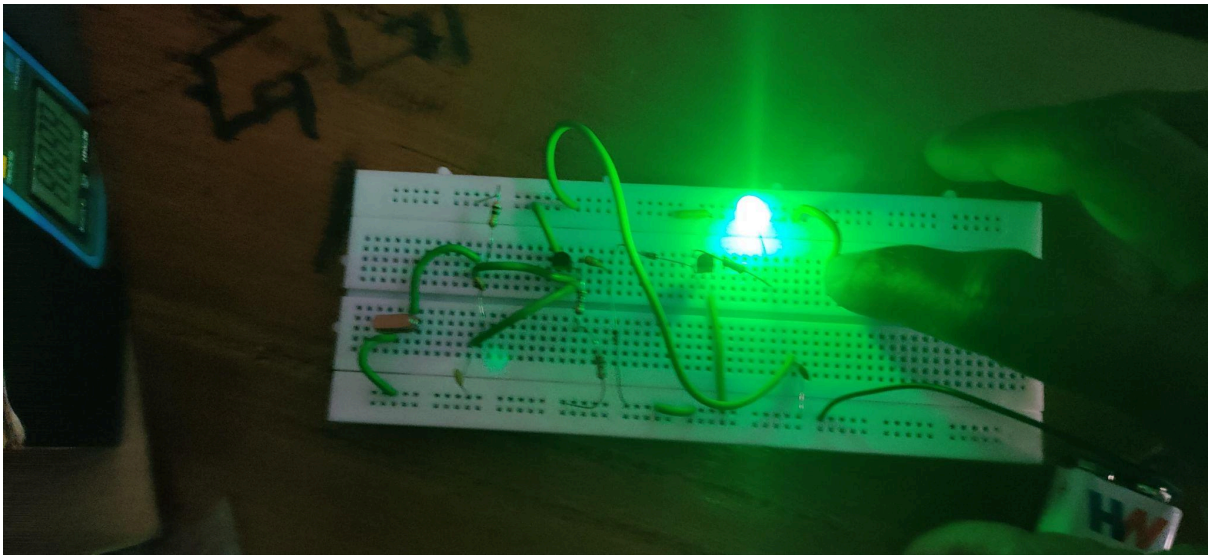
- When Q2 turns ON, current flows through R3 (470Ω) and the LED (D1 - LED-AQUA).
- The LED glows, indicating that the crystal is working.
- If the crystal is faulty (not oscillating), Q2 stays OFF, and the LED remains OFF.

Simulation Diagram



Hardware Circuit





Applications of Crystal Tester

Testing Quartz Crystals:

- Quickly verifies whether a crystal oscillator is functional before use.

Microcontroller and Clock Circuit Troubleshooting

- Helps diagnose faulty crystals in microcontroller boards, digital clocks, and timing circuits.

Radio and Communication Systems

- Ensures crystals used in RF transmitters, receivers, and walkie-talkies are working properly.

Electronics Repair and Servicing

- Useful for repair technicians to check and replace faulty crystals in consumer electronics.

Component Quality Control

- Used in electronics manufacturing to test the quality of crystals before installation..

Conclusion

The crystal tester is a simple yet effective tool for verifying the functionality of quartz crystals. By forming an oscillator circuit with a transistor, resistors, and capacitors, the tester allows users to quickly determine whether a crystal is operational. A working crystal generates oscillations, which can be detected using an LED or an oscilloscope.

It provides a reliable method to test crystals before installation, preventing circuit malfunctions caused by faulty components. Overall, this tester enhances efficiency and accuracy in electronics repair, development, and troubleshooting.
