

4. EVALUATION

4.1 Test Specification

To insure that the controller will operate correctly, several tests must be performed on the individual components. The following procedures use a combination of hardware tests and software simulations to insure the required functionality. Even after passing the required tests, all the components must be brought together and tested as a complete unit. Figure 4.1 shows a block diagram of the antenna controller.

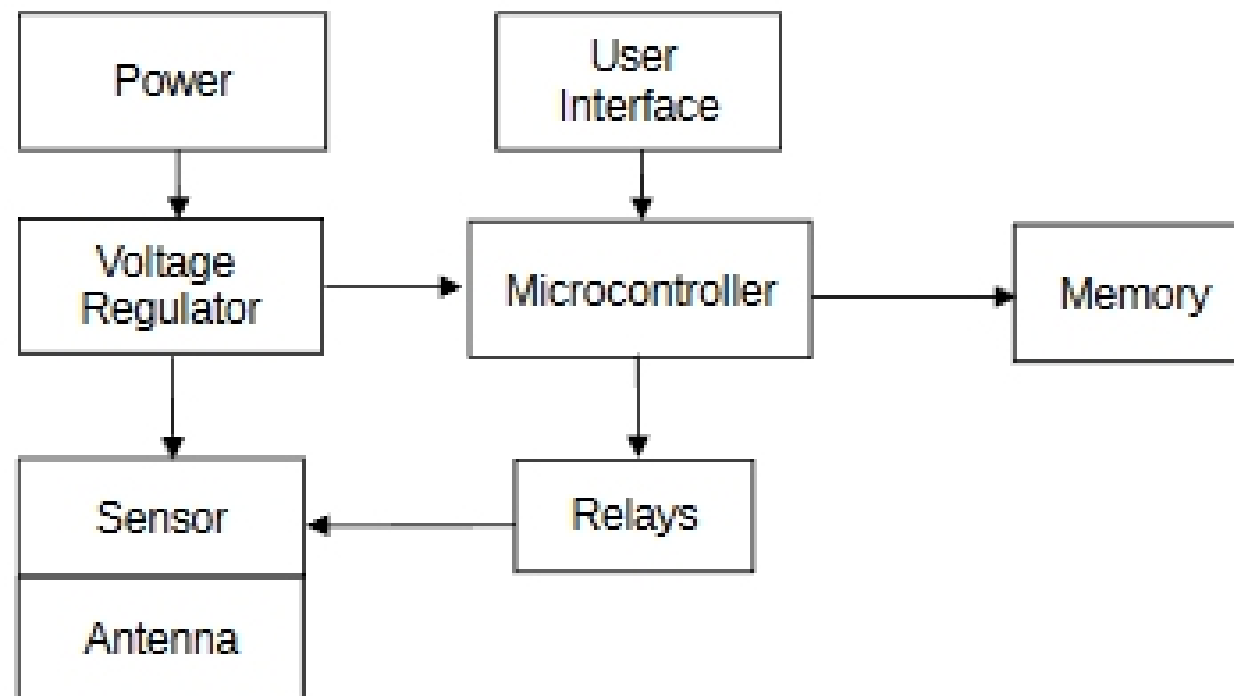


Figure 4.1 System Overview of the Antenna Controller

In order to insure the antenna controller follows the set design constraints, certain pieces of equipment and software are needed. The following equipment and software are needed to verify the controller works within the specified constraints.

1. Digital multi-meter
2. Variable power supply
3. Screwdriver antenna
4. EZNEC software
5. Antenna Analyzer
6. Thermometer
7. Heat gun

4.2 Test Specification – Simulation

A simulation of the antenna will show the characteristics of the antenna when it is properly tuned. The antenna will be simulated using the EZNEC software package at three frequencies in the amateur radio spectrum. The frequencies chosen are the most commonly used in the HF spectrum. The results will show the radiation angle of the antenna and the 2:1 operating bandwidth. Since the controller will recall a position within two inductor turns, the simulation will show that the upper and lower bounds of the saved position will be within the range so that the lowest SWR is achieved.

4.3 Test Specification – Hardware

Hardware testing will be performed on the on the controller based upon the design constraints. Testing will include verifying the voltage regulation, temperature, relay, and the LED display. Each of these components from the controller will be tested to insure they meet the specified design constraints.

4.3.1 Voltage Regulation

The microprocessor and other parts of the controller require a constant 5 volts to operate. The voltage regulation circuit will be required to maintain this voltage level regardless of the vehicle supply voltage, which will constantly change. Since the supply voltage from the vehicle can vary from 8 volts to as high as 16 volts, the voltage for the controller's power circuitry must be 5 volts and accurate to within 5%.

Procedure:

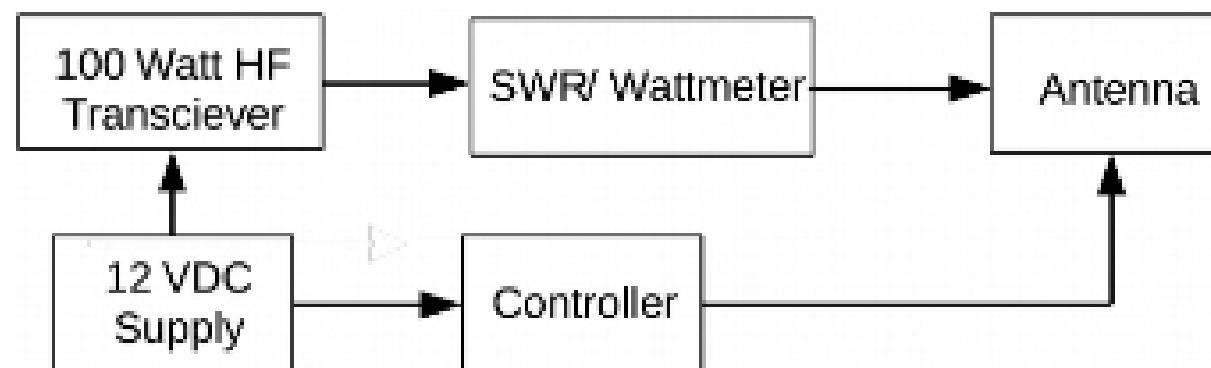
1. Connect variable power supply to voltage regulator
2. Connect multi-meter to the output of voltage regulator
3. Turn on power supply and adjust to 8 volts output.
4. Measure output of regulator and insure it is between 4.75 – 5.25 volts.
5. Increase voltage in 0.5 steps and measure the output of the regulator.
6. With each increase, make sure the regulator output is between 4.75 – 5.25 volts.

4.3.2 Radio Frequency Exposure

The components of the controller must operate properly when RF is radiated by the screwdriver antenna. The tests will be conducted by transmitting 100 watts of RF near the controller. The proximity of the antenna and the controller will closely resemble a typical installation of a screwdriver antenna on a vehicle.

Procedure:

1. Setup the screwdriver antenna.
2. Connect controller circuit to a power supply.
3. Connect the antenna sensor and motor to the controller.
4. Connect a 100 watt HF transceiver and SWR meter to the antenna using RG58 coax.



5. Tune the antenna for resonance on each frequency listed below and save the antenna position using manual control. Verify the SWR using an SWR analyzer.

28.100MHz
 24.900MHz
 21.100MHz
 18.100MHz
 14.050MHz
 10.110MHz
 7.100MHz
 3.500MHz

6. Recall a position
7. Verify the SWR
8. Transmit continuously for 30 seconds.
9. Verify correct operation of the controller
 - a. recall the next antenna position
 - b. verify the antenna frequency and SWR
10. Repeat steps 6-9 for each memory position.

4.3.3 Relay

The relay is required to pass five amps of current for one complete cycle of the antenna. One cycle is defined as completely extending the antenna to lowest resonant frequency and retracting the antenna to the highest resonant frequency. One complete cycle is approximately three minutes. The relay must also be activated from a five volt source providing a maximum of 25mA.

Procedure:

1. Place multi-meter in current mode.
2. Connect variable power supply to control input of relay.
3. Connect 12 volt power supply to relay input.
4. Connect a five amp load to relay output.
5. Turn on 12 volt power supply
6. Check to make sure the 5 amp load is off.
7. Turn on variable power supply and adjust to 5 volts.
8. Insure that the relay clicks, and the 5 amp load is on.
9. Check that the current to the relay control input is less than 25mA.
10. Monitor relay for three minutes and insure the load is fully operational

4.3.4 Display

Each of the seven segment LED displays will be tested for proper data output. The testing will be carried out by a program. This program will display numbers 0 through 9 with a one second delay between each number. This test will be incorporated into the controller software.

Procedure:

1. Connect the display circuit to the PIC.
2. Load PIC with the test software.
3. Power up the test circuit.
4. Visually verify the output of each display as they cycle from 0 through 9.

4.4 Test Specification – Software

Software testing will be done on the controller in conjunction with the antenna to insure that it operates accurately. The functional areas of the software testing will focus on antenna movement accuracy, read and write capabilities of memory, and reset functionality. By ensuring the correct operation of software implementation for these specific areas, the antenna controller will meet desired software design constraints.

4.4.1 Antenna Movement

Movement of the antenna will be accomplished with the microcontroller. When the manual up and down switches are depressed, the controller will activate the appropriate relay moving the antenna in the correct direction. When recalling a position, the controller will determine the direction to move the antenna based on the current position.