LAB 5-1

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OBJECTIVES

The purpose of this experiment is to build a PV Inverter. The goal is to calculate the Modulation index, Amplitude of the AC output voltage, Frequency of the AC output voltage, Amplitude of the AC Current, and the AC Current equation.

ABSTRACT

Inverters are essential electronic devices used to convert direct current (DC) power into alternating current (AC) power. This conversion is crucial in various applications, as many electrical devices and appliances require AC power to operate, while renewable energy sources, such as solar panels and wind turbines, typically produce DC power. Inverters serve as the bridge between these sources and the electrical grid or the equipment they power. They operate by continuously switching the polarity of voltage to create a waveform that simulates the sinusoidal AC waveform found in the typical American household.

One of the most common uses of inverters is in photovoltaic (PV) solar systems, where they convert the DC power generated by solar panels into usable AC power for homes and businesses. Inverters are also essential in uninterruptible power supplies (UPS), allowing for the seamless switch from grid power to battery backup during power outages. They play a vital role in the automotive industry as well, powering electric vehicles by converting the DC power from the batteries into the AC power needed to drive the motor. Inverters have enabled the integration of renewable energy sources into the electrical grid, reducing reliance on fossil fuels and contributing to a more sustainable and environmentally friendly energy landscape

Pulse Width Modulation (PWM) is a widely used technique in electronics and control systems to efficiently control the output of various devices and systems. PWM works by rapidly switching a signal on and off at a fixed frequency, where the duration of the "on" time (the pulse width) can be adjusted to control the average voltage or power delivered to a load. This method is commonly employed to control the speed of motors, dim the brightness of LED lights, regulate the power delivered to heaters, and more. By varying the duty cycle (the ratio of on-time to the total period), PWM can effectively simulate analog control, making it a versatile and precise method for achieving a wide range of control tasks.

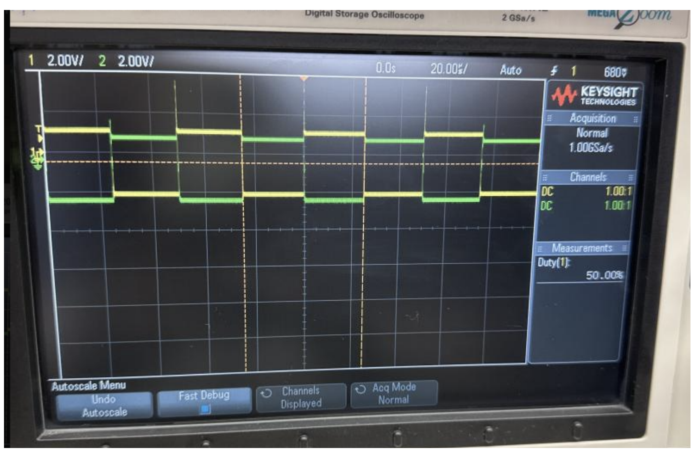
The key advantage of PWM lies in its energy efficiency and the ability to control devices without generating excessive heat. When compared to traditional analog voltage regulation methods that dissipate excess energy as heat, PWM minimizes power losses, making it ideal for battery-operated and energy-efficient applications. Additionally, PWM provides precise control over devices, allowing for fine adjustments and accurate responses to changing conditions. This versatility and efficiency have made PWM a fundamental technique in fields such as robotics, automotive control systems, and even household appliances, where it helps improve performance, reduce energy consumption, and extend the lifespan of components.

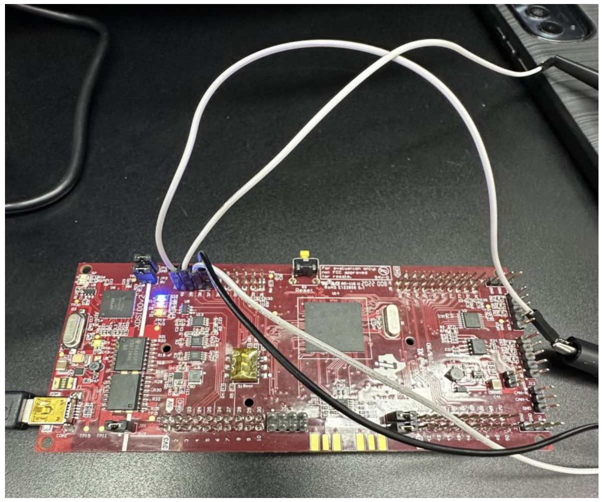
MATERIALS/EQUIPMENT

- UNC Charlotte Educational Inverter Board
- Resistor 10 ohm 75 watt
- C2000 microcontroller
- Software: Simulink, embedded coder, code composer, ControlSuite, C2000 Blocks
- Oscilloscope
- Dc power supply
- Jumper wires
- 2 Oscilloscope probes
- Banana plugs
- Computer w/ USB port

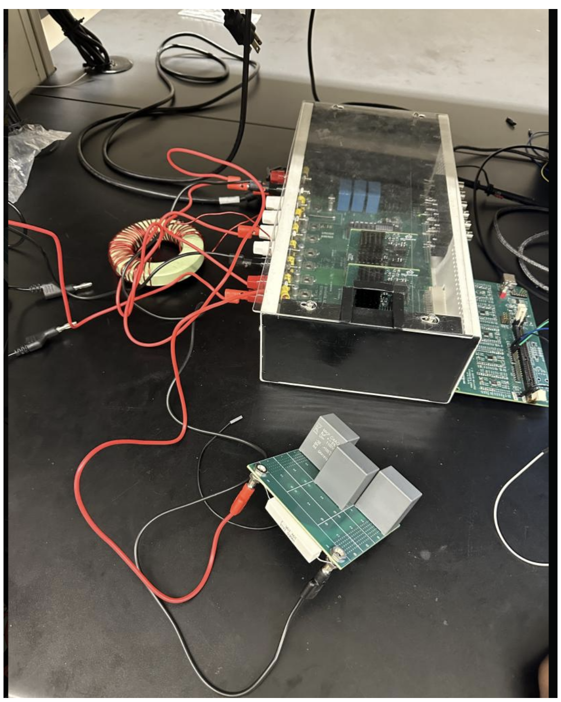
Results:

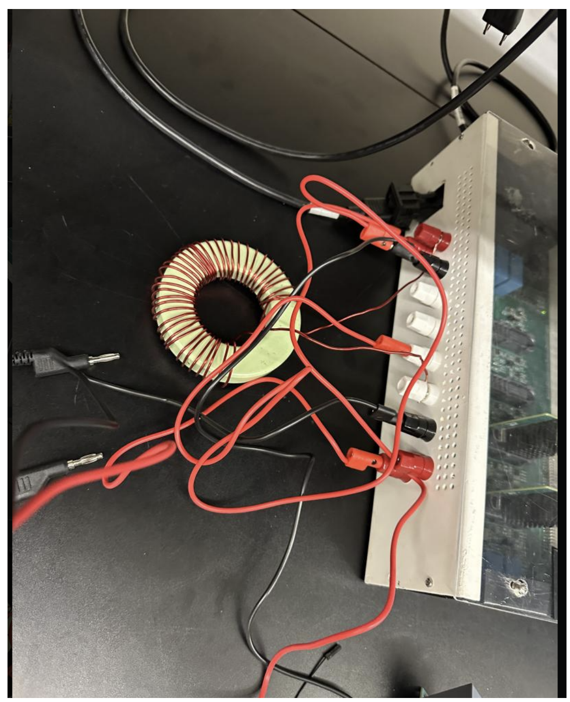
Exercise 0: The objective of this exercise is to verify the capability of the C2000 microcontroller to generate a PWM waveform. This process required numerous pieces of software to communicate perfectly in order to successfully program the microcontroller. It is vital that the proper signal be sent in order to properly control the inverter. The main focus was to ensure that the C2000 microcontroller was capable of fulfilling the requirements for waveform production, thereby demonstrating its suitability for use in relevant applications. Below we can see the output signal on the oscilloscope of the PWM signal.



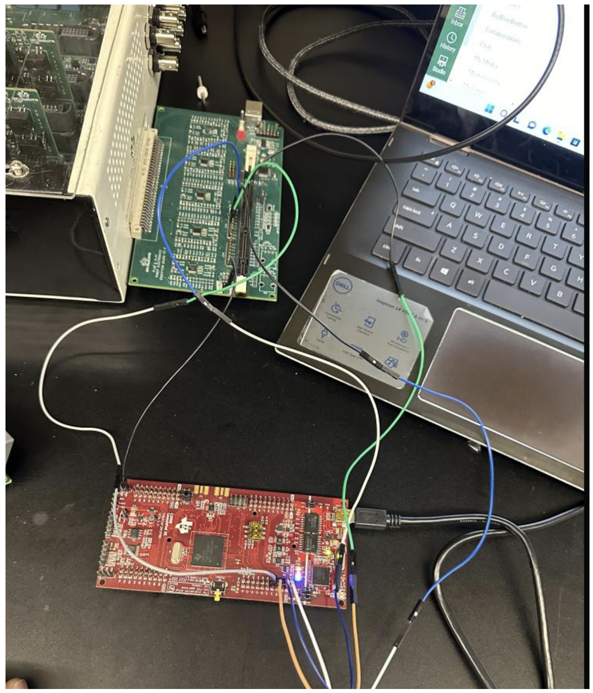


Exercise 1: The objective of this exercise is to configure and prepare the educational revision inverter board for operation. By setting up the inverter board, the aim is to establish the necessary parameters and connections to verify safe operation of the unit. This verification step was to ensure that the inverter board was correctly installed and configured. This exercise further reinforced the comprehensive understanding of the setup and utilization of the educational revision inverter board.



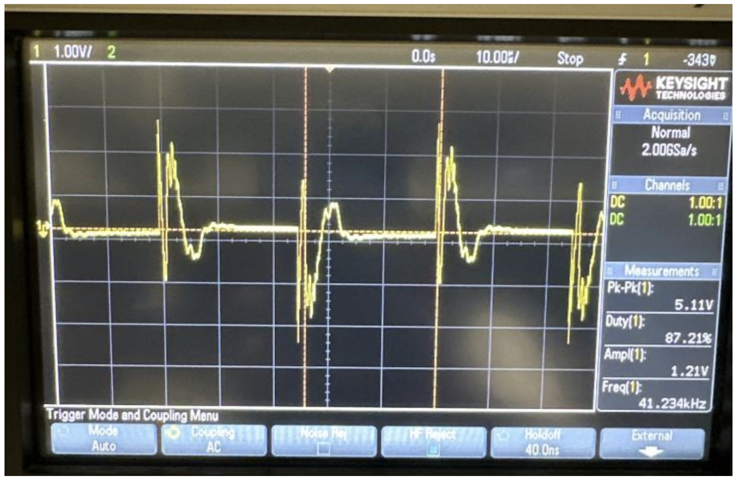


Exercise 2: The objective of this exercise is to establish a connection between the C2000 microcontroller and the education revision board. Linking these components enabled communication and data transfer between the microcontroller and the revision board. This step utilized the open loop control model. The main focus was to facilitate seamless integration between the microcontroller and the revision board..



The objective of this exercise was to manipulate the modulation index, altering the parameters of the sine wave output. By adjusting the modulation index, we examined how variations in this parameter influenced the properties of the produced sine wave. The main focus was to utilize the oscilloscope as a tool for visualizing and analyzing the altered sine wave, thereby gaining insights into the impact of modulation index adjustments on the waveform's behavior. This exercise contributed to a deeper understanding of the relationship between modulation index variations and the resulting sine wave patterns

Exercise 3 modulation at 0:



Exercise 3 modulation at 1:

Exercise 3 Modulation at -1:

Data:

Modulation index	Amplitude of the AC output voltage	Frequency of the AC output voltage	Amplitude of the AC current	AC current equation
0	0	100 khz	0 A	$i = I_0 \sin \omega t$
0.5	~10 v	94.27 KHz	1 A	$i = I_0 \sin \omega t$
0.25	~15 v	41.23 KHz	1.50 A	$i = I_0 \sin \omega t$

CONCLUSION:

In this summary, students successfully performed a series of tasks related to producing and manipulating a waveform that was produced by the C2000 microcontroller that controlled the UNC Charlotte Educational Inverter Board. Initially, the generated waveform was verified before linking the C2000 microcontroller with the inverter board. Subsequently, the necessary configurations were calculated and verified before programming into the microcontroller. Upon establishing the connection between the C2000 microcontroller and the educational inverter board a waveform was produced from the inverter. This waveform was measured and recorded at three different modulations. Notably, the students were able to adjust the modulation index of the PWM signal to produce differing sine wave outputs from the inverter board, enabling them to observe and analyze the corresponding alterations resulting from the changes in modulation. This lab has inspired future engineers to enter the exciting field of solar photovoltaics.