Radio Telescope User Interface Reference Guide

Introduction

The User interface for the radio telescope primarily operates with the following three Pages:

- Main Page - Initial settings for the radio telescope are set here. In addition to this the user can start or stop the radio telescope from here.

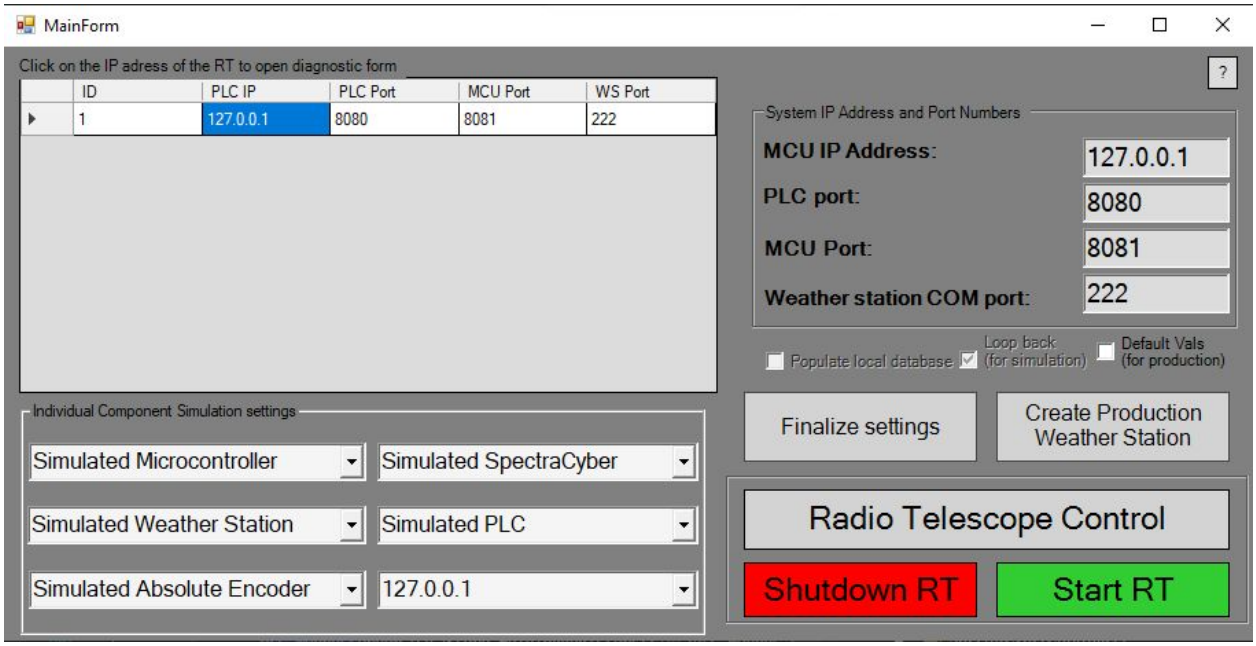
- Radio Telescope Control Page - This page is the main method of control for the user to control the movement of the radio telescope in any capacity. This page allows the user to directly enter desired coordinates of their observation, direct manual control of the telescope, and control scripts the user may need to run.

- Diagnostics Page-The diagnostics Page consists of the following three tabs:
    A- Appointment Control Tab
    B- Sensor Data Tab
    C-Sensor Override Tab

When the control room software is run the main page is the first one to be displayed for the user. The main page allows the operator to set the conditions for the telescope they want to view (mostly just simulated vs. real sensor data). When the start telescope button is pressed the IP address of the Radio telescope you want to control should appear in the gray box at the top left corner of the Page. From here you can reach the diagnostics Page by double clicking the desired IP address. In order to reach the Page to control the radio telescope you click on the radio telescope control button. When testing the telescope it is often necessary to run the control room software as a simulation, in order to do this, the checkbox for loop back (for simulation) should be checked before the start telescope button is pressed

Main Page

Main Page Overview



Features

Radio Telescope Data Grid Display Box- Located in the top left corner. Once the radio telescope has been started the IP and PLC IP addresses will appear here as well as the Port numbers set by the user which the PLC, MCU, and Weather Station are operating on. Double clicking on one of these will open up the diagnostics page for that telescope.

Simulation Settings Group Box- Located in the bottom left corner.This group box contains several spinboxes that allow the user to choose which sensors they would like to simulate and which they would like to run the real version. After the finalize settings button has been pressed this group box will be deactivated temporarily(until the radio telescope has been started). The initialization options in this group box include :

- Microcontroller combo box:
    - Production Microcontroller-real microcontroller is used
    - Simulated Microcontroller-simulates the Microcontroller object

- Weather Station combo box:
    - Production
    - Simulated Weather Station-simulates the weatherstation object
    - Test Weather Station-partial simulation
- Absolute Encoder combo box:
    - Production Absolute Encoder
    - Simulated Absolute Encoder-Simulates the Absolute Encoder object
    - Test Absolute Encoder-partial simulation
- Spectra Cyber combo box:
    - Production Spectra Cyber-used to connect to real life telescope Microcontroller
    - Simulated Spectra Cyber -simulates the Spectra Cyber object
- PLC group box:
    - Production PLC-used to connect to real life telescope PLC
    - Simulated PLC Station-simulates the PLC object
    - Scale PLC-used to connect to the scale model
    - Test PLC - partial simulation
- IP group box-This group box includes the recurring IP addresses used by the control room for different instances of radio telescopes. If a different IP is required the IP can be input directly from the IP addresses and Port numbers groupbox

System IP Addresses and Port Numbers Group Box- Located in the top right corner. This group box contains several text boxes that allow the user to manually input several important IP addresses and port numbers. The initialization options in this group box include :

- PLC IP address text box
- PLC Port number text box
- MCU Port text box
- Weather Station COM Port text box

Populate Local Database Checkbox- Located below the left corner of the System IP Addresses and Port Number Group Box. This checkbox will fill the database with a predetermined set of data for the control room application to draw from.

Loop Back (for simulation) Checkbox- Located below the center of the System IP Addresses and Port Number Group Box. This checkbox will autofill all of the

System IP Addresses and Port Numbers using predetermined values to connect to all of the simulated components.

Default Vals (for production) Checkbox- Located below the right corner of the System IP Addresses and Port Number Group Box. Functions the same as the Loop back checkbox, but uses values to connect to the real life telescope.

Finalize Settings Button- Located below and to the left of the Populate Local Database, Loop back, and Default Vals Checkboxes. This button finalizes the settings input by the user in the Simulation settings group box as well as the system IP addresses and port numbers groupbox. Once this button has been pressed those groupboxes will be deactivated and the remaining functionality on the main Page will be activated to allow the user to finish creating the current radio telescope instance.

Create Production Weather Station Button- Located below and to the right of the Populate Local Database, Loop back, and Default Vals Checkboxes. This button is only necessary if the user chooses a setting other than a simulated weather station in the weatherstation spinbox.

Radio Telescope Control Button- Located below the Finalize Settings and Create Production Weather Station buttons. This button brings the user to the Radio Telescope Control Page. This Page provides the user with access to the control scripts in addition to allowing the user control over the RT both manually and by inputting coordinates. This button remains inactive until the user clicks on the Start Radio telescope button.

Start RT Button- Located below the Radio Telescope Control Button in the bottom right corner. This button starts the telescope. If the user desires to run the control room software as a simulation the loopback (for simulation) checkbox needs to be checked before the start telescope button is pressed. No other functionality on this page will be active until this button has been pressed.This button will not be enabled until the Finalize settings button has been pressed (if using a test or production weather station the user must also click the create weather station before the start button will activate).

Shutdown RT Button- Located below the Radio telescope Control Button and to the left of the Start Telescope Button. This button shuts down the telescope as

well as the control room software.This button will remain disabled until the start radio telescope button has been pressed.

User Interface Operation

After clicking on the executable the first page the user will encounter is the Main Page (Figure 1). The purpose of this page is to set all of the initial conditions necessary to activate an instance of the radio telescope. The start button for the radio telescope will only activate after these steps have been completed.

Step 1- Locate the simulation settings groupbox in the bottom left corner of Figure 1. This group box contains 6 dropdown boxes that each pertain to a different component of the radio telescope. The user must select between simulation, test, and production for each of the components in this groupbox (with the exception of the ip spinbox).

Step 2- Locate the system IP and Port number groupbox in the top right corner of the main Page.This group box contains 4 text boxes that each pertain to a different component of the radio telescope. The user can enter specific Ip addresses and port numbers for each component. These will fill automatically for the simulation if the user checks the Loop Back box, and for a real telescope if the user checks the Devault Vals box.

Step 3- After the user has finished inputting the settings they must click on the finalize settings button. This button disables all of the functionality in the settings groupboxes and enables the simulation checkbox and start button.

> ***Step 3.A-*** If the user chooses the test or production weather station they must press the create production weather station button before the start radio telescope button will be enabled.

Step 4- If steps 1-3 have been completed correctly then the radio telescope button should be enabled. The last step to creating and starting an instance of the radio telescope is to hit the start button. Once the start button is pressed the user should see several changes happen to the page. The first change that will be evident is that the settings group boxes

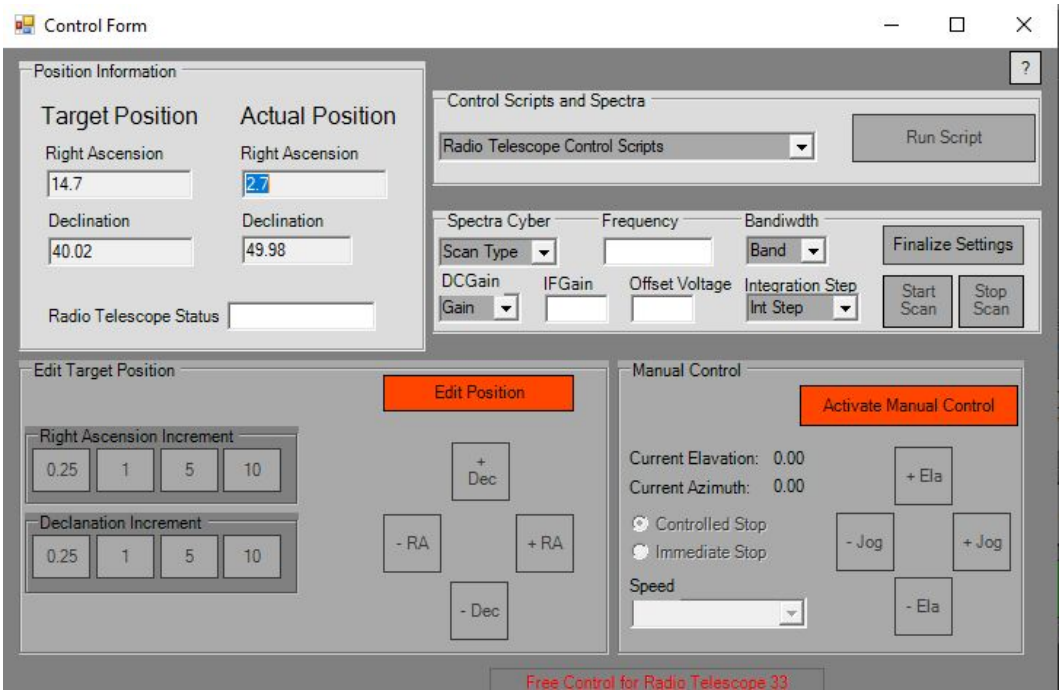
re-enable. The Data grid display box on the top left corner of the Page should populate with the values from the port and IP number group box , and the radio telescope control button and shut down button will now be enabled as well.

Step 6- The Radio telescope Control Button should be enabled once the radio telescope has been created and started. The user can navigate to the radio telescope control page by clicking on the Radio telescope control button located above the start button.

Step 7- Once the radio telescope has been started the user can navigate to the Diagnostics Page by double clicking on the desired radio telescope IP address displayed in the Data Grid display box in the top right corner of the main Page.

Radio Telescope Control Page

Radio Telescope Control Page Overview



Features

Position information groupbox

> *Target Position Information*- These boxes display the current value for the target position of the Radio telescope.
>
> *Actual Position Information*-These boxes display the current value for the actual position that the Radio telescope is pointed at.

Edit target position groupbox

> *Edit Position Button*- This button allows the user to edit the target position information for the RT. None of the functionality within the Edit target position groupbox will be accessible to the user until this button has been pressed.

Increment Right Ascension Buttons- These buttons allow the user to control the amount each button click of the plus or minus Right ascension buttons increments onto the target value for the telescope

Increment Declination Buttons-These buttons allow the user to control the amount each button click of the plus or minus Descension buttons increments onto the target value for the telescope

Save Position-This button finalizes and applies the changes to target position data made by the user. After this button is clicked the telescope will start moving towards the new target position

Manual control groupbox

Activate Manual Control-This button allows the user to begin controlling the telescope manually. Until this button is pressed the rest of the functionality within this groupbox for manual manipulation of the radio telescope will be disabeled.

Current Azimuth Label- displays the value for the radio telescopes current azimuth.

Current Elevation Label- displays the value for the radio telescopes current elevation

Speed Dropdown Box- This drop down allows the user to change the speed at which the radio telescope moves. It provides the user with several options

-*Jog Button*-This allows the user to move the telescope counter clockwise

+*Jog Button*-This allows the user to move the telescope clockwise

+*Ela Button*- This allows the user to move the telescope upward

-*Ela Button*- this allows the user to move the telescope downward

Controlled Stop- When this option is clicked the telescope will come to a controlled stop when it is no longer being told to move.

Immediate Stop- When this option is clicked the telescope will come to an immediate when it is no longer being told to move.

Deactivate Manual Control- This button is clicked when you are finished manually controlling the telescope. You need to press this button in order to use the Edit Target Position groupbox.

Control Script Group Box

Radio Telescope Control Scripts Combo Box- Allows the user to select which Control script they would like the telescope to perform (Descriptions of these scripts can be found in the General Maintenance section of Script Descriptions).

Run Script Button- This button will run the script that the user has selected in the Radio Telescope Control Scripts Combo Box.

Spectra Cyber Group Box

Scan Type Combo Box- Allows the user to select which type of scan they would like to perform (continuous or spectral).

Bandwidth Combo Box- Allows the user to input what bandwidth they would like to scan through (15Kz or 30Khz)

Frequency Text box- Allows the user to input the frequency that they would like to scan through (80Mhz to 1000Mhz)

DC Gain Combo Box- Allows the user to change the gain applied to the spectra cyber's scan (1, 5, 10, 20, 50, or 60 DB)

IF Gain Text Box- Allows the user to input the specific IF gain that they want to use.

Offset Voltage Text Box- Allows the user to change the voltage that will be offset in the spectra cyber scan (0 <= Offset <= 4.095 Volts)

Integration Step Combo Box- Allows the user to change the time interval that the spectra cyber reads rf data during a scan (0.3, 0.5)

Finalize Settings Button- Locks in the selections that the user has made for the parameters described above of the spectra cyber.

Start Scan Button- Starts a scan using the specified parameters described above.

Stop Scan Button- Stops a currently ongoing scan.

Operation of the Radio Telescope Control Page

After clicking the radio telescope control button the Control Page will be displayed for the user. This control page provides several different options for the user. These options include control scripts, “free control”, and manual control. The free control and manual control however cannot be activated at the same time as that would send conflicting commands to the radio telescope and the scripts override both free and manual control.

When free control is activated the user may input their desired coordinates directly into the text boxes or they may use the buttons provided in the edit target position groupbox located in the bottom left corner of the control Page.

When manual control has been activated the user can control the telescope directly using the jog and elevation buttons located in the manual control groupbox located in the bottom right corner of the control page. In addition to this functionality the user can also control the speed of movement and the type of stop executed by the radio telescope.

The control scripts the user has access to here consist of actions that the telescope will have to execute regularly. For example, snow dump, calibrate, and stow are script functionalities The user simply has to select their desired script then hit the run script button to execute that script. This overrides appointments and manual control however.

Free Control Operation

Step 1- In order to activate the free control functionality (appointment control using coordinates) the user must first press the edit position button located in the edit target position groupbox. Once this button has been pressed the entire target position groupbox will be enabled for the user to operate.

> ***Step 1.a***- If the manual control group box is currently active then the edit position button will be disabled because the radio telescope cannot operate with instructions from free and manual control simultaneously. You must deactivate manual control.

Step 2- The user can use the +,- Right ascension and declination buttons to edit their desired target position. The current position as well as the active target position are displayed for the user in the top left corner of the page in the position information group box.

> ***Step 2.a***- If the user desires a different increment for the right ascension and declination buttons then they may choose a new increment in the section provided to the left of the right ascension and declination buttons

Step 3- If the user has a specific coordinate already picked out then they may skip the tedious process of clicking to it using the right ascension and declination buttons and instead simply enter the desired coordinates in the target position fields located in the Position Information groupbox.

Manual Control Operation

Step 1- In order to activate the manual control functionality (direct control of Radio Telescope movement) the user must first press the activate manual control button located in the manual control groupbox on the right side of the page. Once this button has been pressed the entire manual control groupbox will be enabled for the user to operate.

> **Step 1.a**- If the edit position group box is currently active then the activate manual control button will be disabled because the radio telescope cannot operate with instructions from free and manual control simultaneously.

Step 2- The user must first choose the speed at which they want the radio telescope to operate. To do this the user must find and access the speed drop down box in the bottom left corner of the manual control groupbox. After viewing the speed options available the user can choose their desired speed by double clicking.

Step 3- Next the user must specify whether they desire a controlled stop or an immediate stop by using the stop buttons located directly above the speed combobox.

Step 4- Now that the other settings have been modified the user is ready to control the telescope. To do this the user may use the elevation and azimuth buttons located in the bottom right corner of the manual control group box. The following buttons are included:

Ela(+)- This button increases elevation of the Radio telescope. An elevation of 0 is horizontal while an elevation of 90 is pointing straight up.
Ela(-)- This button decreases elevation of the Radio telescope. An elevation of 0 is horizontal while an elevation of 90 is pointing straight up.
Jog(+)- This button rotates the telescope clockwise.This corresponds to a + RA .
Jog(-)- This button rotates the telescope counter clockwise. This corresponds to a -RA

When using the RT manual controls the user can view the current elevation and azimuth displayed in the top left corner of the manual control groupbox.

Step 5- When the user is finished using manual control they must press the lock manual control button (same button as activate manual control).

Control Script Operation

Step 1- The first step for running a control script is to locate the control scripts groupbox in the top right hand corner of the control form. Within this group box is a combobox with all of the available control scripts as well as a run script button.

Step 2- First the user must click the drop down arrow and select the desired script. After a script is selected the run script button will be enabled.

Step 3- After a script is selected the user may run the chosen script by clicking the run script button. This will interrupt any current appointment or script being run.

Spectra Cyber Operation

Step 1- Input the Type of scan that you want to perform, the bandwidth, the gain, the offset voltage, and the integration step (See above for descriptions).

Step 2- Click the finalize settings button to lock in your parameters and unlock the start scan button.

Step 3- Click the start scan button to begin the scan. The finalize settings and start scan button will lock and the stop scan button will unlock.

Step 4- Once you have completed the scan to your liking, click the stop scan button to end the scan, and unlock the start scan, and finalize settings button. The stop scan button will also lock

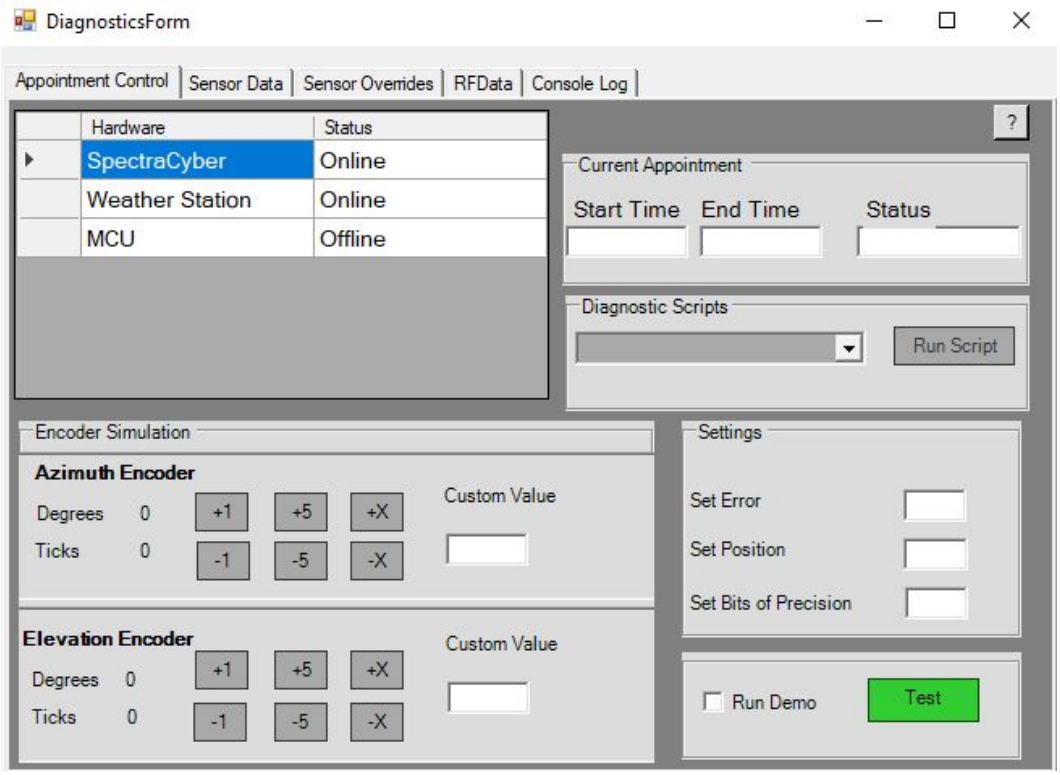
Diagnostics Pages

Diagnostics Page Overview

After clicking the radio telescope IP address the diagnostics page will be displayed for the user. This page is organized into five different tabs:

1) Appointment Control Tab
2) Sensor Display Tab
3) Sensor Override Tab
4) RF Data Tab
5) Console Log Tab

Appointment Control Tab Overview



Features

Hardware Status Box- This box displays different hardware components for the radio telescope and the current status of these pieces of hardware.

Encoder Simulation Group Box- This box displays the azimuth and elevation encoder tick and degree values, and allows for changes to them via +1, +5 and +X buttons, the x determined by the Custom Value text box to the right of the buttons.

Current appointment group box- This displays the current appointment start and end times, as well as the status of the appointment

*Diagnostic Scripts Dropdown***-** This dropdown box contains a list of the diagnostic scripts that a user may want to run. In order to run these, select a script from the dropdown box, and then click the Run Script button.

*Settings groupbox***-** Allows the user to set error, position, and bits of position. This functionality has yet to be implemented in the code

*Test Group Box***-** This lets the user select the Run Demo check box which will iterate through the encoder positions, hitting all of the sensors in its range to ensure they work correctly. The Test button has no functionality.

Appointment Control Operation

Step 1- To provide simulated information while testing press the run demo check box located in the bottom right corner of the page. This activates a demo for how a functioning RT will be working.

Step 2- To customize values used by azimuth and elevation encoders locate the encoder simulation groupbox in the bottom left corner of the page. This groupbox includes buttons to incrementally increase or decrease values for azimuth and elevation encoders.The custom value being set is then displayed in the custom value text box located on the right side of this groupbox.

Step 3- The user may view current appointment information and status in the top right corner of the page.

Diagnostic Script Operation

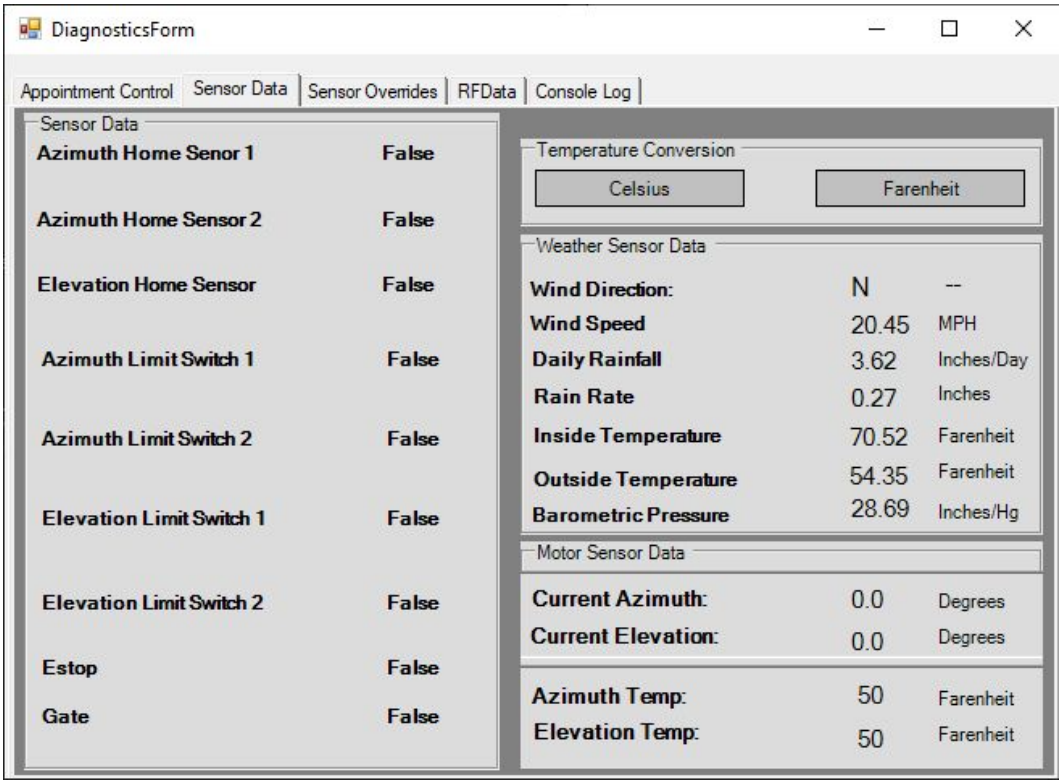
Step 1- The first step for running a control script is to locate the control scripts groupbox in the top right hand corner of the control form. Within this group box is a combobox with all of the available control scripts as well as a run script button.

Step 2- First the user must click the drop down arrow and select the desired script. After a script is selected the run script button will be enabled.

Step 3- After a script is selected the user may run the chosen script by clicking the run script button. This will interrupt any current appointment or script being run.

Step 4- The diagnostics tab is organized into 3 different tabs. In order to navigate to these other pages the user must simply click on their desired tab in the top left corner of the page.

Sensor Data Page Overview



Features

Sensor Data Group Box: This group box allows the user to view the status of the azimuth and elevation's home and limit switch sensors, the E-Stop, and the Gate.

Temperature Conversion Buttons: in the temperature conversion groupbox on the top right side of this page there are 2 buttons with the words Farenheit and Celsius. Pressing either of these will convert all of the temperatures displayed to that unit of measurement.

Weather sensor data: This group box allows the user to view the current values of being read in by the weather station:

Wind Direction-no units are associated with this measurement
Wind Speed- measured in MPH
Daily Rainfall- measured in inches
Rain Rate- measured in inches
Inside Temperature- measured in Farenheit or Celsius(Default is F)
Outside Temperature- measured in Farenheit or Celsius(Default is F)
Barometric Pressure- measured in Inches/Hg

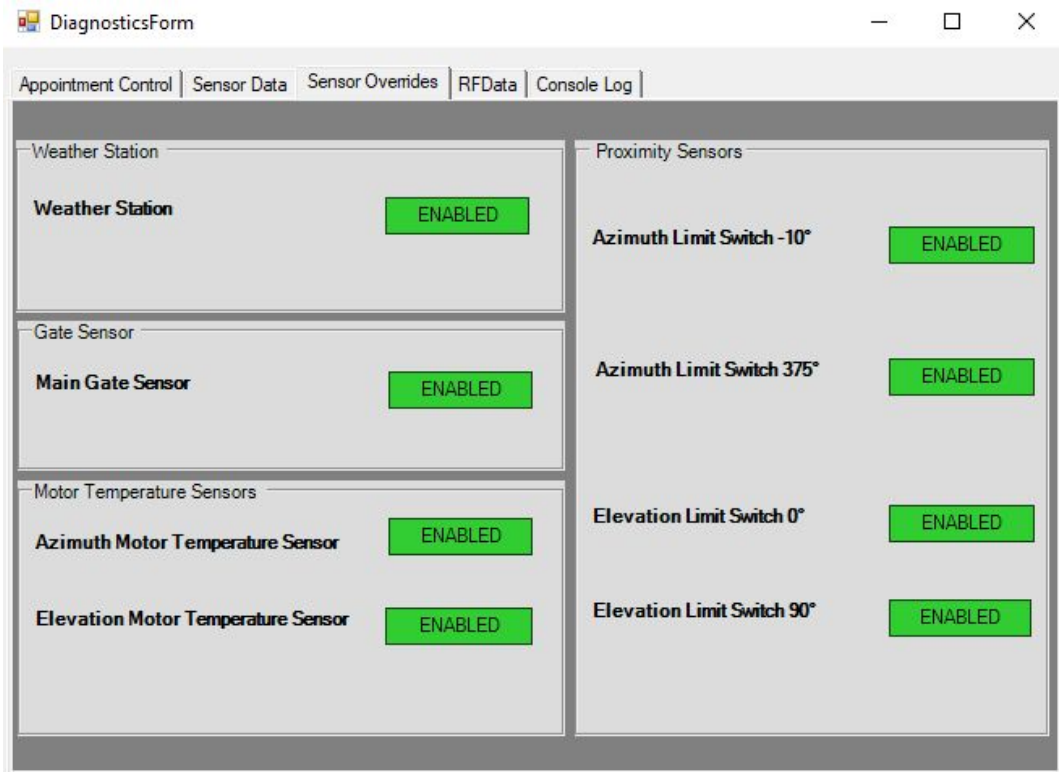
Motor sensor data: This group box allows the user to view the current azimuth and elevation of the RT as well as the current temperature for both the azimuth and elevation motors.

Sensor Data Operation

Step 1- This tab is fairly simple because it is primarily designed to display information and not have interactions from the user. The only user functionality this tab offers lies in the temperature conversion groupbox in the top right. The default unit of measurement for temperature is fahrenheit. Pressing the Celsius button converts all temperature values on this page into celsius while the fahrenheit button switches all temperature values to fahrenheit.

Step 2- The diagnostics tab is organized into 3 different tabs. In order to navigate to these other pages the user must simply click on their desired tab in the top left corner of the page.

Sensor Override Page Overview



Overrides

Weather Station- Overrides the wind speed data being received from the weather station in case of an error.

Main Gate- Overrides the main gate sensor in case of error.

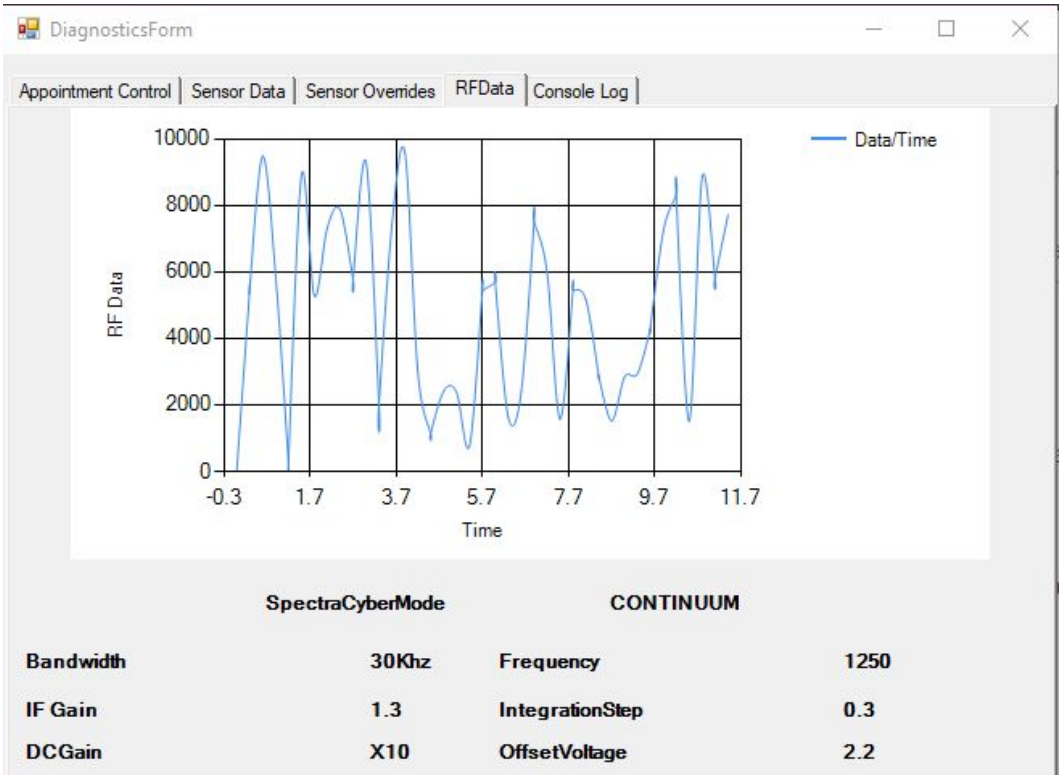
Motor Temperature Sensors- These buttons override the Motor Temperature sensor in case of error.

Limit Switches- These buttons override the Motor Temperature sensor in case of error.

Sensor Override Operation

Step 1- This tab is fairly simple. The only user functionality this tab offers are the sensor override buttons. Each of these buttons overrides the sensor it is labeled with. For a more detailed description of these sensors see general documentation.

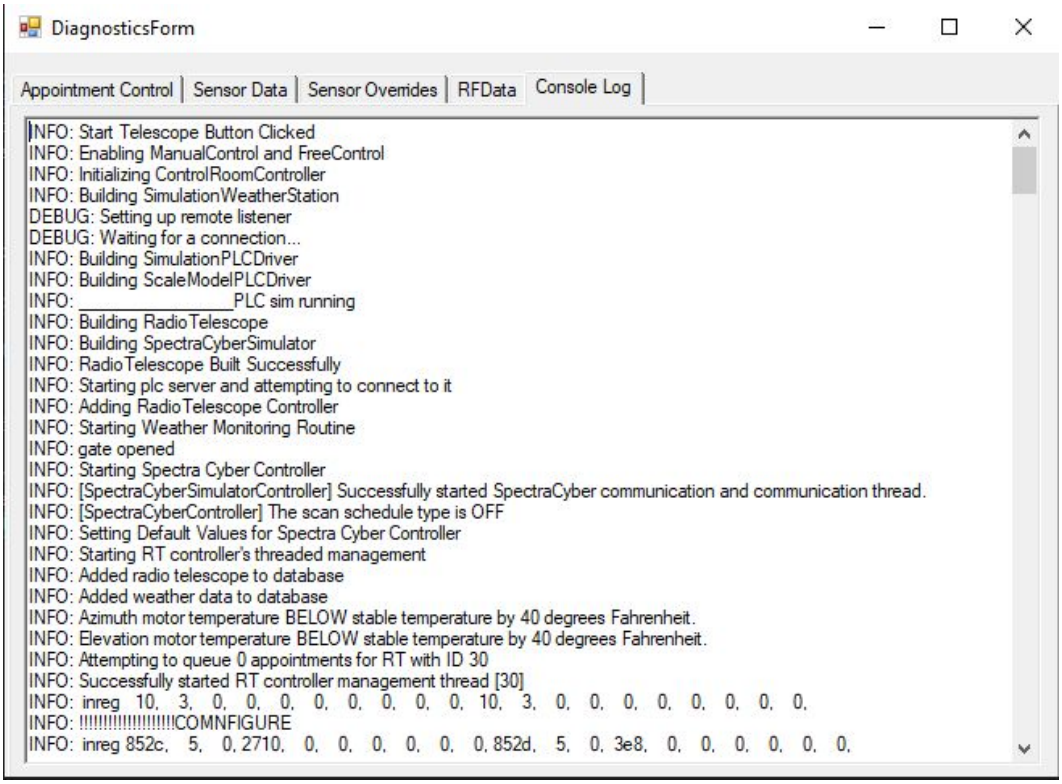
RF Data Tab



SpectraCyber Scan Chart and Config Values

This line chart displays the rf data intensity received from a spectra cyber scan. The data received is measured on the Y-axis, and the time received from the start of the scan in seconds. Below the chart, displays the current configuration values of the spectra cyber. These are the values available for the user to change in the Radio Telescope Control Page: Mode, Bandwidth, Frequency, IF Gain, Integration Step, DC Gain, and Offset Voltage.

Console Log Tab



This tab displays the output of the logger function used throughout the code to log when various functions are performed, current values within the system, and errors and exceptions that may occur during operation of the telescope. By default the output automatically scrolls down to the most recently added log statement, however, the user can select the output window to scroll freely within the log statements.

Script Descriptions

General Maintenance(RT Control Scripts)

-Stow: Moves the telescope to 0° on the azimuth and 90° on the elevation
-Full Elevation: Moves the telescope elevation from -10° to 90°
-Full 360 Clockwise: Moves the telescope azimuth from 0° to 360°
-Full 360 Counter-Clockwise: Moves the telescope azimuth from 360° to 0°
-Calibration: Moves the telescope to 200° azimuth and 20° elevation; used to test the validity of the data collected by measuring the temperature of a constant, and comparing it to a known
-Snow Dump: Moves the telescope to 0° azimuth and 0° elevation in order to dump the snow to prevent the dish from breaking

Emergency Recovery Scripts

-Recover From Limit Switch: This script is a loop that checks both the encoder values and the limit switch sensors on both the azimuth and elevation and moves the telescope away limit switches
-Recover From Clockwise Hardstop: Moves the telescope along the azimuth in order to move away from the clockwise hardstop
-Recover From Counter-Clockwise Hardstop: Moves the telescope along the azimuth in order to move away from the counterclockwise hardstop

Diagnostic Scripts

-Hit Azimuth Counter-Clockwise Limit Switch: Moves the telescope along the azimuth to hit the counter-clockwise limit switch at approx. -5°
-Hit Azimuth Clockwise Limit Switch: Moves the telescope along the azimuth to hit the clockwise limit switch at approx. 365°
-Hit Elevation Lower Limit Switch: Moves the telescope along the elevation to hit the lower limit switch at approx. -15°
-Hit Elevation Upper Limit Switch: Moves the telescope along the elevation to hit the upper limit switch at approx. 85°
-Hit Hardstops: Moves the telescope along the azimuth to first go past the clockwise limit switch and hit the hardstop, and then spins counter-clockwise, passing that limit switch and hitting the other hardstop