

4. Evaluation

Evaluating the effectiveness of the animal deterrent design relies on testing the major components of the product. The design's main functions are to output visual and audio warnings when the device is triggered by animal movement. Once the device is triggered the microprocessor will store the date and time creating a historical data log. The basic functionality of the project design can be tested traditionally to determine whether the component is meeting operational design constraints. Other aspects of the design will need to be tested and evaluated in actual use to determine effective deterring patterns and make changes if needed.

4.1 Evaluation Testing Resources

Spectrum Analyzer with High Frequency Microphone Input: Used to test the ultrasonic and sonic audio intensity (decibel level) output of the speaker. It is also used to measure intensity and pitch levels at various distances from the device in order to map the area covered by the speaker outputs.

Oscilloscope: Used for analyzing audio outputs from the Pic18 microcontroller and Flash Digital-to-Analog Controller (DAC). It is also used in testing and circuit debugging.

Function Generator: Needed to provide test waveforms for the audio circuit in comparison with the waveform generation from the microcontroller and DAC.

DC Power Supply: Provides multiple direct-current (DC) voltage levels and grounds that are needed for each of the individual components of the circuit design. The DC power supply also allows the user to vary the output. This is important because some components vary in function when supplied with different voltage levels.

Digital Multi-meter: Measures general voltage, current, and resistance in individual components of the circuit design.

Resistance Box: Provides the capability of varying resistance values. The audio output is evaluated with varying loads attached to the amplifier to determine an optimized loading for the RC load attached to the amplifier.

PSPICE: Computer simulations are needed to estimate gain and simulate smaller controlling circuits in the circuit design before they are actually implemented on a prototype board.

4.2 Hardware and Software Specifications

Hardware test specifications clarify the steps that will be taken to determine if each component of the hardware design is working properly. Each of the major components will be discussed individually with the smaller circuit connection details being discussed collectively. The main hardware components are the motion sensor, the rectifier circuit, the audio circuit, the speaker output, and the microcontroller circuit. Other components of the design such as the relay switch, power input, power regulation, and enclosure shielding will also be discussed in detail. Each portion of the design will emphasize the importance of meeting design constraints and in turn determine if each component is functional.

4.2.1 Motion Triggering Input

The motion triggering input includes the viewing parameters of the motion sensor. This includes testing the sensitivity and viewing angles of the sensor. The sensitivity is tested by using different

size objects to trigger the input. The viewing angle will use the different size object entering from different horizontal and vertical viewing angles. The result of these experiments will develop all of the testing criteria for the input of the motion sensor.

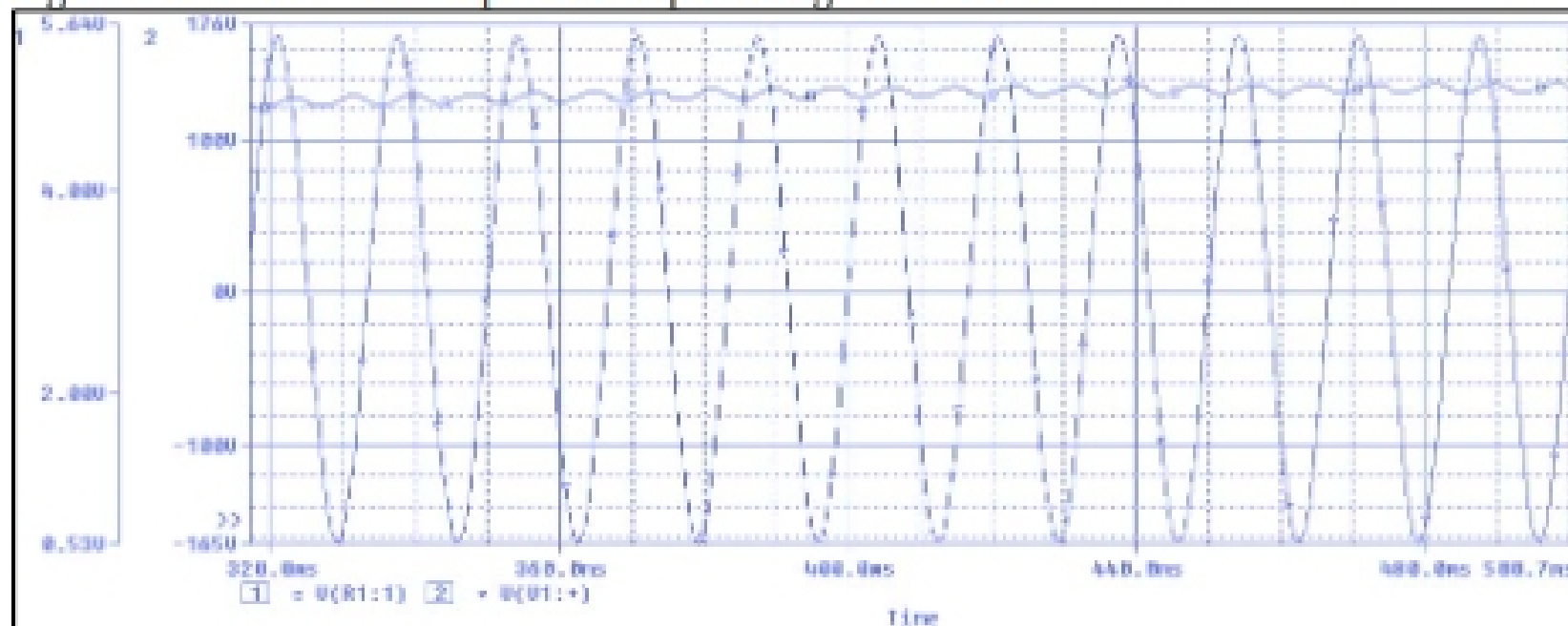
4.2.1.1 Motion Sensor

The motion sensor relies on 120 VAC. When the motion sensor is triggered the control wire outputs 120 VAC for four seconds. This was measured with a multi-meter to determine correct functionality before feeding it to the rectifier circuit.

4.2.1.2 Rectifier Circuit

The rectifier circuit is used to convert the 120 VAC output from the motion sensor control wire into 5 VDC. The rectifier circuit is a full-wave rectifier with the output across the bridge resistor results into the 5 VDC required. The waveform of the rectifier circuit is rippling slightly. This ripple is smoothed out by the use of a capacitor. An oscilloscope is used to determine if the ripple does not go below 3 VDC. The microcontroller uses this input to determine if the motion sensor is activated. If the input to the microcontroller were to go below the 3 VDC, the microcontroller would stop transmitting an output. Therefore, the output from the rectifier circuit must remain above the 3 VDC.

Figure 1: Rectifier Circuit: Input and Output Voltage Versus Time



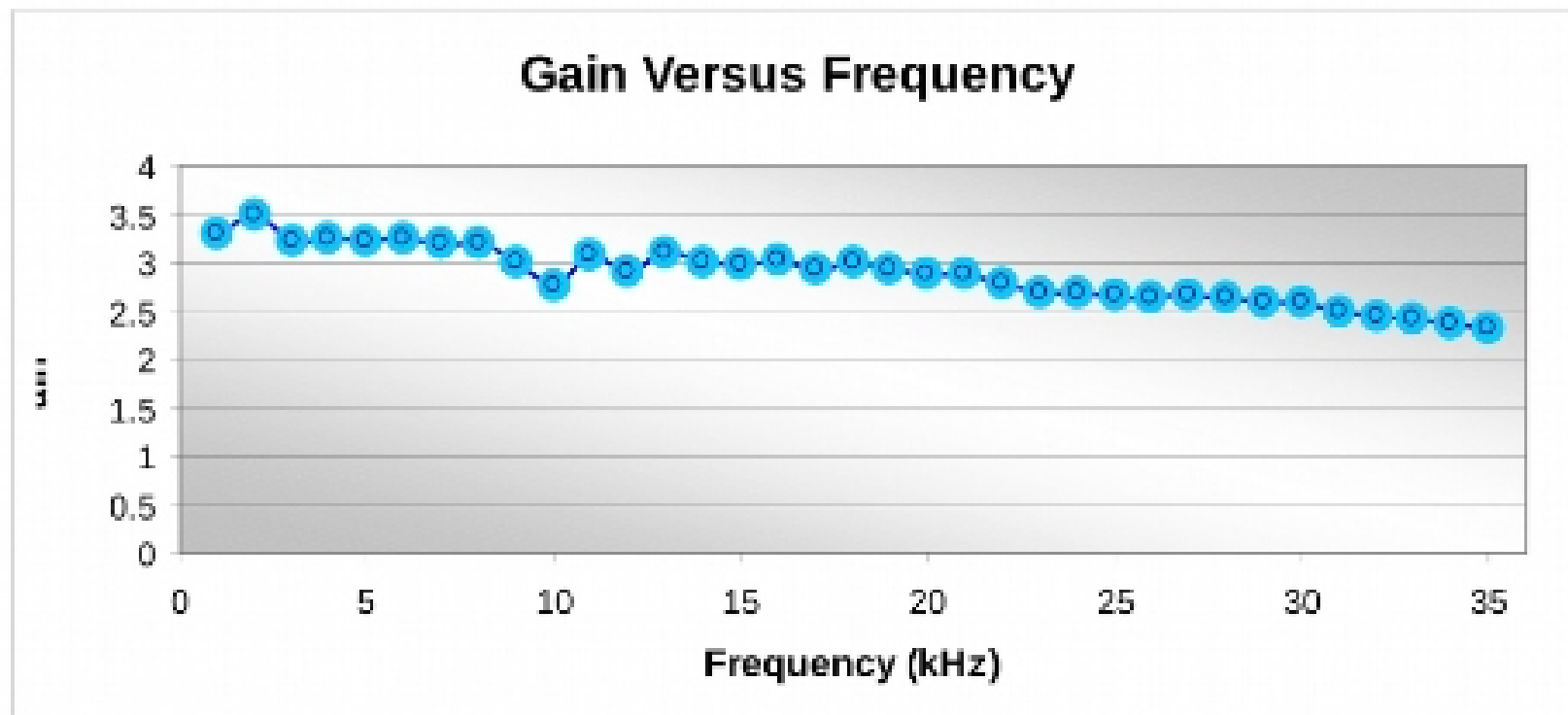
4.2.2 Audible Warning Output

The audio warning output involves testing the output parameters of the design. The operation of the amplifier circuit and the output of the piezo-electric speakers are tested to determine the audible warning output.

4.2.2.1 Amplifier Circuit

The amplifier circuit was tested for its frequency response and gain. The function generator was used as the input to the amplifier circuit. Two channels of the o-scope were used to verify the input signal and measure the amplified output signal. The gain of amplifier was 18 and the frequency response was stable throughout the desired 1k-30kHz operating range.

Figure 2: Audio Amplifier: Gain Versus Frequency



4.2.3 Microcontroller Circuit

The microcontroller circuit includes a PIC18242 microcontroller, Flash DAC, and two serial EEPROM memory modules. This circuit is essentially the “brains” of the entire circuit design and will control the function of the entire device. The Pic18 is the primary device in the circuit, and it must be tested thoroughly to ensure proper communication with the other circuit components.

4.2.3.1 Serial EEPROM Memory

The two EEPROM (electrically erasable programmable read-only memory) modules in the circuit are connected to the Pic18 through an I²C interface. This is a two-wire serial interface that sends encoded packets of information to all devices attached to the I²C interface. Each I²C compatible device in the circuit is hard-wired with three specific logic values. The two EEPROM modules are programmed as 110 and 011 to establish themselves as separate units. The main performance test with these devices is to send, store, and retrieve data to the EEPROMS.

This test will be performed by sending a test data sample to each EEPROM unit separately, each with its own identity information. When the information is retrieved from the EEPROM, it will be displayed on a personal computer (PC) to prove that the data is the same data previously sent to the memory module.

The function of the EEPROM in this design is to store recorded predator noises in its memory. The predator noises are analog signals and they must be converted to a digital signal by the DAC.

Digital-to-Analog Controller

The Flash DAC is a 16-pin controller capable of parallel communication. Eight data lines are needed between the DAC and the Pic18 for the parallel communication link. Parallel communication will allow the device to handle more data in a shorter amount of time than a serial DAC. The DAC will be tested using the Pic18, the amplifier circuit, and one of the serial EEPROM modules. A sound clip will be recorded onto an EEPROM module. This data will then be pulled from the EEPROM by the Pic18 and be sent simultaneously out to the DAC. The digital output of the Pic18 will then be converted to an analog signal by the DAC and sent to the