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Project Design Essay
Function Generator and Oscilloscope – STM32 Nucleo
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Needs Designed to Meet

This project is designed to address a personal and practical need: having access to an affordable yet functional function generator and oscilloscope. As a student, I often find myself needing reliable equipment for circuit design, testing, and debugging, especially during off-track semesters when I am away from campus and no longer have access to university lab resources. Commercially available signal generators and oscilloscopes can be prohibitively expensive for students on a limited budget, so this project aims to provide a cost-effective alternative that offers sufficient performance for most basic electronic development and troubleshooting tasks. Although this tool will not match the precision or features of high-end laboratory instruments, it is intended to be "good enough" for the purposes it serves, namely, enabling experimentation and learning in a personal workspace. The functionality and usability are prioritized over absolute accuracy, making it an ideal solution for students, hobbyists, or anyone needing low-cost electronic diagnostic tools. Ultimately, this project has the potential to benefit a broader audience by lowering the barrier to hands-on electronics work and supporting continued learning outside of traditional lab environments.

Effect on Various Areas

While the primary focus of this project is to create a low-cost function generator and oscilloscope for personal and educational use, it is important to evaluate its potential impact across a variety of societal and global factors.

- **Public Health**: The project is not expected to have a significant impact on public health. However, care must be taken to ensure that the device does not unintentionally emit electromagnetic interference that could affect sensitive medical or other equipment in its vicinity.

- **Public Safety:** Although the device is not intended to operate at high voltages or currents, there is still a minimal risk of electrical shock if not properly insulated or used with caution.

- **Public Welfare:** The device may have a modest positive impact on public welfare by making basic diagnostic tools more accessible to individuals who cannot afford commercial equipment. While its effect on the general public is limited, it can be particularly beneficial for students, hobbyists, and educators.

- **Global, Cultural, and Social Factors:** The project is not expected to have a direct impact on global, cultural, or social factors. Its purpose is primarily educational and technical, with limited scope outside of personal and academic use.

- **Environmental Factors:** This project has a minimal environmental impact. Its small size and relatively simple construction mean it will not require significant materials

or energy consumption. However, the use of environmentally friendly components and proper disposal of electronic waste should still be considered.

- **Economic Factors:** Economically, the project offers a low-cost alternative to expensive lab equipment, making it more accessible to individuals with limited budgets. It has the potential to reduce financial barriers to entry for students and hobbyists pursuing electronics-related interests or education.

Major Course Concepts

This project incorporates several core concepts from major coursework, including Analog-to-Digital Converters, Digital-to-Analog Converter, UART communication, the I2C protocol, and digital external interrupts. The ADC is used to convert incoming analog signals from the oscilloscope into digital data that can be processed and analyzed. In contrast, the DAC is responsible for generating output waveforms for the function generator by converting digital signals into analog form. Two displays are integrated into the design, one is an LCD module connected via the I2C protocol, which shows key parameters like the selected output frequency and peak-to-peak voltage. The second is a computer interface that serves as a display for the oscilloscope, receiving waveform data over UART communication. Additionally, digital external interrupts are used to capture user input from pushbuttons, allowing the user to cycle through and select specific frequency and amplitude settings, which are then reflected on the LCD. These combined technologies enable both functional waveform generation and signal visualization, while also providing an interactive and responsive user interface.