NATIONAL UNIVERSITY OF SCIENCES AND TECHNOLOGY

School of Electrical Engineering and Computer Sciences

ELECTRONIC CIRCUIT & DESIGN (EE-215)
FINAL PROJECT REPORT

PROJECT TITLE: **Function Generator**

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SEMESTER: *Spring-2023*

CLASS + SECTION: *BEE-13A*

SUBMISSION DATE: *21st May 2023*

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ABSTRACT

The frequency generator circuit project involves the design, construction, and testing of a versatile frequency generator device using commonly available electronic components. The project aims to create a circuit capable of generating various waveforms, including sine, triangle and square waves, with adjustable frequency ranges. The circuit assembly involves the use of components such as Op-Amps, diodes, transistors, resistors, capacitors, and potentiometers. The report provides a detailed description of the materials, methods, and results of the project, including schematic diagrams, flowcharts, simulation results, and photographs of the actual hardware. The report concludes with a summary of the project's findings, highlighting the successful completion of the frequency generator circuit and its potential applications in various fields. The references section provides sources of information and inspiration used throughout the project. The project serves as a valuable learning experience in circuit design, component selection and practical electronics skills, contributing to a deeper understanding of signal generation and waveform manipulation.

INTRODUCTION

The frequency generator circuit is a fascinating project that aims to create a versatile and customizable device capable of generating various frequencies for testing, experimentation, and educational purposes. This project offers the opportunity to delve into the world of electronics, circuit design, and signal generation while providing hands-on experience in assembling and testing electronic circuits.

Frequency generators are essential tools in fields such as electronics, telecommunications, and audio engineering. They allow engineers, hobbyists, and researchers to generate specific frequencies and waveforms for a wide range of applications, including signal testing, calibration, circuit analysis, and audio signal synthesis. While commercial frequency generators are available, building a frequency generator provides the flexibility to customize the circuit according to specific requirements and learn about the underlying principles and components involved in signal generation.

The objective of this project is to design and construct a frequency generator circuit using readily available electronic components such as operational amplifiers (Op-Amps), diodes, transistors, resistors, capacitors, and potentiometers. The circuit will generate various waveforms, including sine, triangle and square waves, with adjustable frequency ranges. Additionally, the project will explore the integration of calibration techniques to ensure accurate frequency output.

MATERIALS & METHODS

The following materials were used in the construction of the frequency generator circuit:

Active Components:

Component	Function	Ratings
LM741 Op-Amps	Oscillator and amplification	Supply voltage: ±15V
2N2222 Transistor	NPN transistor for amplification	Collector current: 600mA
PN2907 Transistor	PNP transistor for amplification	Collector current: 600mA

Passive Components:

Component	Function	Ratings	Value/Range
1N4732 Zener Diode	Voltage regulation	Zener voltage: 4.7V	-
IN4007 Diode	Rectification	Maximum forward current: 1A	-
Resistors	Control and voltage/current limiting	Power rating: 0.25W	1k , 100k Ohm
Potentiometers	Frequency control	Power rating: 0.25W	10k , 100k Ohm
Capacitors	Filtering and timing	-	100nF, 10uF

Steps Involved:

The circuit was designed and implemented by following these steps:

1. **Schematic design:** The schematic diagram provides a visual representation of the circuit connections and component placement. Therefore, schematic diagram was created to illustrate the circuit connections and component placement.

2. **Component selection**: During the component selection process, suitable components were chosen based on the required specifications and availability. The specifications include parameters such as voltage ratings, current ratings, capacitance values, resistance values, and power ratings. Careful consideration was given to select components that meet the circuit requirements and are accessible for purchase.

3. **Circuit assembly**: The circuit assembly involved physically connecting the chosen components as per the schematic diagram. The connections of the components were made onto a breadboard. Special attention was paid to ensure proper polarity and correct placement of the components.

4. **Testing and troubleshooting**: After the circuit assembly, testing and verification were performed to ensure the functionality of the frequency generator circuit. This involved applying power to the circuit and checking for proper operation. Various test points were probed using measurement tools such as a multimeter or an oscilloscope to verify the expected signals and voltages at different stages of the circuit. Any issues or unexpected behavior encountered during testing were carefully examined and troubleshooting steps were taken to identify and rectify the problem.

WORKING PRINCIPLES

The principle used behind the working of the frequency generator circuit is based on the concept of feedback and oscillation.

- **Feedback Principle**: The LM741 Op-Amps in the circuit are used in a feedback configuration known as an astable multivibrator. In the astable multivibrator configuration, the output signal is continuously fed back to the input through a feedback network. This feedback enables the circuit to sustain oscillations and generate a continuous output signal.

- **Oscillation Principle**: Oscillation is the repetitive variation of a signal between two states. In the frequency generator circuit, the oscillation principle is employed to generate a periodic waveform. By properly selecting the values of resistors and capacitors in the oscillator stage, the circuit is designed to generate a specific frequency of oscillation. This frequency determines the output signal's frequency.

- **Waveform Shaping Principle**: The waveform shaping stage in the circuit modifies the generated square wave signal from the oscillator stage to create different waveforms such as sine or triangle. This shaping is achieved through specific configurations of diodes and resistors that alter the amplitude and shape of the signal.

- **Amplification and Buffering**: The output stage of the circuit amplifies and buffers the shaped waveform to ensure a stable and reliable signal output. Transistors are used for amplification, where the signal is amplified to a level suitable for the desired application. The buffering stage isolates the output from the influence of external factors, such as changes in load impedance, to maintain signal integrity.

Working:

The frequency generator circuit operates in the following manner:

1. **Oscillator Stage:** The oscillator stage generates the basic frequency signal. It utilizes one or more LM741 Op-Amps configured as an astable multivibrator. The resistors and capacitors connected to the Op-Amps determine the frequency of oscillation. By adjusting the values of these components, the desired frequency can be achieved. The output of the oscillator stage is a square wave signal.

2. **Waveform Shaping Stage:** The square wave signal from the oscillator stage is then passed through the waveform shaping stage to modify its shape and create a more desirable waveform. This stage typically consists of diodes and resistors configured in specific configurations, such as a voltage divider or integrator circuit. These configurations shape the square wave into waveforms such as sine or triangle.

3. **Frequency Control:** The frequency of the generated signal can be controlled by adjusting values of resistors and capacitors in the oscillator stage. Potentiometers can be used as variable resistors to fine-tune the frequency output. By adjusting potentiometers, the frequency of the output signal can be increased or decreased within a certain range.

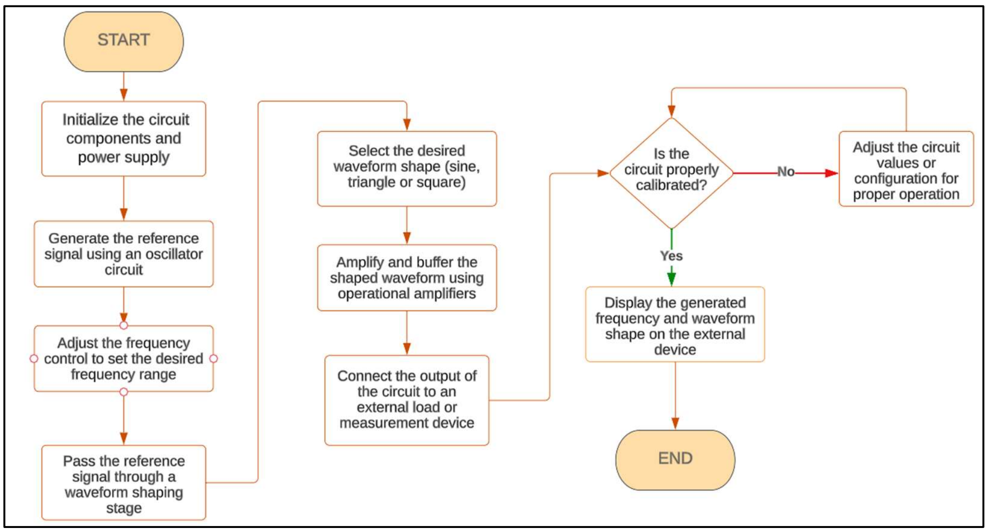
4. **Output Stage:** The shaped waveform is then amplified and buffered by the output stage to provide a stable and reliable signal output. Transistors, such as the 2N2222 NPN and PN2907 PNP transistors, can be used for amplification. The amplified signal is then made available at the output terminals of the circuit.

The circuit is powered using a suitable power supply, and the output is connected to an oscilloscope or other measurement equipment for analysis and utilization.

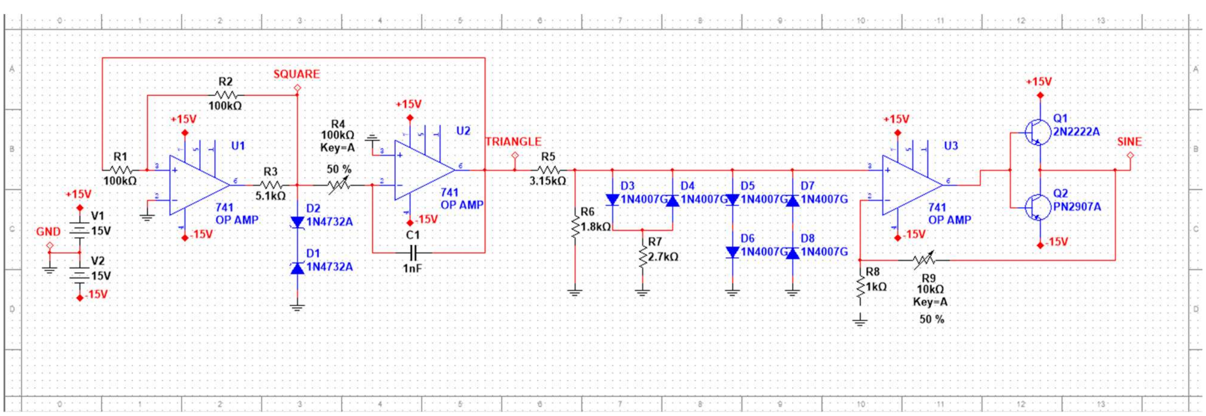
By adjusting the component values and configurations, the frequency generator circuit can produce a wide range of frequencies suitable for various applications such as signal generation, testing, and calibration.

RESULTS

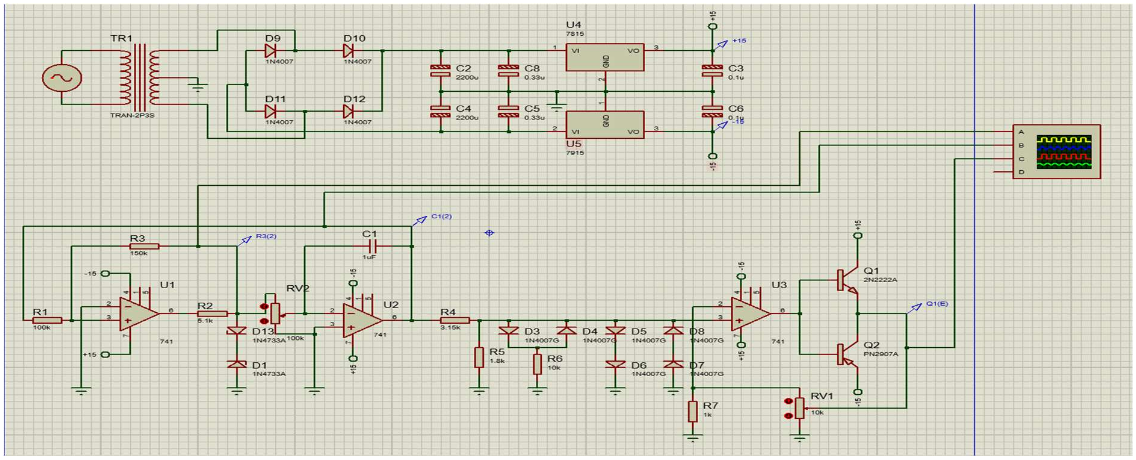
Flowchart:



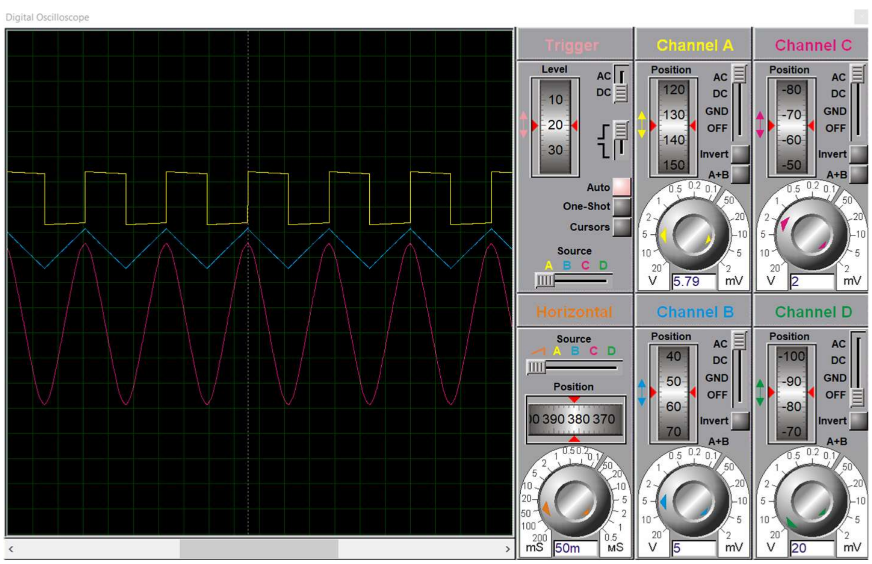
Schematics:



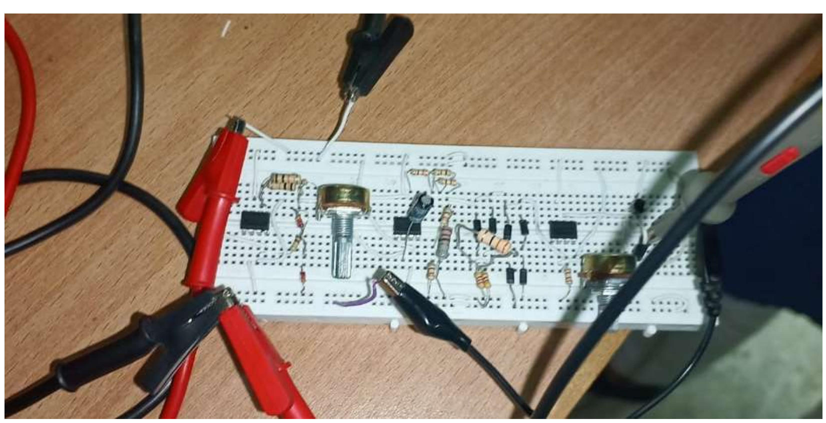
Proteus Simulation:



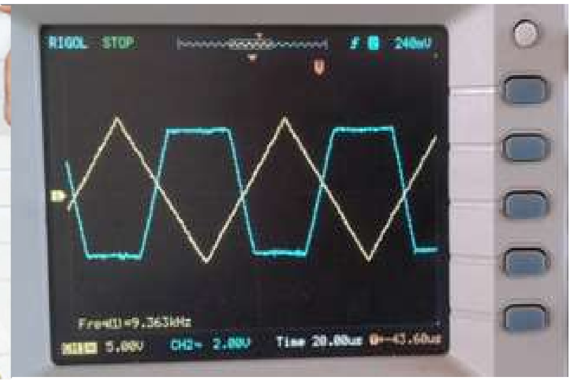
Oscilloscope Output:



Hardware Implementation



Oscilloscope output:



CHALLENGES FACED

During the project, several challenges were encountered and overcome. These challenges included:

- **Component availability**: Obtaining all the required components for the circuit proved to be a challenge, as some components were not readily available or had long lead times. This required thorough research and sourcing from different suppliers to ensure all necessary components were acquired.

- **Circuit troubleshooting:** Assembling and testing the circuit revealed various issues such as incorrect wiring, faulty connections, or component malfunctions. Identifying and rectifying these problems required careful examination of the circuit, extensive debugging, and rechecking of component values and connections.

- **Understanding circuit principles**: The project involved working with complex circuit principles, such as feedback, oscillation, and amplification. Understanding these principles and their practical application in the circuit design required in-depth study and research, as well as consulting reference materials and seeking assistance from experienced individuals.

- **Calibration and accuracy:** Achieving precise and accurate frequency output proved to be a challenge due to component tolerances and external factors. Calibrating the circuit and ensuring the desired frequency range required careful adjustment of component values and fine-tuning of the circuit parameters.

- **Time management**: Managing time effectively to complete the project within the given timeline was a significant challenge. The project involved multiple stages, including research, component selection, circuit assembly, testing, and troubleshooting. Proper planning and organization were crucial to ensure each stage was executed efficiently and on schedule.

FUTURE RECOMMENDATIONS

1. **Advanced Functionality**: Consider expanding the functionality of the DIY frequency generator circuit by incorporating additional features such as frequency modulation, amplitude modulation, or waveform synthesis capabilities. This will enhance the versatility and usefulness of the circuit for a broader range of applications.

2. **User Interface Enhancement**: Explore the possibility of integrating a user-friendly interface, such as an LCD display or a graphical user interface (GUI), to provide easy control and monitoring of the frequency generator parameters. This will improve the user experience and accessibility of the circuit.

3. **Miniaturization and Portability**: Investigate methods to miniaturize and optimize the circuit design for compactness and portability. This could involve using surface mount components, designing a custom PCB, or exploring modular designs that allow for easy integration into other projects or systems.

4. **Frequency Range** Expansion: Evaluate the feasibility of extending the frequency range of the generator. This could involve selecting higher-performance components, implementing frequency multiplication techniques, or exploring alternative circuit topologies to achieve a wider frequency coverage.

5. **Integration with Digital Systems**: Investigate the possibility of integrating the frequency generator circuit with digital systems or microcontrollers. This would allow for automated frequency control, remote operation, or integration into larger electronic projects.

By considering these recommendations, future iterations of the DIY frequency generator circuit project can be further improved in terms of functionality, user experience, portability, and educational value. Continual exploration and innovation will ensure the project's relevance and contribution to the field of frequency generation.

CONCLUSION

In conclusion, the frequency generator circuit provides a practical and cost-effective solution for generating adjustable frequency signals using a few key components. By implementing principles of feedback, oscillation, waveform shaping, and amplification, the circuit is capable of producing a wide range of frequencies with stability and signal quality.

However, it is important to note that the accuracy and precision of the generated frequency may be subject to variations due to component tolerances and external factors. Calibration and validation against reference equipment are recommended to ensure accurate frequency output. The project not only enhanced our knowledge of electronics and circuit design but also developed our skills in circuit assembly, testing, and troubleshooting.

Overall, this project has provided us with hands-on experience in constructing a functional frequency generator circuit and a deeper understanding of the underlying principles. It serves as a stepping stone for further exploration and experimentation in the field of electronics and signal generation.

REFERENCES

1. Texas Instruments. (2012). **LM741 Operational Amplifier**. Retrieved from https://www.ti.com/lit/ds/symlink/lm741.pdf

2. Fairchild Semiconductor. (2001). **1N4732A Zener Diode**. Retrieved from https://www.onsemi.com/pdf/datasheet/1n4732a-d.pdf

3. Vishay Semiconductors. (2016). **1N4001 - 1N4007 General Purpose Rectifiers**. Retrieved from https://www.vishay.com/docs/88503/1n4001.pdf

4. Philips Semiconductors. (1996). BC546/547/548/549/550 **NPN Epitaxial Silicon Transistor**. Retrieved from https://www.nxp.com/docs/en/data-sheet/BC546_BC547_BC548_BC549_BC550.pdf

5. Philips Semiconductors. (1996). BC556/557/558/559/560 **PNP Epitaxial Silicon Transistor**. Retrieved from https://www.nxp.com/docs/en/data-sheet/BC556_BC557_BC558_BC559_BC560.pdf

6. **Resistors**: Vishay Dale. (2021). Retrieved from https://www.vishay.com/resistors/

7. **Capacitors**: KEMET Electronics Corporation. (2021). Retrieved from https://www.kemet.com/en/capacitors/

8. **Potentiometers**: Bourns, Inc. (2021). Retrieved from https://www.bourns.com/products/potentiometers