Global Tree Potential Monitoring Network

Installation Guide

Contents

Introduction

Welcome to the global network by becoming a citizen scientist and having a location that qualifies as a hosting site for a tree sensor. This guide will explain how to select an appropriate tree for monitoring, how to install the remote tree unit (RTU), the base station and how to connect to the network website where you can see the data from your tree as well as other trees that are being monitored.

1. Overview

Please keep in mind that monitoring of tree electrical activity globally is a new endeavor that has never been attempted before! There is much that we do not yet know, and you will truly be a citizen scientist helping to generate new questions for us to explore in the lab. Although we are doing our best to provide you with instructions and guidelines, there will undoubtedly be some things we have not thought of or have not previously encountered.

The first step to installing the tree sensor, which continuously measures the electrical voltage potentials generated by the tree and the electrical potentials between the earth and the tree, is to select an appropriate tree. Once the tree has been selected (see section 3. Tree selection guidelines), you will install a Remote Tree Unit (RTU) which involves a few steps, such as installing the electrodes in the tree's trunk, driving a ground rod into the ground near the base of the tree, installing a solar panel to keep the RTU battery charged, and connecting the wiring.

Once the RTU is installed, you will then find a good location for the base station which receives the tree data from a RTU via a low power radio transmitter and receiver link. The base station sends the data to the Tree Rhythms network via a Wi-Fi connection to the router in your home or business which is connected to the internet. Once your tree is connected to the website and database, you will be able to monitor your tree's electrical activity (as well as others' trees) anytime you like. Each RTU normally monitors two "channels" which detect different voltage potentials. Channel one is the voltage being recorded from the two electrodes that will be placed in the tree's trunk and channel two records the voltage between the tree trunk and the earth. In addition, RTUs contain outdoor temperature sensors which can be monitored on your system dashboard.

Tree Rhythm Architecture
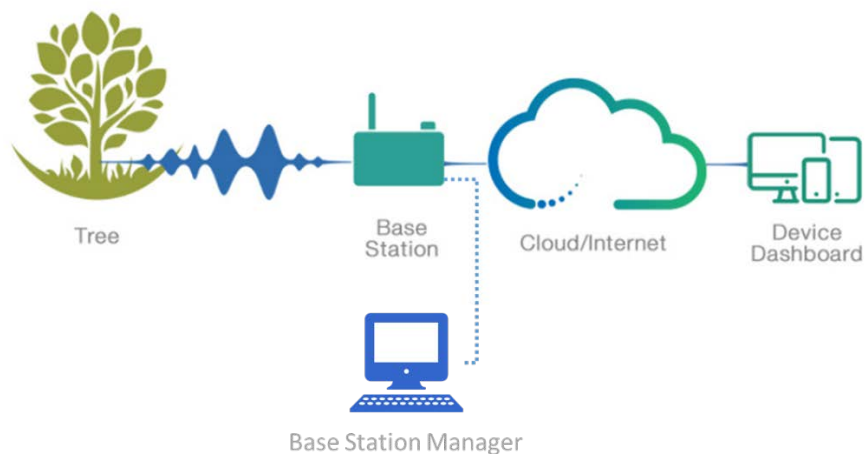
Trees tend to produce relatively strong voltage potentials that are in the millivolt (mV) range, which are similar to the potentials measured in human and animal electrocardiograms (ECG). Changes in these voltages are slow, occur over hours and tend to exhibit a 24-hour or circadian rhythm. The voltage potentials are affected by some things that are known such as the amount of water that is available (they tend to change more dramatically after it rains) and other factors as yet unknown. One of the key research questions we will be asking is: Do the electrical responses in multiple trees correlate to events that trigger an emotional outpouring in large numbers of people? In order to answer this question, the electrical data from many trees located around the planet is required. Collected data will be analyzed across many events that have triggered different types of emotional responses in sufficiently large numbers of people. This does not mean that you cannot try to interact with your tree by paying attention to it, touching or hugging it, or sending it love, etc. However, how trees may respond electrically is unknown at this time and as the electrical data produced by trees is quite slow and affected by many factors such as light and dark cycles, water availability and so on, potential responses may occur over several days. We look forward to hearing about your experiments as citizen scientists.

The second channel, which measures the electrical potentials between the tree trunk and ground, will be used to address the question: Can trees help inform us of approaching earthquakes? A rather amazing observation has shown that longer-term trends in tree recordings seem to respond prior to earthquakes. NASA Ames scientist Friedemann Freund, with whom we are collaborating, has developed a theory that explains how rocks deep in the earth act as batteries when they are stressed by tectonic forces preceding earthquakes. The theory also explains how the electrical charge carriers that flow through the rocks appear to cause a response in the electrical activity of trees. Research in Japan has shown that tree potential changes can occur well before the earthquakes actually happen. It may very well be that trees will end up playing a role as low-cost sensors that can help predict when larger earthquakes are about to occur.

2. What you will need to install the system

The following tools will be needed:

1. Regular-sized hammer
2. Large hammer (for driving the ground rod into the earth)
3. Medium-sized Phillips screwdriver
4. Large-sized flat blade screwdriver
5. Wire cutters
6. Flat chisel (if tree has thick bark)
7. Wire strippers or knife
8. Windows 10*, with a 64-bit Intel/AMD or equivalent processor. Older and 32-bit versions of Windows are not supported.
9. Internet over Wi-Fi

3. Selecting a tree

Select a tree that has 6-inch (15 CM) or greater diameter (distance across the tree trunk) at chest height (approximately 4 to 5 feet or 120 to 150 CM) from the ground. The tree should be at least 25 feet tall (7.5 meters). Select a tree that is healthy with a generally round trunk cross-section.

Minimum Diameter
6 IN (15 CM)
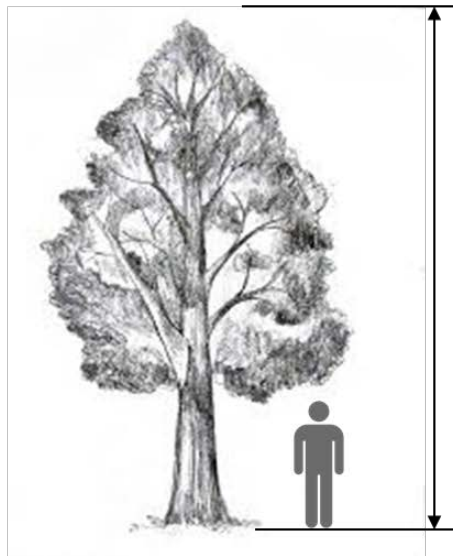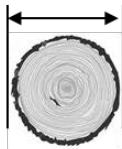
Minimum Height
25 FT (7.5 M)

The tree's location should be in line of sight from the building where the base station will be set up. The tree should also be in a spot that receives as much direct sunlight as possible year-round, so that the solar panel can keep a Remote Tree Unit (RTU) battery charged. If the solar panel does not receive enough direct sunlight close to the tree, the panel can be placed further away where it can receive more sunlight. Keep in mind that a thin cable has to be safely connected between the solar panel and the RTU, which will need to be protected from being damaged by

lawn mowers, pets, yard activities, etc. There is not an exact limit for how far the solar panel can be from the tree location, but under 50 feet is recommended as long as the cable can be run in a way that does not create a tripping hazard and is not in danger of being damaged.

4. Installing and connecting the base station

The base station receives data from the RTU and connects to your local Wi-Fi network, which connects via the internet to the Tree Rhythms network and uploads your tree's electrical potential data. The base station is not waterproof and should be located indoors on the side of the building closest to the tree if possible. The base station is powered by a USB power adapter (provided) or a USB connection to a computer. The enclosed USB power supply has a North America style AC plug. If installing in a country that uses a different style of power outlet, you will need either an adaptor or a USB power supply that works with your style of AC power outlets.

Computer Requirements

The Base Station Manager app requires a computer (laptop, tablet/convertible, or desktop) running Windows 10*, with a 64-bit Intel/AMD or equivalent processor. Older and 32-bit versions of Windows are not supported.

One USB port (2.0 or higher) is required to connect to the base station. This must be a powered port capable of supplying the standard 500 milliamps. Ports on keyboards or external USB hubs may not supply the required power and should be avoided. The USB connector itself can be either a conventional Type-A or a newer Type-C, as long as it is used with an appropriate cable (the base station uses a Micro-B connector).

If connecting your base station to a laptop or tablet computer, keep the computer plugged into AC power to avoid rapid battery drain whenever the base station is attached.

* Note about Windows 10 versions: Windows 10 S is not supported, because that version is too limited and does not allow the installation of software from outside of the Microsoft app store. Similarly, devices running Windows 10 Home or Pro in "S Mode" will not work unless you disable S Mode.

Installing the Base Station Manager

In order to access the download page for the Base Station Manager app you must first register on the Tree Rhythms Network server. See section 6 of this guide and complete step A & B only then return here and continue.

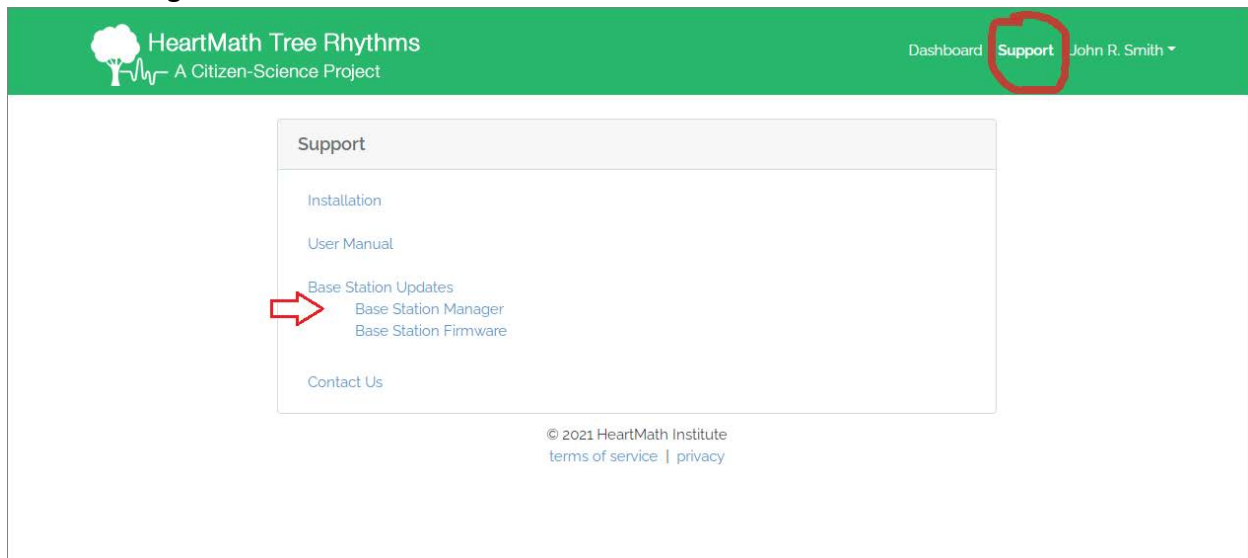Download the Base Station Manager app from the Tree Rhythms server at the following URL
https://treerhythms.net

Log in to your Base Station dashboard if you are not already logged-in.
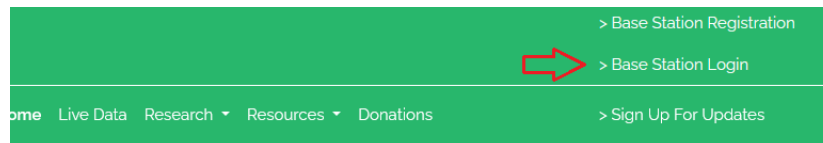
In the upper right corner, click on "Support". Then select Base Station Updates and click the "Base Station Manger" link to start the download.

After you have downloaded the installer for the Base Station Manager, locate the installer file and double-click to run it. The installation is self-guided and normally takes less than a minute to complete. When Windows prompts you for administrator permissions, you will need to accept the dialog to continue the installation. The installer will create a "HeartMath" folder under the Start menu (if one does not already exist) and will also place a shortcut to the Base Station Manager app on your desktop for easy access.

Initial Windows Driver Setup

After installing the Base Station Manager app, but before running it for the first time, you will need to allow Windows to recognize the base station hardware. This is a one-time process which should take just a few moments.

IMPORTANT: Before connecting the base station to your computer, verify that your computer is connected to the internet. This will allow your computer to automatically download a software driver which is required to communicate with the base station hardware.

Attach the base station to the computer using any available USB port. When you do this, Windows will automatically configure a required device driver for the base station. Wait until you see the message "Your device is ready to use" in the Windows taskbar, then disconnect the base station from your computer. You may now start the Base Station Manager app and proceed to the next step.

About the Base Station Manager

The Base Station Manager is a simple desktop application for Windows PCs which allows you to quickly configure and manage your base station and RTUs independently of the Tree Rhythms website. The Base Station Manager uses a "profile" to store all the settings for a given base station and its paired RTUs. These settings are stored locally on your computer and may be edited anytime. You can then upload the profile settings to your base station when convenient.

Many, but not all of the settings in a profile can also be edited via the Tree Rhythms website. However, some base station settings such as the Wi-Fi credentials can only be edited using the Base Station Manager. In addition, the Base Station Manager provides useful tools to monitor and interact with a base station during operation, and to upgrade the base station's firmware when needed. All of this makes the Base Station Manager an indispensable tool both to get new systems up and running, and then to help maintain them over time.

Initial Profile Setup

The first time you open the Base Station Manager app, you will be asked to create a new profile (Figure 1). A profile is a collection of settings for a particular base station, including its code, RTU pairings, and Wi-Fi credentials. The following sections will explain how to set up a new base station profile if you do not already have one.

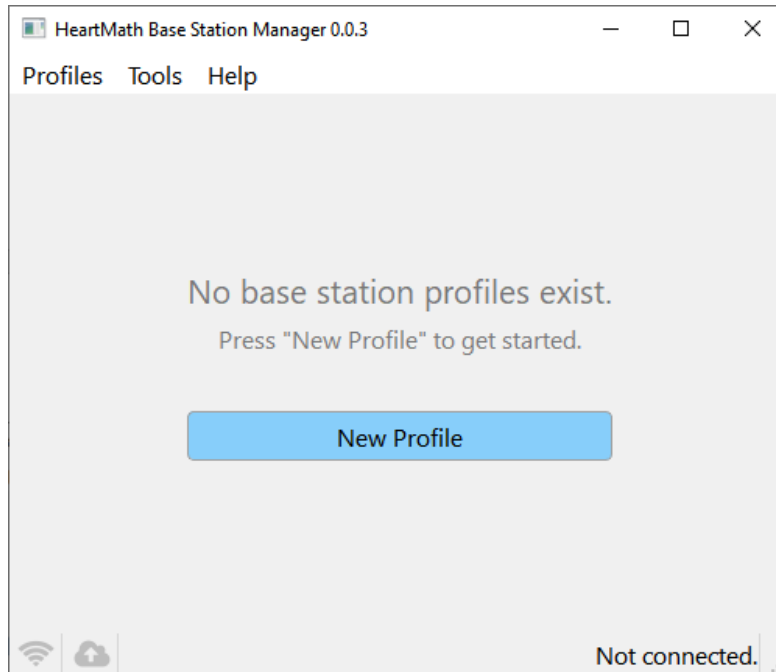To get started, click the New Profile button shown in Figure 1.

Figure 1

Name your Base Station

The first required field is Base Name (Figure 2). A default name is automatically generated from your computer's user account name, but you can change this by typing a custom name instead. This can be anything you like but should clearly identify your base station. (Currently this is only used in the Base Station Manager and is not synced to the Tree Rhythms portal).
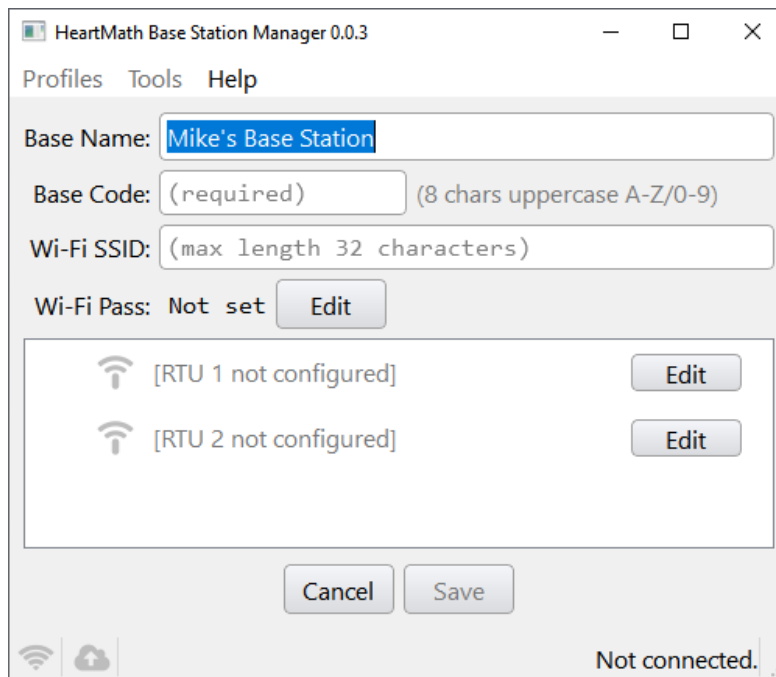

Figure 2

Base Code

The next required field is the Base Code (Figure 3). This must be in the format of 8 uppercase alphanumeric characters in the range A-Z and 0-9. Make sure to enter the exact code found on your base station's enclosure label. The editor will ensure that the code is typed in the correct format, but cannot check the validity of the code itself. Please verify that you have entered the base code correctly or your base station will be unable to communicate with the Tree Rhythms server.

Figure 3

Wi-Fi Credentials

Next, enter the Wi-Fi SSID (network name) to which the base station will connect (Figure 4). In this example we have a network named "mywifinetwork_2.4" but you will need to type the name of your own network. This can be up to 32 characters long as per the Wi-Fi standard. Make sure the SSID is spelled correctly or your base station will be unable to connect to the network. Note: networks with empty or "wildcard" SSIDs are not supported at this time.
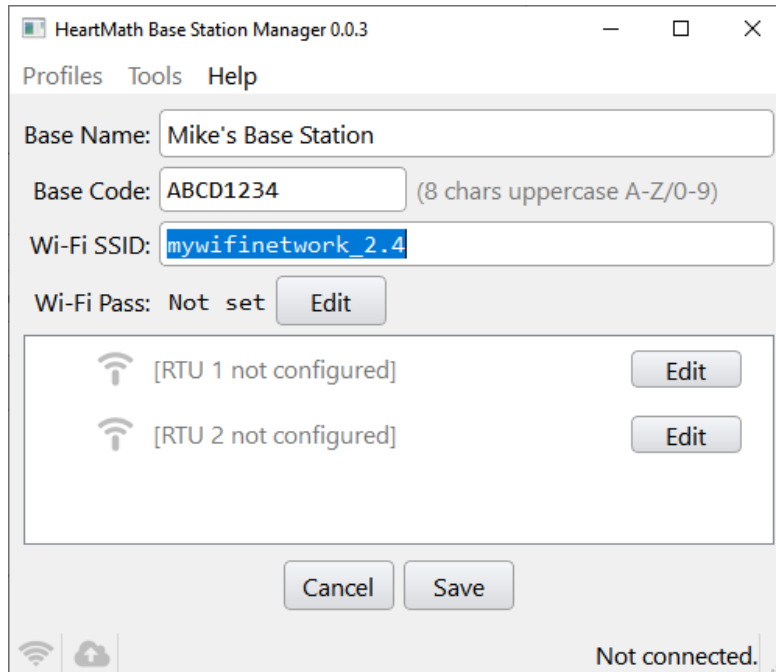
Figure 4

If your Wi-Fi network requires a password, click the Edit button next to the Wi-Fi Pass field (Figure 5). Otherwise, you can skip the next step.
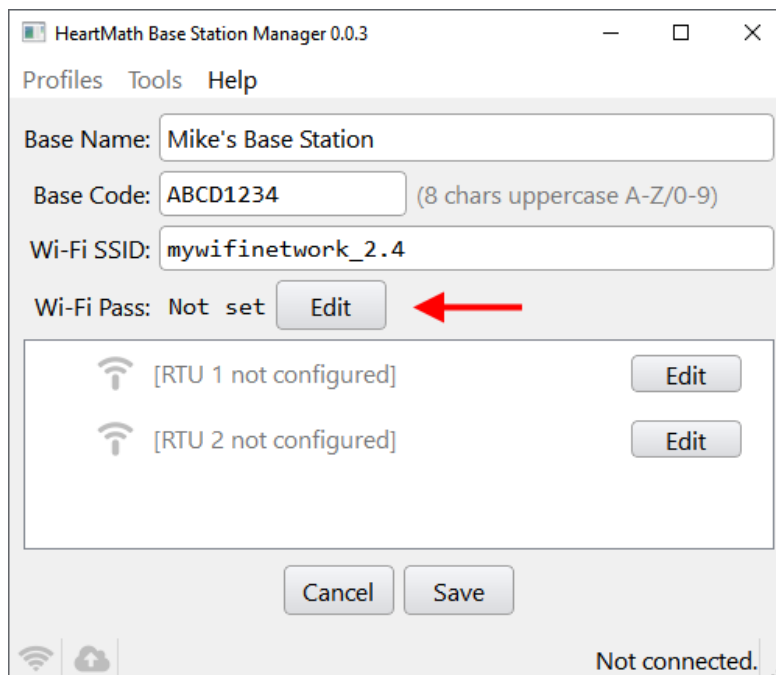

Figure 5

Follow the instructions in the popup dialog to enter the Wi-Fi password (Figure 6). Make sure the password is typed correctly or your base station will be unable to connect to the network.

Click OK when done. Note: this is the only time when the actual password is displayed. If you want to edit it later, you will need to re-enter the password at that time.
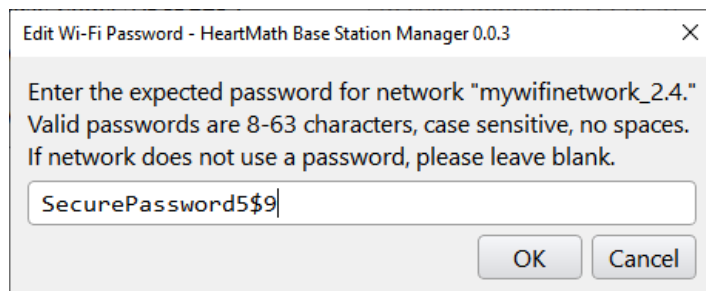
If you provide a non-blank Wi-Fi password, you will see a line of asterisks next to Wi-Fi Pass (Figure 7). The actual password is not displayed. If no password was set, this label will instead say "Not Set."
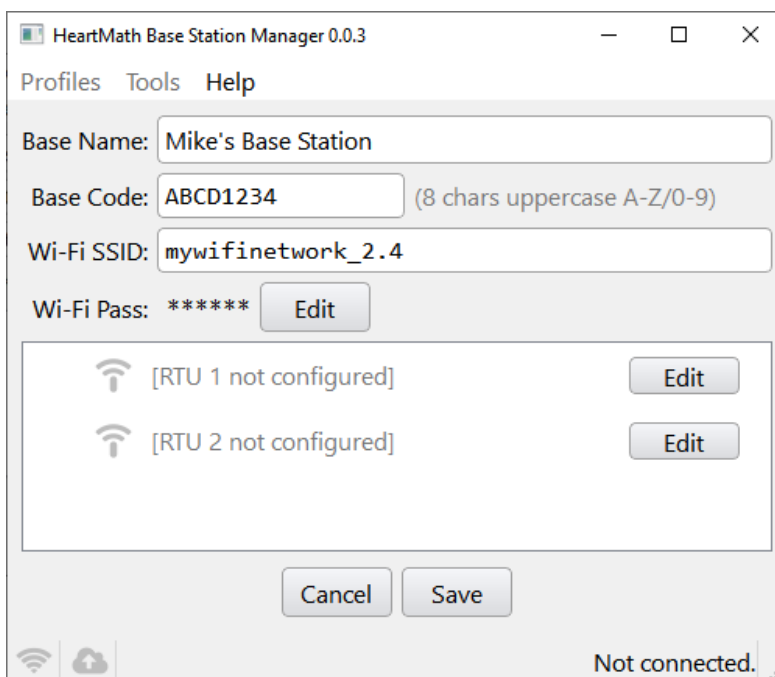

Figure 7

RTU Details

Now you can configure RTUs to use with your base station. Currently, up to two RTUs per base station are allowed.

Unpack the RTU from the shipping container and attach the antenna that was removed for shipping. See section 6d for details. Inside the RTU enclosure is a card with the RTU code you will need for the next step.

When ready, click the Edit button on the row for the first RTU as shown in Figure 7.

In the Edit RTU popup (Figure 8), first enter a descriptive name, then enter the RTU's code, and finally choose the number of channels to acquire (default is 2) and should remain set at 2. Make sure the RTU code exactly matches the one indicated on the RTU's label. (The RTU code can be found on the card inside the RTU enclosure). Again, the editor will ensure that a code is typed in the correct format, but cannot check the validity of the code itself. Click OK when done.
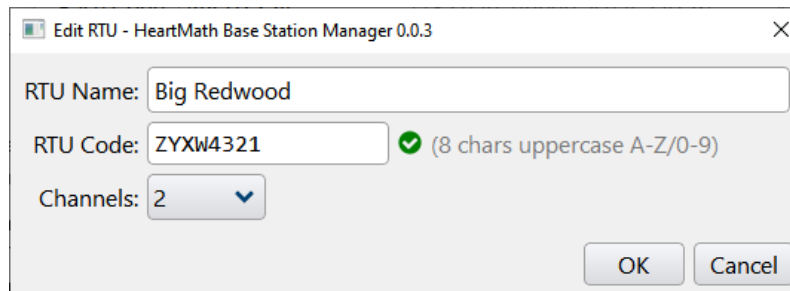

Figure 8

After you finish configuring your first RTU, its settings will be shown in the RTU list (Figure 9).
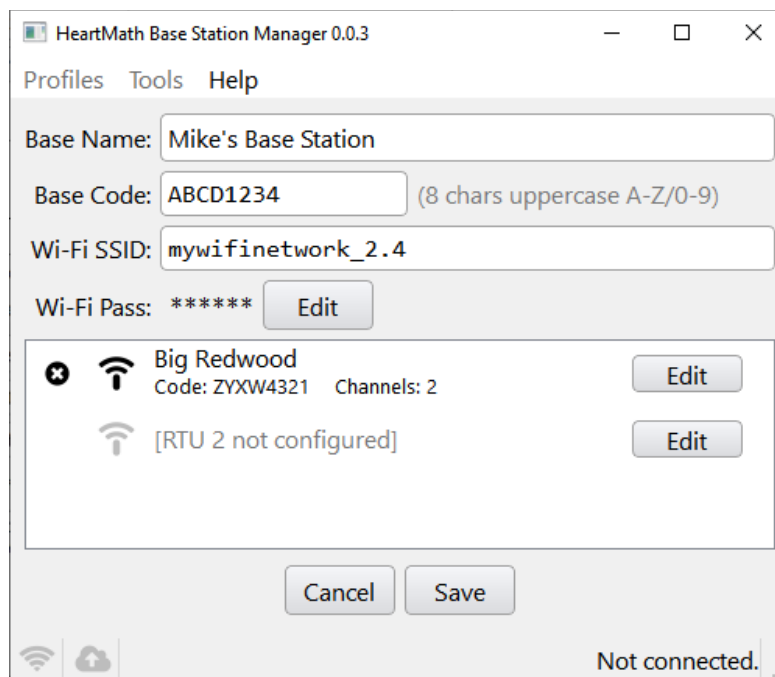

Figure 9

You can repeat the editing process for a second RTU if applicable. (The order in which you configure your RTUs does not matter.)

To delete the settings for an RTU, you can click the round "x" button to the left of that RTU's name. The remaining RTU(s) will be automatically reordered in the list.

Uploading a Profile to the Base Station

After you have entered all the details for your base station and RTUs, click the Save button at the bottom of the app window. The interface will change to a status view (Figure 10).
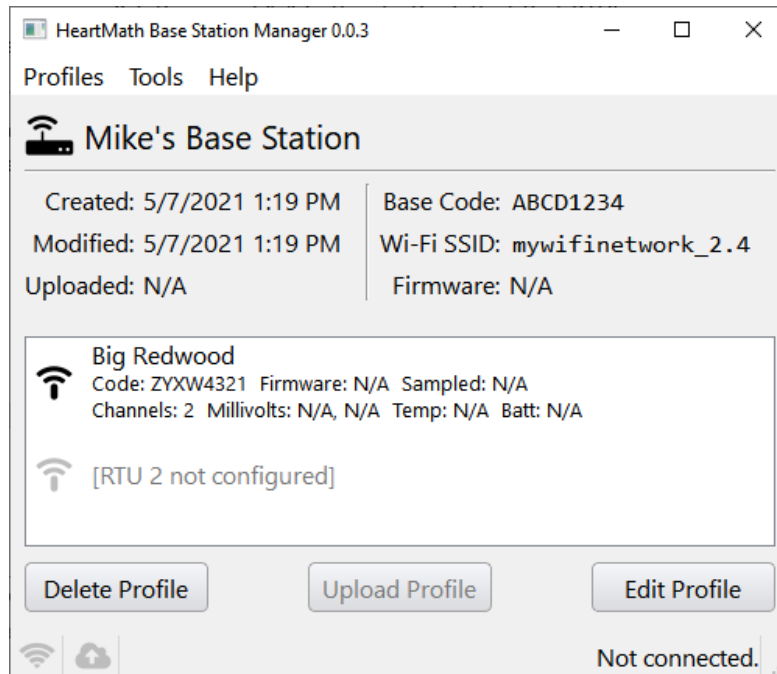

Figure 10

The next step is to upload the profile settings to your base station. Connect the base station to your computer using any available USB port and wait a few seconds. When the status bar says "Ready," click the Upload Profile button (Figure 11).
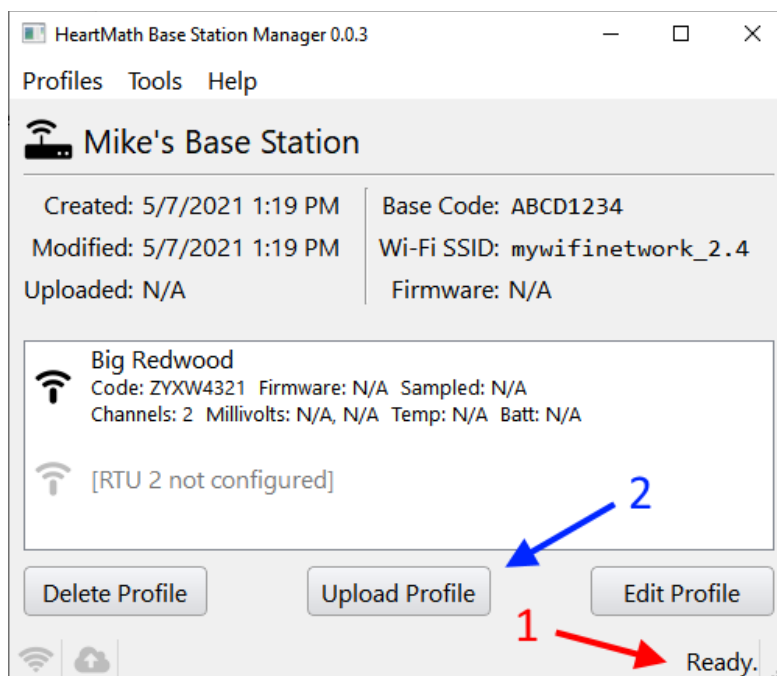
Figure 11

The Base Station Manager will proceed to upload the profile settings to the base station (Figure 12). This will take a few seconds. Do not disconnect the base station from your computer before the progress dialog disappears.
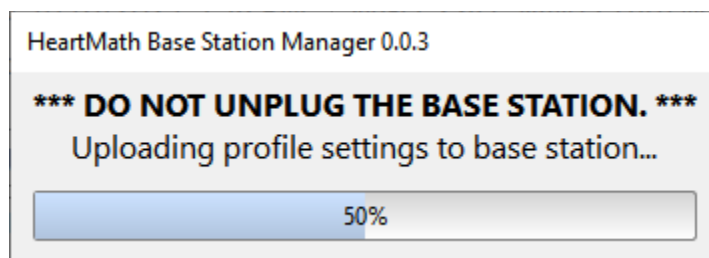

Figure 12

Monitoring System Status

After the profile settings have been uploaded to the base station, leave the base station connected to your computer for several minutes to monitor the overall status of the system and make sure that things are working correctly.

To test the communication link between the base station and RTU prior to installation of the RTU on a tree, it is necessary to temporarily power up the RTU in close proximity to the base station. The RTU is powered by a battery that must be connected to the RTU circuit board.

In most cases, the RTU battery was removed for shipping and does not need to be installed for this test. If the battery is not already in the RTU enclosure simply place it next to the enclosure and connect the RTU circuit board power leads to the battery terminals (see image below). The

red RTU power wire should be connected to the red battery terminal. The black RTU power lead should be connected to the black battery terminal. When the RTU is first powered on the red LED on the circuit board will blink 4 times indicating a successful startup.
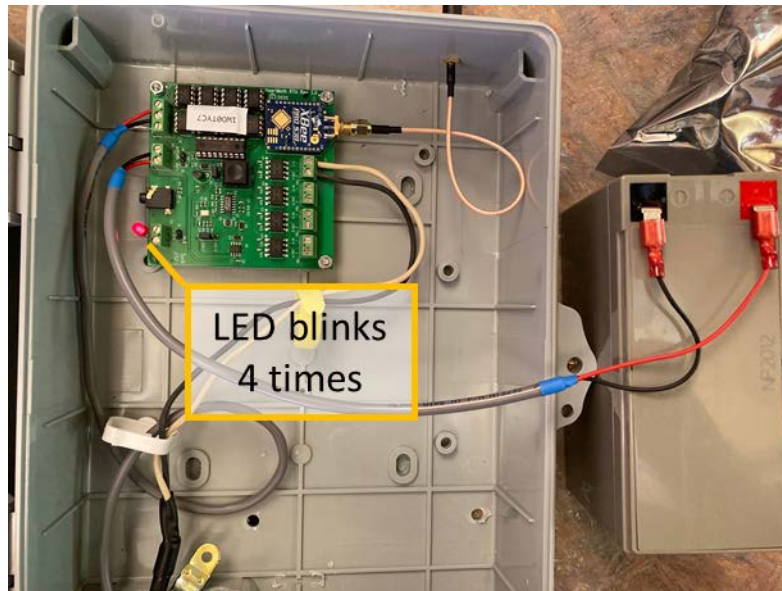
After an RTU is powered on and communication with the base station has been automatically established, the RTU will send new data samples to the base station on a regular schedule (about once a minute). When the base station receives a new sample from an RTU, the line item corresponding to that RTU will show all the details of the new sample, and the RTU's icon will change to green (Figure 13). Sample data includes the millivolts measured on each configured channel, the ambient temperature in Fahrenheit, and the RTU's battery level in volts.
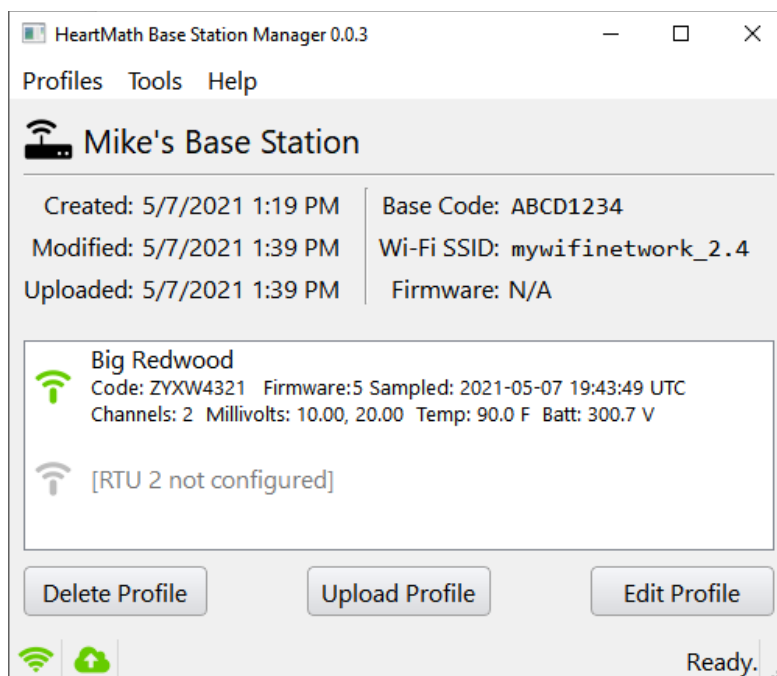
Figure 13

While the RTU continues to communicate normally, its corresponding icon in the Base Station Manager's RTU list will remain green. If the RTU loses power or stops communicating normally for more than a minute, its corresponding icon will turn red (Figure 14). This means you should take action to determine and fix the problem.
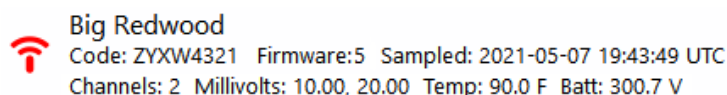

Figure 14

While trees typically generate voltages well within the +/- 1,650 millivolts input range of the RTU, suboptimal electrode-tree connections may result in voltages which are outside of this range. This will cause flat lines to be displayed in the Tree Rhythms portal. To verify that your RTU is measuring within the acceptable range of +/- 1,650 millivolts, we recommend using the Base Station Manager to observe the status of the RTU during installation and quickly improve electrode-tree connections without waiting for data to be displayed in the Tree Rhythms portal. Later, if flat lines at either voltage extreme are observed in the Tree Rhythms portal, the Base Station Manager can be used again to facilitate electrode-tree connection improvement.

In the bottom-left corner of the app window are two status icons which show how the base station is communicating with your Wi-Fi router and the Tree Rhythms cloud server. These icons are refreshed about once every 15 seconds and will change colors to indicate when things are working properly or when there is a problem. The following table describes what each icon and color means.

Icon	Meaning
	Base station has not yet connected to Wi-Fi, or Wi-Fi details are not configured.
	Base station failed to connect to Wi-Fi, or Wi-Fi connection was lost.
	Base station Wi-Fi is connected.
	Base station has not yet communicated with the cloud.
	Base station failed to communicate with the cloud.
	Base station successfully communicated with the cloud.

Assuming your base station and RTU(s) are configured correctly, these icons should turn and remain green once the base station is connected to your computer and has finished its normal startup sequence. If any status icon alternates between green and red, or remains persistently red, it may indicate a problem which should be investigated in more detail.

Managing Multiple Base Station Profiles

Normally you will only need to create one profile containing all the settings for your base station and RTUs. However, in some cases you may wish to create additional profiles for experimentation and switch between them as needed. For example, in a different profile you might specify details for more than one RTU (if available), or you might specify a different number of channels for the same RTU. You can create as many different profiles as you want.

To create another profile, open the Profiles menu at the top of the app window and click New Profile (Figure 15). This will show the same editor screen that you used earlier when creating your original profile.
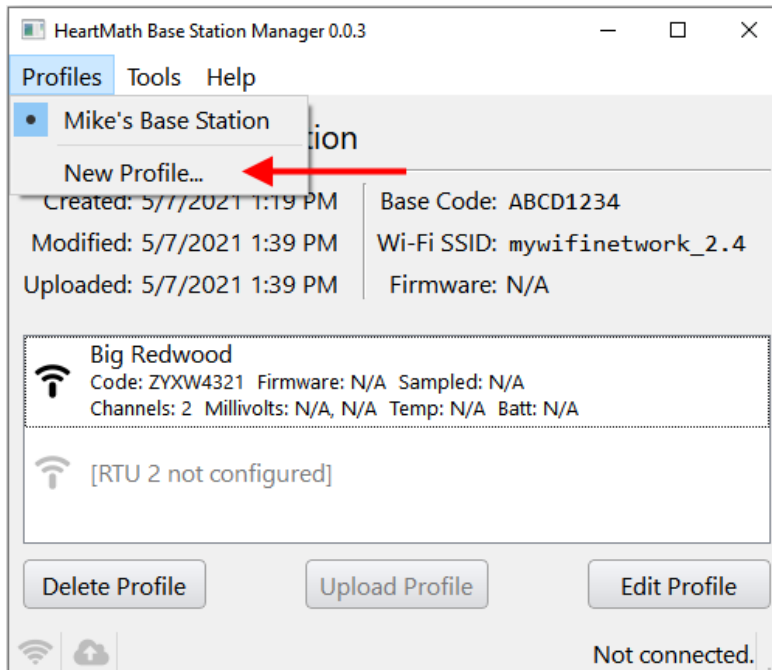
Figure 15

This time you will need to enter a different Base Name (Figure 16) to distinguish this new profile from your other existing profile. Again, this name can be anything you like but should clearly identify your base station.
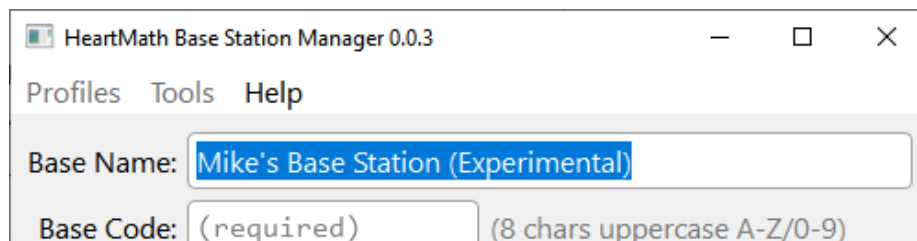

Figure 16

After you save the new profile, it will be automatically added to the Profiles menu alongside your other existing profiles (Figure 17). This allows you to switch between profiles when needed.
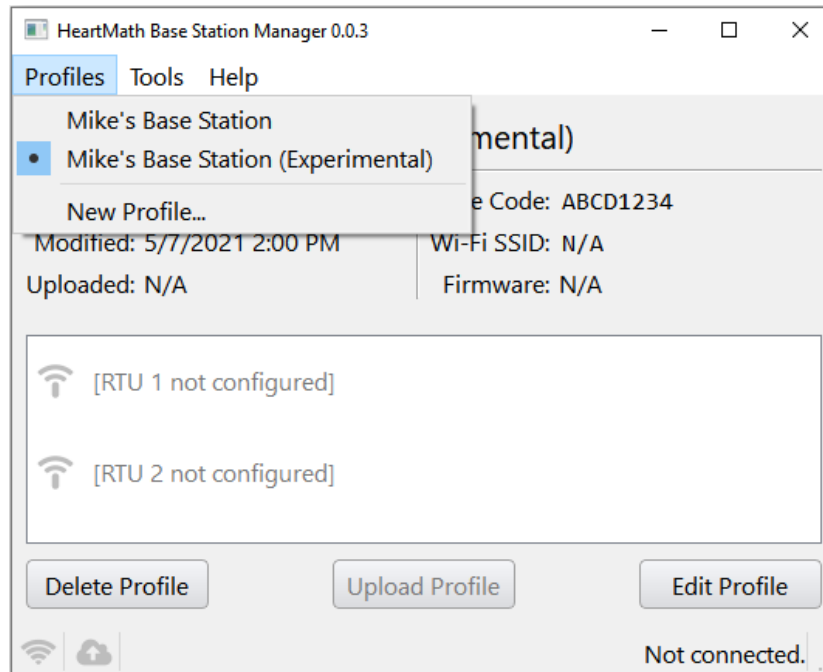
Figure 17

Important: after you switch profiles, you must click the "Upload Profile" button to apply the active profile's settings to your base station. This action will replace any existing settings on your base station.

When you exit the Base Station Manager app, it remembers which profile was last active, and will automatically reopen the same profile the next time you open the app.

Editing a Profile

Sometimes you may need to edit an existing profile, such as to add or delete RTUs, change the Wi-Fi password, etc. This can be done from the profile status view by clicking the Edit Profile button. This will bring up the same editor screen that you previously used when creating the profile. When you are finished editing, you need to click the Save button.

Remember to connect your base station to the computer and click Upload Profile to apply your modified settings as soon as possible. In the profile status view, you can compare the "Modified" and "Uploaded" times to verify if this has been done. If the "Uploaded" time is earlier than the "Modified" time, it means that you have not yet uploaded the modified settings.

Deleting a Profile

If you no longer need a particular base station profile, you can delete it by pressing the Delete Profile button in the profile status view. A message box will ask you to confirm your choice. Note that the act of deleting a base station profile does not remove that base station or its associated RTUs from your Tree Rhythms account. It also does not affect any current settings stored onboard the base station itself.

Updating Base Station Firmware

HeartMath will occasionally release base station firmware updates. These may include important bug fixes, new features, and performance improvements. To ensure that your base station continues to work reliably, we encourage you to download and install firmware updates as soon as they become available. Base station firmware updates can be downloaded here:

https://treerhythms.net/installation

After downloading an update, open the Base Station Manager and connect your base station USB cable to the computer. Wait for the "Ready" status, then open the Tools menu and click "Update Firmware" (Figure 18).
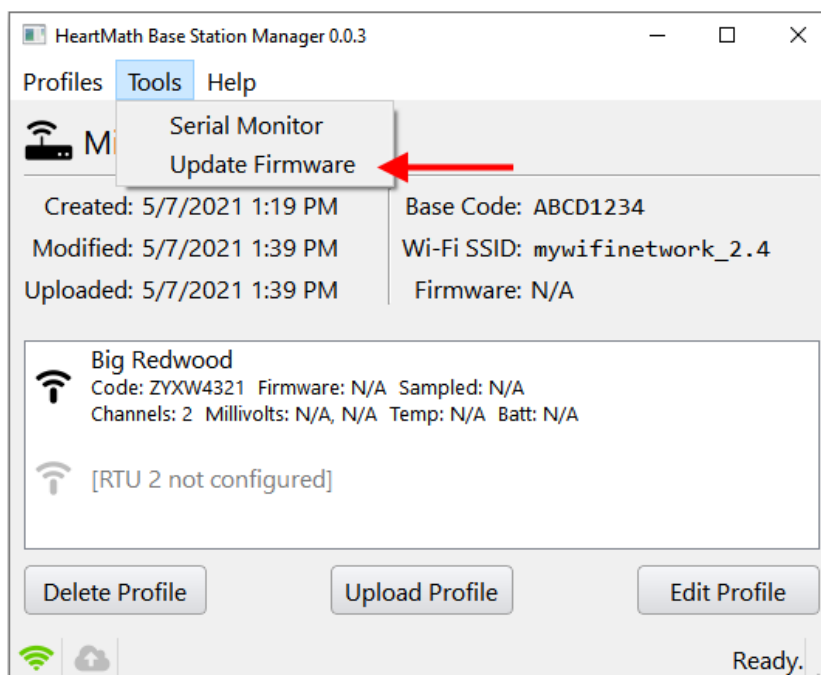

Figure 18

In the file browser dialog (Figure 19), navigate to the location on your computer where you downloaded the firmware file, click once on the file to select it, and then click "Open" to continue.
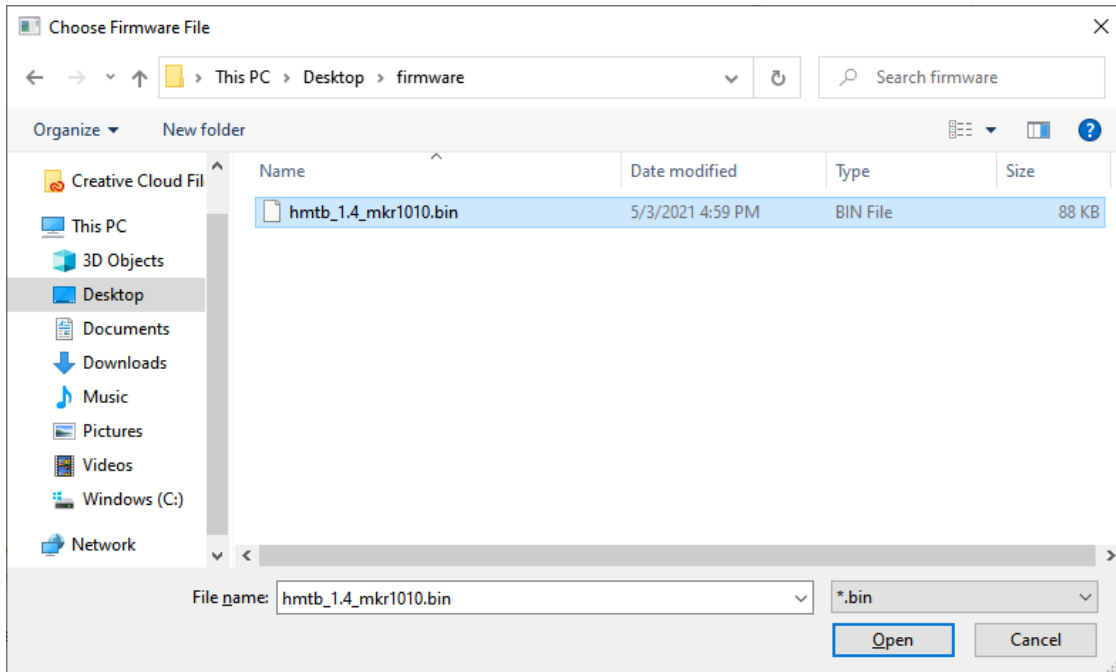
Figure 19

At this point the automatic firmware update process will begin. The update involves several stages and usually takes less than 20 seconds to complete. During this time, a progress window will keep you informed about what is happening (Figure 20). Do not unplug the base station from the computer until the update is complete.

Figure 20

If the update completed successfully, you should see a message like the one shown in Figure 21. At this point you can safely unplug the base station from the computer, or leave it connected to continue monitoring its activity.

Figure 21

If a problem occurs during any stage of the firmware update, a popup message will explain what to do.

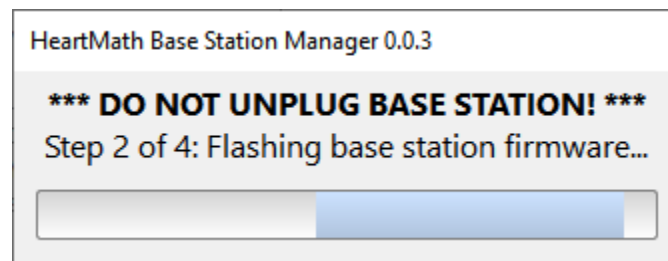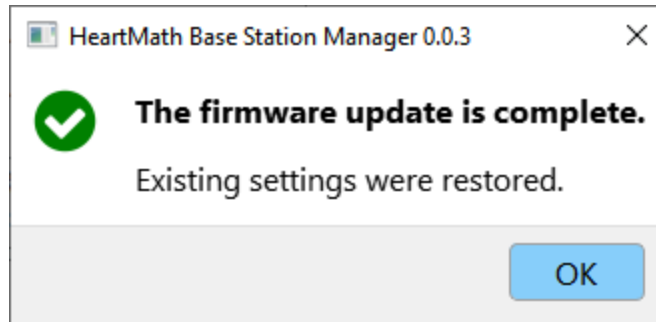## Accessing the Serial Monitor (for Advanced Support)

Most of the time you will be tracking your base station and RTU activity via the Tree Rhythms website, or, when the base station is attached directly to your computer, by looking at the various displays in the Base Station Manager app. However, in some situations, especially for advanced customer support, it can be helpful to access a more detailed live view of the system in operation. This is done using the Serial Monitor, which is accessible from the Tools menu. Because this is a complex topic intended mainly for advanced support, the following is just a brief overview of the Serial Monitor's purpose and capabilities.

The Serial Monitor window (Figure 22) provides a scrolling text display of the activities of your base station and paired RTUs as they collect data and communicate with the Tree Rhythms server. The Serial Monitor is also interactive, allowing you to control and configure your system directly by typing special commands.
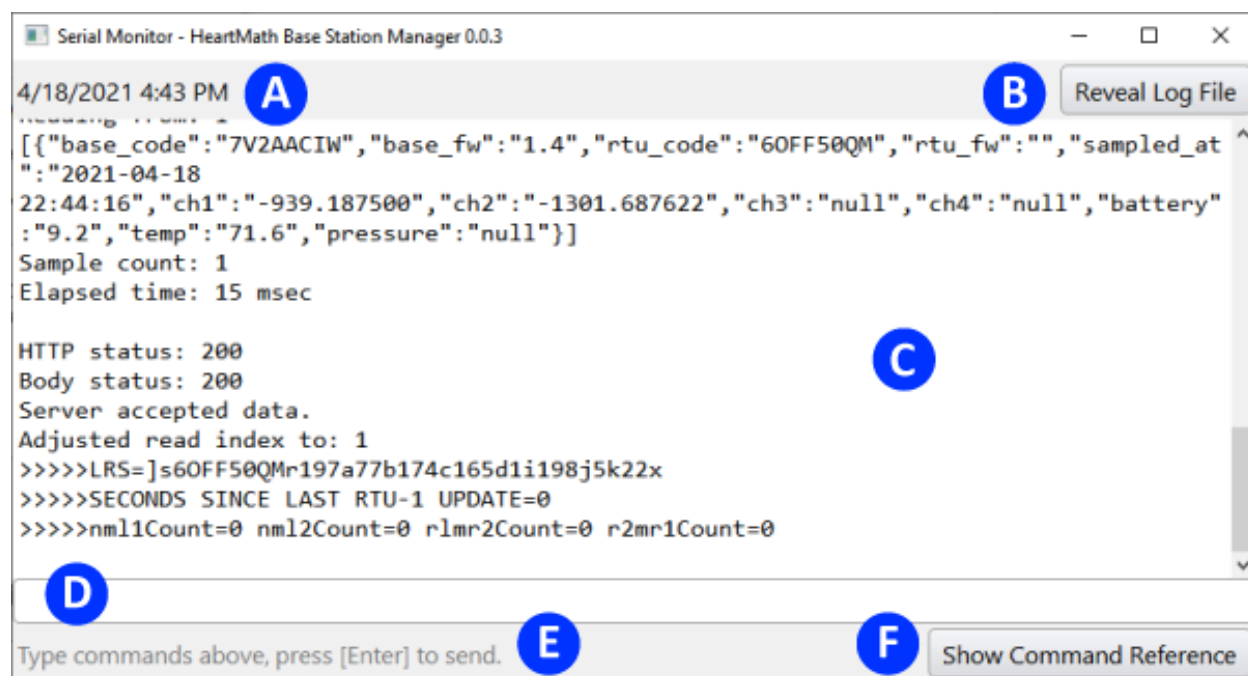
Figure 22

At the top of the window, a label indicates the date and time when the base station was most recently connected to the computer (A), and a button is provided to reveal the current serial log file (B). In the middle is the main display area where messages, events, and other information are printed (C). Below that, a text box allows you to type commands and respond to system prompts (D). At the bottom is a status label (E), and another button which can be pressed to bring up a reference of available commands (F).

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Accessing Log Files

For troubleshooting purposes, advanced customer support may request to see logs of device and app activity, which can often help to solve challenging problems. These logs can be obtained using the actions provided under the Help menu (Figure 23, highlighted in red).
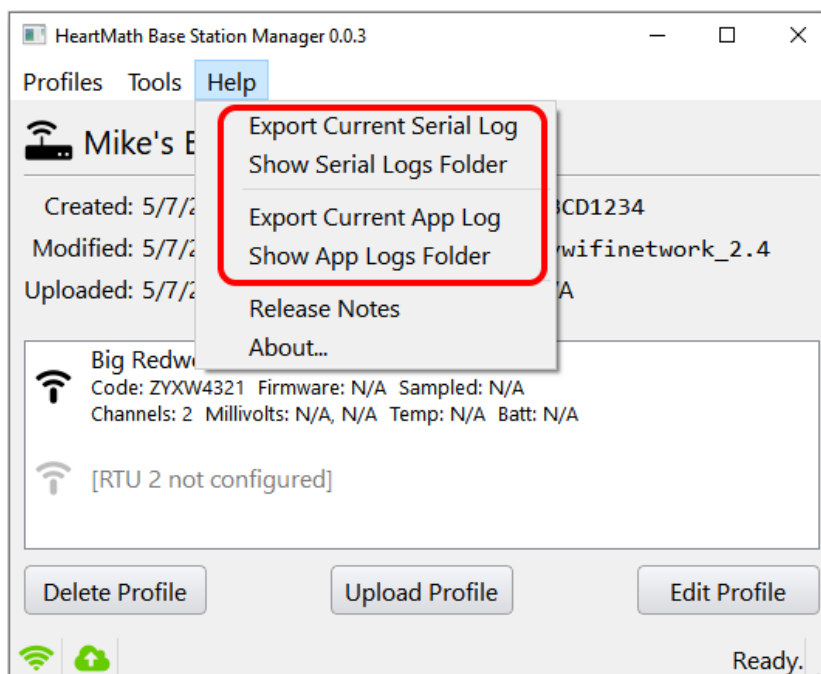

Figure 23

From top to bottom these actions include:

- **Export Current Serial Log** (only available when the base station is actively connected to the computer): Allows you to save a file containing a timestamped record of all events related specifically to the base station, its paired RTUs, and server communications, spanning from the moment the base station was most recently connected to the computer up until the moment that the file is exported. This corresponds with what is viewable in the Serial Monitor window.
- **Show Serial Logs Folder**: Opens a folder containing all available serial logs. This can be accessed anytime regardless of whether the base station is actively connected to the computer.
- **Export Current App Log**: Allows you to save a file containing a timestamped record of events related to the Base Station Manager app itself, spanning from the moment the app was most recently started up until the moment that the file is exported. This includes information not available in the serial logs.
- **Show App Logs Folder**: Opens a folder containing all available app logs.
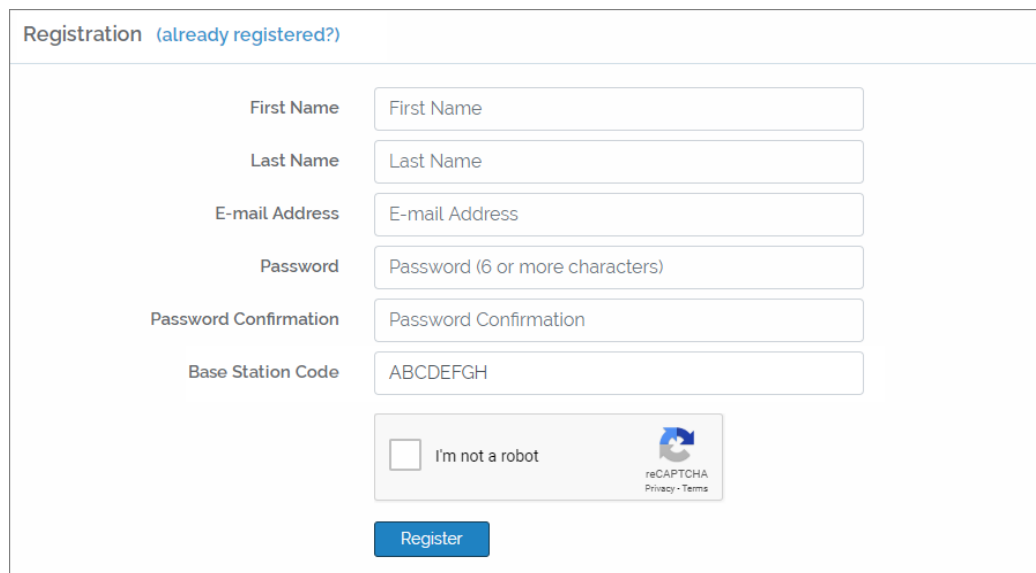
5. Connecting to the Tree Rhythms Network server

Registration (RTU and Base Station owners only)

After you have set up and connected the base station to your RTU and Wi-Fi network, the next step is to log into the Tree Rhythms website.

Using your web browser log into https://treerhythms.net/

A. The Registration window can be accessed by clicking on the Registration link in the upper right corner of the home screen. If you don't see the Registration link, click on the "Tree Rhythms" label in the upper left corner of the window to make sure you are on the home screen.

- enter your name and email address and a password of your own choosing
- enter your base station code into the Base Station Code entry box. (The code can be found on the back of the Base Station.)
- check the "I'm not a robot" checkbox
- click on the "Register" button to complete the registration process

B. Login (RTU and Base Station owners only). The login window can be accessed by clicking on the Login link in the upper right corner of the home screen. If you don't see the Login link, click on the "Tree Rhythms" label in the upper left corner of the window to make sure you are on the

home screen.

- enter your email address and the password you selected when you registered
- check the "I'm not a robot" checkbox
- click on the "Login" button to complete the login process

If you have previously registered and forgotten your password selection, you can use the "Forgot Your Password" link to reset your password.

Login (not yet registered?)

E-mail Address	E-mail Address
Password	Password

I'm not a robot
reCAPTCHA
Privacy - Terms

Login   Forgot Your Password?

Linking to a New Base Station:

Base stations must be configured by connecting a laptop directly to the base station before they can be linked to the web interface software. This configuration process registers the base station with the web-based software.

Once a base station has been successfully configured, opening your personal dashboard should automatically locate the base station and begin the linking process as shown in the window below.

Once linking is complete:

- enter a name to identify the base station on your dashboard display
- click on the "Save" button to complete the linking process

If one or more RTUs have already been configured, the system will immediately begin linking those units once base station linking has been completed.

Registration (already registered?)

First Name	First Name
Last Name	Last Name
E-mail Address	E-mail Address
Password	Password (6 or more characters)
Password Confirmation	Password Confirmation
Base Station Code	ABCDEFGH

I'm not a robot — reCAPTCHA Privacy - Terms

Register

Linking to a New Remote Tree Unit (RTU)

RTUs can be configured and then linked to the system by connecting a laptop directly to the base station. Once an RTU has been successfully configured, opening your personal dashboard should automatically locate the RTU and begin the linking process as shown in the window below.

Once the linking process is complete, the system will display the RTU editing window shown below for you to fill in information describing the tree where this RTU is located, or will be

installed. You can also upload a picture of the tree if one is available. If you don't have one, you can always come back and upload a picture at a later time (see below). Please do your best to provide all this information about your tree and upload a photo of it.

Dashboard

Your personal dashboard is the screen you arrive at immediately after logging in. Once you have configured and linked to a base station and one or two RTUs, the data from those RTUs will be displayed in a chart format on your dashboard screen as shown below. Essentially all operations described in this document will be performed from this screen.
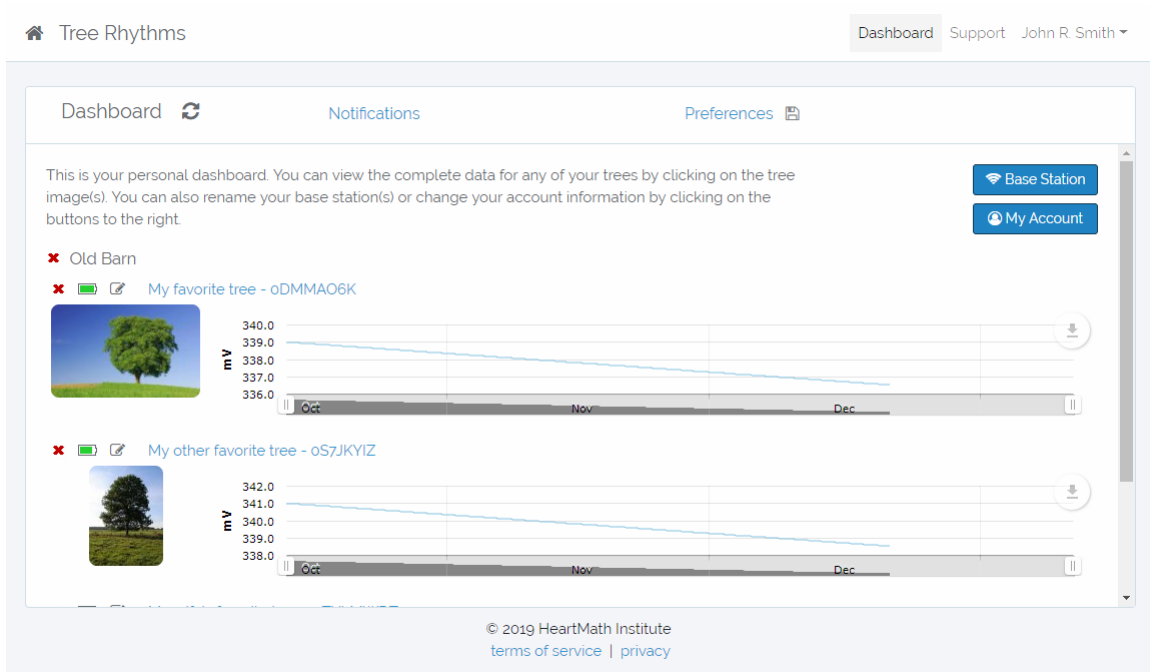
6. Installing the Remote Tree Unit

If possible, locate an RTU enclosure with electrodes on the shadiest side of the tree (the north side in the Northern hemisphere/South side if below the equator). This will help reduce the effects of solar heating on the system electronics.

A. Using a tape measure, mark the tree approximately 5 feet (150 CM) from the ground. This is where the top electrode will attach (stainless steel machine screw with the black wire attached). Make another mark 10" (5.5 CM) below the top mark. This is where the electrode with the white wire will be placed.
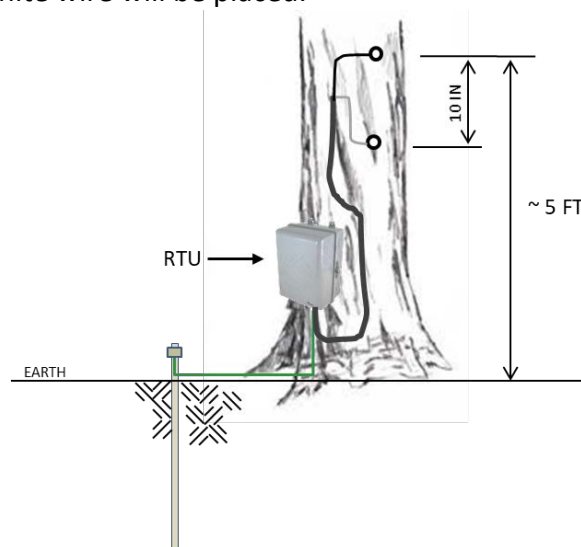
B. Using a large flat blade screwdriver or small chisel, carefully remove the outer bark, making a circle or square about 2 inches (5 CM) in diameter at both of the electrode locations. It should be large enough that the wax-filled cap can connect with the cambium layer, but not much larger. Carefully scrape the bark away so that the cambium layer is exposed. The cambium layer is a wet delicate tissue right under the inner bark between the wood. This is the layer that forms the annual rings of wood.
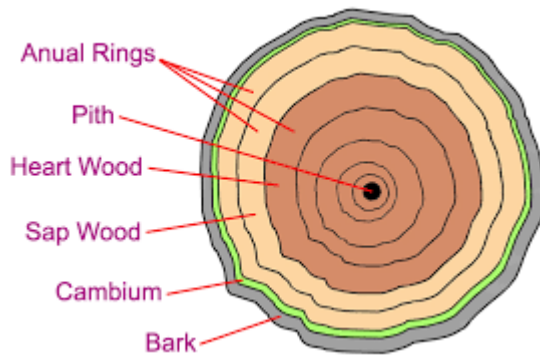
The thickness of the bark varies greatly among different tree types; it can be paper thin on some trees and several inches thick on others. On trees with a thicker bark, start by removing the thick layers, one at a time. If the tree has thin bark or you are unsure how thick the bark is, use a small to medium sized knife and gently peel back a thin layer of bark one layer at a time until you see the cambium. Typically, the inner bark holds more water and you will notice the bark becoming damp or wet as you get close to the cambium layer. Try not to damage the cambium layer.

The next image, left side shows the bark of a Madrone tree thin enough to scrape away with a small pocketknife. On the right, the exceptionally thick bark of a Redwood tree which ranges from a few inches to a foot thick on the older trees.

C. Next, choose a location below the electrode sites to mount an RTU enclosure. Using the three stainless steel wood screws, attach an RTU enclosure to the tree (two screws on top and one on the bottom of the enclosure), below the electrode sites. Typically, an RTU

enclosure is mounted to the tree trunk a foot or more below the lower electrode location. As an option, if the tree is smaller or the bark is too uneven, an RTU enclosure can also be mounted to a wooden 4-inch square post placed near the tree trunk.

D. Install the RTU antenna, the RTUs antenna was removed for shipping and should be reattached to the RTU at this time. The antenna attaches to the threaded jack on the top of the RTU enclosure. Carefully screw the antenna onto the threaded jack rotating clockwise. The antenna should be snug but do not over tighten, tighten with fingers only.

E. Now it is time to install the electrodes (stainless steel screws with wires already attached, one to a black wire and the other to a white wire).

Place the 1-1/2" stainless steel screw (electrode), which has the black wire attached to it, in the center of the area you have removed the bark from that is highest on the tree. This electrode is referred to as the reference electrode. Tap the screw with a hammer until 1 inch is embedded in the tree and 1/2 inch (1.5CM) is still exposed. Next, in same way as above, place the electrode attached to the white wire in the lower area where you have removed the bark. This is referred to as the active electrode.

F. Using cable ties with mounting holes, wrap any excess electrode wire into a coil, being careful not to tug on the electrodes. Secure the extra length of wire to the tree with one or two cable ties and screws.

G. Before installing electrode cap over the electrode, gently bend the wire connector down as shown in the image below. This will make the cap installation easier.

Next, center the wax-filled, white PVC caps over the exposed electrode and wire and push on the caps firmly until they make solid contact with the tree. Put one cap over each of the electrodes.
NOTE: Allowing the caps to sit in the warm sun or a warm place to soften the wax before installation will make it easier to install them over the electrodes and make good contact with the tree trunk.

H. In addition to measuring the voltage of the tree itself, the system also monitors the voltage between the tree and the earth. A ground rod is use for the earth electrode and should be located far enough away from the trunk to avoid hitting the trees roots. Large trees have larger roots that extend far beyond the tree trunk.

Install the ground rod near the tree by driving it into the ground with a large hammer, being careful to avoid tree roots. Tap gently at first, and if you feel that the rod is hitting a tree root, stop and try another location. If you can drive the rod in for approximately 12-24 inches (30 CM) without an abrupt increase in resistance, you are likely clear of tree roots and can continue driving the rod in to the ground. However, if you hit something hard, pull the rod out and try a new location. Drive the rod 36-40 inches (~90 CM) into the ground leaving only 8-12 inches (25-30 CM) of the rod above the ground.

Place the wire clamp on the rod about 2 inches (5 CM) below the top of the rod. Strip approximately one inch (2.5 CM) of the plastic insulation off the end of the green wire. Run this green wire (ground) from the RTU enclosure to the ground clamp and clamp it under the ground clamp screw.

Note: The green wire can be shortened if desired, but ensure that the wire is not too tight. There should be enough wire length that it can lay on the ground and go up the tree trunk into the enclosure. Leave several loops of wire near the enclosure.

Next, mount the solar panel in a location that gets as much direct sun as possible. It should face the noon day sun (to the south in the Northern hemisphere and to the north in the Southern hemisphere). Do not place the solar panel on the ground, especially where people walk. Use the mounting tabs and screws provided to attach it to a sunny spot on the tree or on a nearby post, fence, etc. When choosing a location for the solar panel it is important to consider the position and angle of the sun year-round. Choose a location

that will not be in the shadows or obstructed by other trees or buildings during the winter months when the sun is lower in the sky.

Plug the cable coming out of an RTU box into the connector at the end of the solar panel cable. Run the cable in such a manner so that it will not be in the way of people walking, lawn mowing, etc. Note: the standard length of the solar panel cable is 25 feet (7.6 meters). Longer cables can be ordered depending on where the solar panel will need to be located.

I. Connecting the solar panel to the battery. Open the RTU enclosure and connect the lead wires from the solar panel to the battery. Start by connecting the black wire to the black battery terminal and the white wire with red marker tubing to the red battery terminal. Slide the connectors all the way on the appropriate battery terminal.


J. Connecting power to the RTU circuit board.

BEFORE PROCEEDING: do not connect the RTU circuit board to the battery until you are ready to complete the base station setup. Anytime the RTU circuit board is first powered up it enters an active listening mode, waiting for signals from the base station. The RTU will stay in listening mode until it hears from the base station. While in listening mode the RTU consumes more power than during normal operation and could drain the battery if left for too long waiting for the base station to contact it.

In most cases, the RTU battery was removed from the enclosure for shipping and must be installed before using the RTU. Remove the bolt from the battery straps, put the battery in the enclosure and bolt the straps around the battery.

K. After the RTU has been mounted to your tree or post and you are ready to turn it on connect the RTU power cable leads to the piggyback terminals of the solar panel that have already been connected to the battery. The red RTU power wire should be connected to the connector on the red lead of the solar panel on the red battery terminal. The black RTU power lead should be connected to the connector on the black wire terminal. When the RTU is first powered on the red LED on the circuit board will blink 4 times indicating a successful startup.
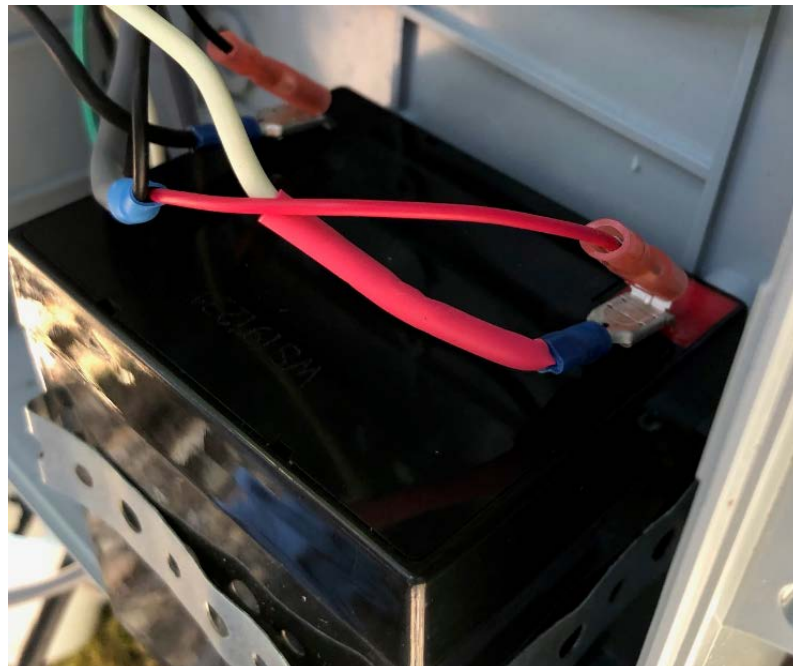
Should the RTU ever need resetting, the black button in the center of the board will initiate a reset by temporally interrupting power to the board.
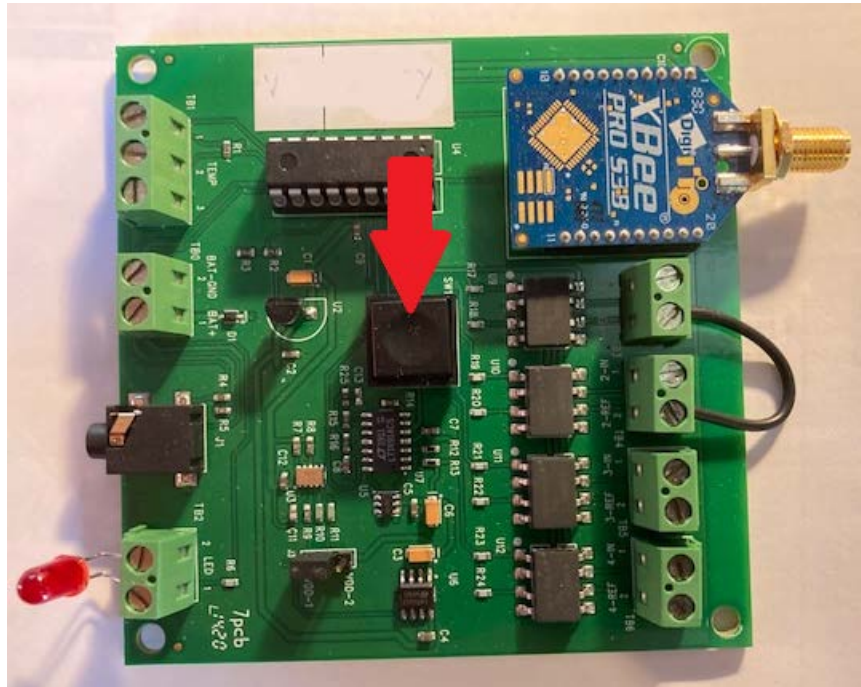
7. How to use the primary data display on the website

Live Data

The Live Data screen is available to any website visitor and does not require registration or login. As described below, this screen allows you to view and compare tree rhythms for up to 8 trees at a time.

The Live Data screen can be accessed by clicking on the Live Data link in the upper right corner of the home screen. If you don't see the Live Data link, click on the Tree Rhythms label in the upper left corner of the window to make sure you are on the home screen.

Below is a description of the various options that are available when charting tree rhythm data. The chart will automatically begin updating approximately 3 seconds after you make a change to one or more of the charting options. This delay is designed to give you time to make several changes before the chart begins updating. Note that the time required for the chart to update will depend on the amount of data requested, so charting times will increase with longer time periods and more tree selections.

Here are the basic steps to produce a chart:

1. Select a time interval by clicking on the appropriate button or click on Dates to set a custom date range.
2. Select the channel(s) you would like displayed for each tree that you would like to chart. (channel 1 = voltage potential within a tree, channel 2 = voltage potential from a tree to the ground.)
3. Click on one or more trees using the large icons at the bottom of the charting window. Clicking once on these icons causes their images to be added to the row of small icons above. (Clicking again on a large icon causes its image to be removed from the row of small icons.)
4. Click on one or more trees in the row of small icons causing their border to thicken and be displayed in a unique color. The color of the border on each of these icons indicates the color of the line(s) on the chart corresponding to that particular tree. (Clicking on a small tree icon a second time will remove the border and remove that tree from the chart.)
5. Any of these settings can then be changed in any order you choose. Changing any of these settings will automatically cause the chart to refresh approximately 3 seconds after the change has been made.