2. DESIGN REQUIREMENTS

Many challenging design constraints must be set in order to make the Memory Driven Screwdriver Antenna Controller a viable product. The following design requirements define the constraints that the product will need to meet. Technical design constrains are discussed in Section 2.1. Practical design constraints are discussed in Section 2.2. At the end of the semester, the project will be compared against all the listed constraints to show each constraint was achieved.

2.1. Technical Design Constraints

The technical design constraints determine the conditions at which the controller will be required to operate. The ability to store the memory positions accurately is crucial to the successful operation of the final product. The major obstacle the team will have to overcome is making the controller as accurate as possible using the single sensor that is built into the antenna. The constraints chosen for this project are listed in Table 2.1-1.

Name	Description
Tuning Accuracy	The controller must return the antenna to a programmed location within +/- 0.5 inches.
Voltage Regulation	The supply voltage for the controller circuitry must be regulated to five volts, within +/- 5%.
RF Exposure	The controller must operate properly when exposed to 100 watts of RF.
Memory	The memory must be non-volatile and hold ten antenna locations.
Relay Specifications	The relay must pass five amps of current for an entire cycle of the antenna.

Table 2.1-1. Technical Design Constraints

2.1.1. Tuning Accuracy

The controller will turn the motor inside a screwdriver antenna. This will change the resonant frequency of the antenna. A magnetic sensor located inside the antenna allows the controller to track the number of rotations the antenna makes when it is being turned. Since DC motors have momentum after they are switched off, the antenna drifts beyond the desired stopping point. With only one sensor, it is difficult to determine where the antenna has actually stopped. If this drift is not taken into account, the controller becomes inaccurate. The positions that are stored in memory as well as the indicated position will be invalid. Software will be written to compensate for the drift of the motor and insure an accurate count at all times.

2.1.2. Voltage Regulation

The controller circuit requires five volts DC to power the microcontroller, memory, and display. This voltage must remain constant for the controller to operate properly. Damage will occur if the circuit supply voltage is not maintained. Since the controller will be used in automobiles where the electrical system is based on 13.8 volts DC, a regulator will be used to maintain the five volts DC needed for the circuit. Variations in the supply voltage occur commonly as the load on the vehicle's electrical system changes. The regulator will be able to maintain the five volts needed with an input ranging from 8-16 volts. This range will take into account any surges from the vehicle and keep the five volt output to within a 5% margin of error.

2.1.3. Radio Frequency Exposure

The controller will be exposed to electromagnetic radiation in the form of RF. Electronic components and traces on the circuit board may be sensitive to strong RF fields causing them to operate incorrectly or causing damage. The controller must operate in the presence of RF. A radio connected directly to the antenna typically outputs one hundred watts of RF which will be radiated by the antenna. The controller must operate in a vehicle while exposed to the RF from the antenna which is mounted on the vehicle.

2.1.4. Memory

A memory chip will be used to store antenna positions. These positions will be programmed by the user. The memory will also store the position of the antenna each time the antenna is moved. The last active antenna position will be reloaded into the PIC when power is restored to the controller. The memory chip will communicate with the PIC microcontroller using I2C communication protocol.

2.1.5. Relay Specifications

The relay supplies power to the motor when a position is recalled with the press of a memory button. The relay also provides power when the user manually adjusts the antenna by pressing the up/down switch. The relay must pass five amps of current to the motor for rotation. This continuous flow of five amps must be sustained by the relay for a complete cycle to fully extend or contract the antenna.

2.2. Practical Design Constraints

The practical design constraints address manufacturability and economic issues. These constraints will determine the overall success of the product. The practical constraints include cost, production, packaging, life expectancy, and welfare. Each of these constraints will improve the quality and usability of the final product. The practical constraints for this project are listed in Table 2.2-1.

Type	Name	Description
Economic	Cost	The antenna controller parts and assembly will be produced for less than $100.
Manufacturability	Production	The controller will utilize surface mounting techniques for most components to increase production efficiency.
Durability	Packaging	The controller will be assembled in an enclosure with dimensions 3 ¾" (H) x 3 ½" (W) x 1 ¾" (D).
Sustainability	Life Expectancy	The relays chosen for the design have a life expectancy of 150,000 cycles [1].
Social	Welfare	The controller will be useful to amateurs and beneficial to the public during emergencies.

Table 2.2-1. Practical Design Constraints

2.2.1. Cost

The cost of materials and parts must be considered on all design projects. These costs determine whether the project is feasible for an individual or company to pursue. If the cost of production and parts becomes too high, the profit made on a product quickly deteriorates. Also, higher costs for the manufacturer ultimately result in higher prices for the consumer. The enclosure, circuit board, and microcontroller contribute the majority of the production costs. The overall manufacturing costs for the controller will not exceed $100. The components are commonly used off-the-shelf electronics that can be purchased through any major distributor. The design team will try to use parts readily available at MFJ Enterprises Inc. to minimize the cost of the antenna controller.

2.2.2. Production

The antenna controller must be designed for production in large quantities. Most electronic components will be placed onto the circuit board by machine using surface mount technology. Only large components will need to be mounted by hand. Surface mounting the components reduces the amount of time and labor required for production.

2.2.3. Packaging

The primary installation of the screwdriver antenna is on automobiles. The antenna controller must be designed to operate and withstand the harsh, demanding environment often found with vehicles. The controller will be enclosed in a metal container for protection. The enclosure allows amateur operators to easily mount the unit inside a vehicle. The design of the display and controls will make operation simple for the operator.

2.2.4. Life Expectancy

The life expectancy of the antenna controller is limited by the number of cycles of the relays. The maximum amount of current the relay coil will encounter is five amps. At this current level the relays are expected to function 150,000 cycles without failure.

2.2.5. Welfare

In times of natural disaster and emergencies amateur radio has proved to be very useful [2]. The antenna controller will give amateurs the ability to tune their screwdriver antennas quickly and easily. These stations may be used in vehicles, which allow stations to be setup in any location. It will also be safe to use while the operator is driving.

References

[1] "Songle Relay SRSB Datasheet", *http://www.songle.com/pdf/SRSB.pdf*, January 23, 2005.

[2] "Section I: The Amateur Radio Emergency Service (ARES)", *http://www.arrl.org/FandES/field/pscm/sec1-ch1.html*, January 23, 2005.