Using LOGGER for Electricity Usage Monitoring

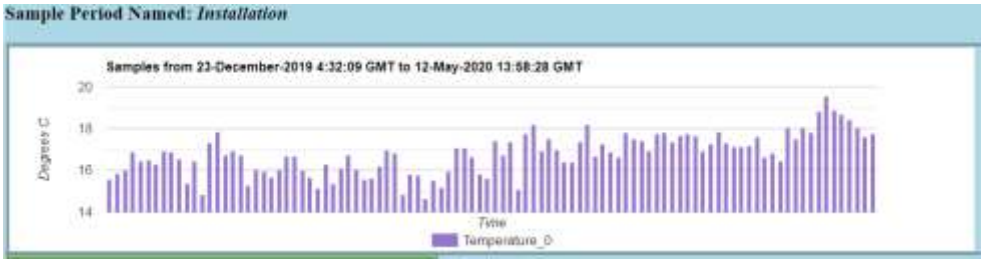
USER MANUAL

DRAGONNORTH GROUP

1 Contents

2 Introduction

For Electric Consumption monitoring the LOGGER typically is used to record a history of Kwh usage. Other sensors if connected are also logged. The LOGGER reads sensors and creates a permanent record of what it has observed. This data is stored on the SD card inserted into the LOGGER. By default, the LOGGER reads all sensors every 10 seconds. A 32Gb card will store about 20 years of data.



The LOGGER is a miniature Web Server allowing you the user to observe the history and control the LOGGER from tablets, computers and smart phones.

The LOGGER presents on it's web pages a menu of choices which allow the user to navigate among options. Sections of this menu will be covered in later chapters of this document.

Caution: The connectors on the LOGGER box are the same connectors that are used for the internet. These connectors are not internet connections and should not be plugged in to your router. The LOGGER communicates only by WiFi.

3 Network Setup

When the LOGGER is first turned on it is ready to work with you. In addition to being a Web Server the LOGGER is an Access Point (like a WiFi router). You can connect to the LOGGER as you do with any WiFi router and then use it as a Web Server. After connecting to the LOGGER all of the LOGGER web pages are available. Connect to the LOGGER as if it were a WiFi router and browse to http://10.1.1.1/. Some display features (graphs in particular) will not work when you use the LOGGER as your Access Point (Wifi router). These features depend on libraries that your browser must obtain from servers on the internet. When you use the LOGGER as an Access Point the rest of the internet is not available.

3.1 Tell LOGGER About Your Network Server

The LOGGER does not know about your local WiFi network when you start. To tell it about the local network first connect to it instead of the local network. The images below come from a Windows computer. Tablets, Smart Phones or Apple computers will not exactly match.

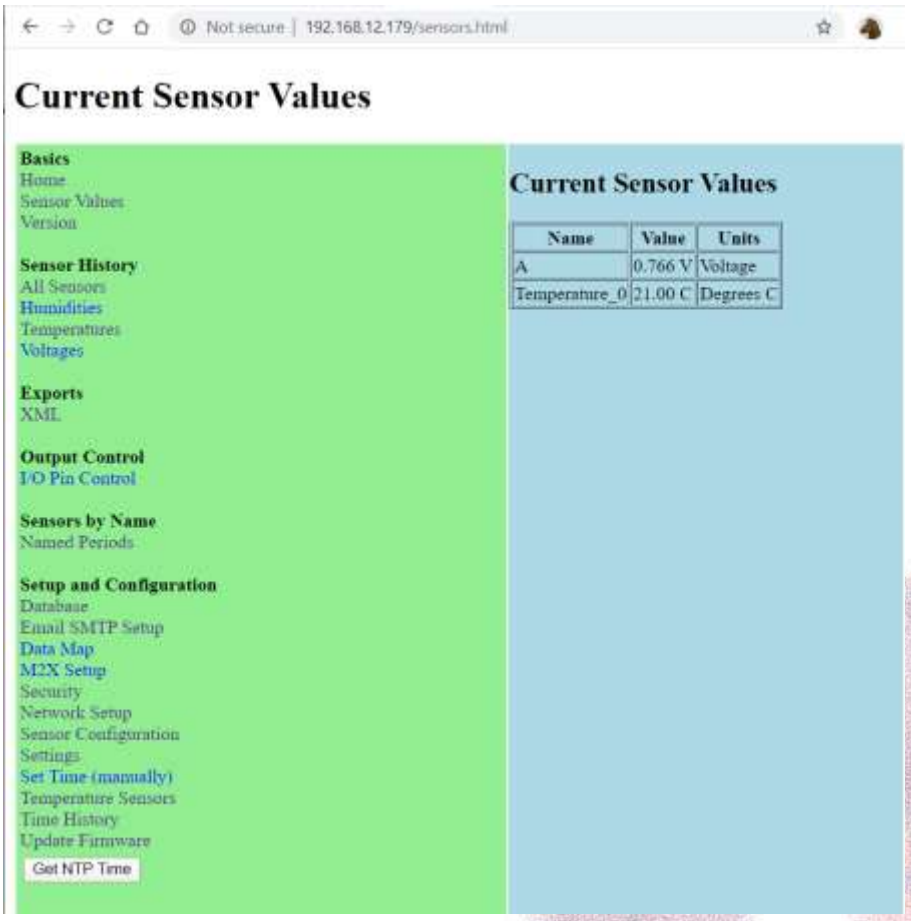
3.1.1 Connect to the LOGGER

Scan the local WiFi networks on your phone or tablet. The LOGGER shows up in the list of networks using the name LOGGER_xxxx where xxxx is part of the LOGGER's serial number.

Treat the LOGGER like any other WiFi network and connect to it. The Tablet or Computer system will likely say that there is "No Internet". This is normal, while connected to the LOGGER you will only be able to see the LOGGER itself and will not be able to browse other web sites.

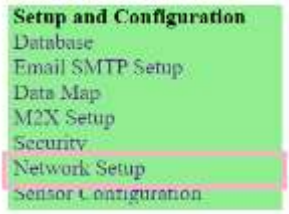
3.1.2 Talk to the Logger With a Web Browser

Open a web browser and type http://10.1.1.1/ into the address line browser. This will bring up the home page of the LOGGER showing the Current Sensor Values:

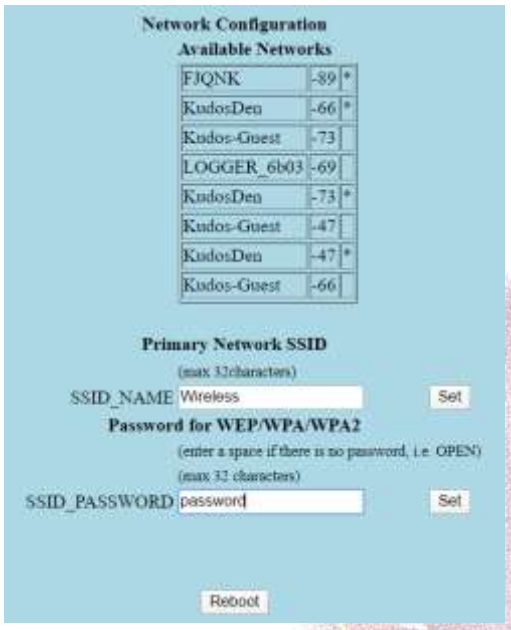


3.1.3 Network Setup Page

Choose “Network Setup” from the menu at the left

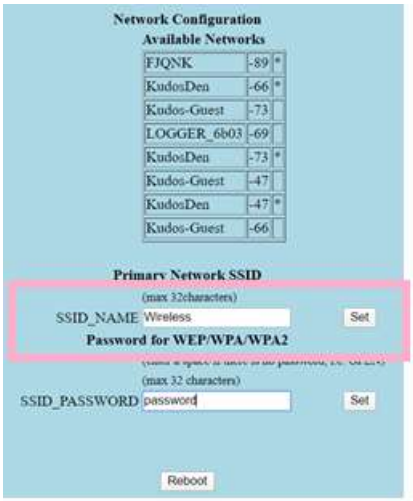


to bring up the Network Configuration page:



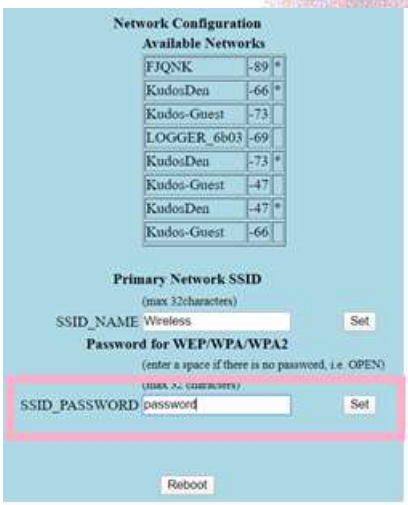
3.1.4 Enter SSID Name and SSID Password

In the SSID_NAME field enter the name of your wireless router and press the Set button next to that field.

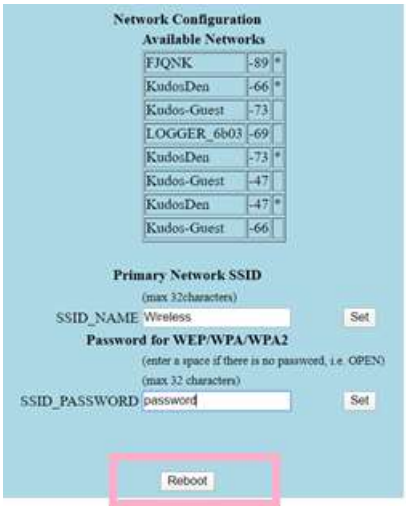


It is very important to press the Set button before going on to the next step.

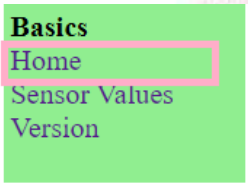
Next enter the password of your wireless router where it says SSID_PASSWORD and press that Set button.



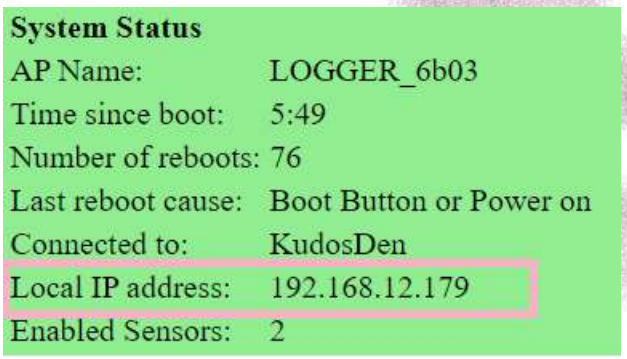
Finally press the Reboot button. Don't forget to press the Set button for the password first.



After pressing the Reboot button it will likely be necessary to connect to the LOGGER WiFi network again. It can take a minute for the system to reboot. After connecting to the LOGGER WiFi network again browse to http://10.1.1.1/.



At the bottom of the menu System Status information is displayed. Write down the Local IP address (192.168.12.179 is shown here yours will be different). This address will be needed later:

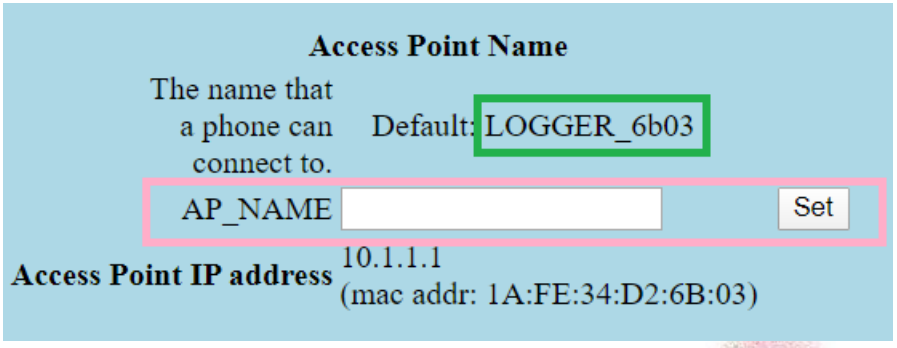


3.1.5 Network Setup Complete

LOGGER network setup is now complete, reconnect to your normal WiFi network.

3.1.6 Optional: Name Your LOGGER

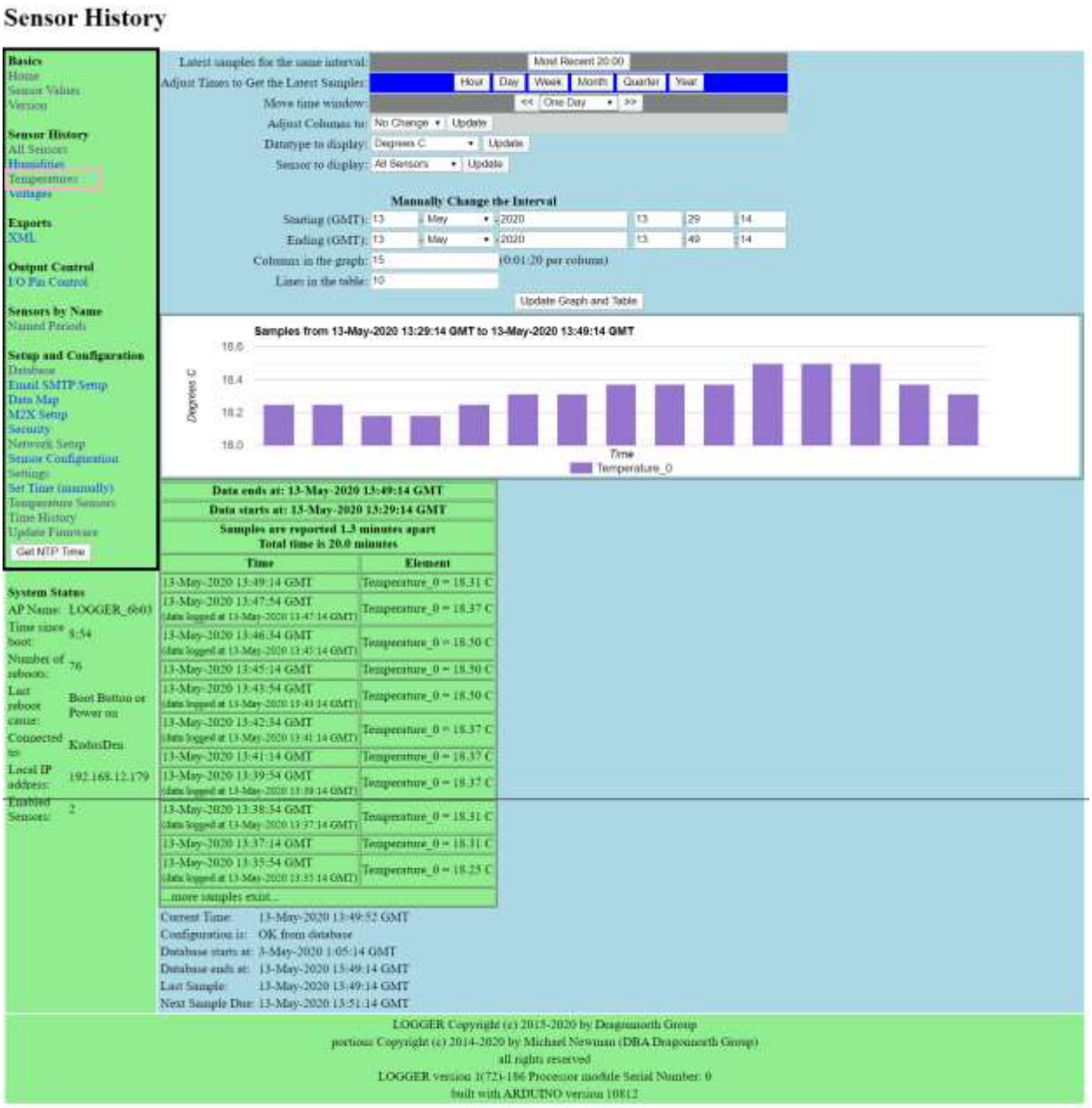
Like a WiFi router the LOGGER has a name that shows up in the list of WiFi routers. This name starts out as LOGGER_xxxx where xxxx comes from the unique MAC address of the LOGGER (green box below). you can change this name. Call the logger whatever you want “Refrigerator_7” might be a good name for the LOGGER watching that refrigerator. Fill in your desired name (pink box) and press the Set button. Remember the name will change, the LOGGER will now use this name (in your WiFi router list) after a Reboot.



4 Temperature History

Put the **Local IP address** noted when the system was set up into your browser. This brings up a page on the LOGGER acting as a web server.

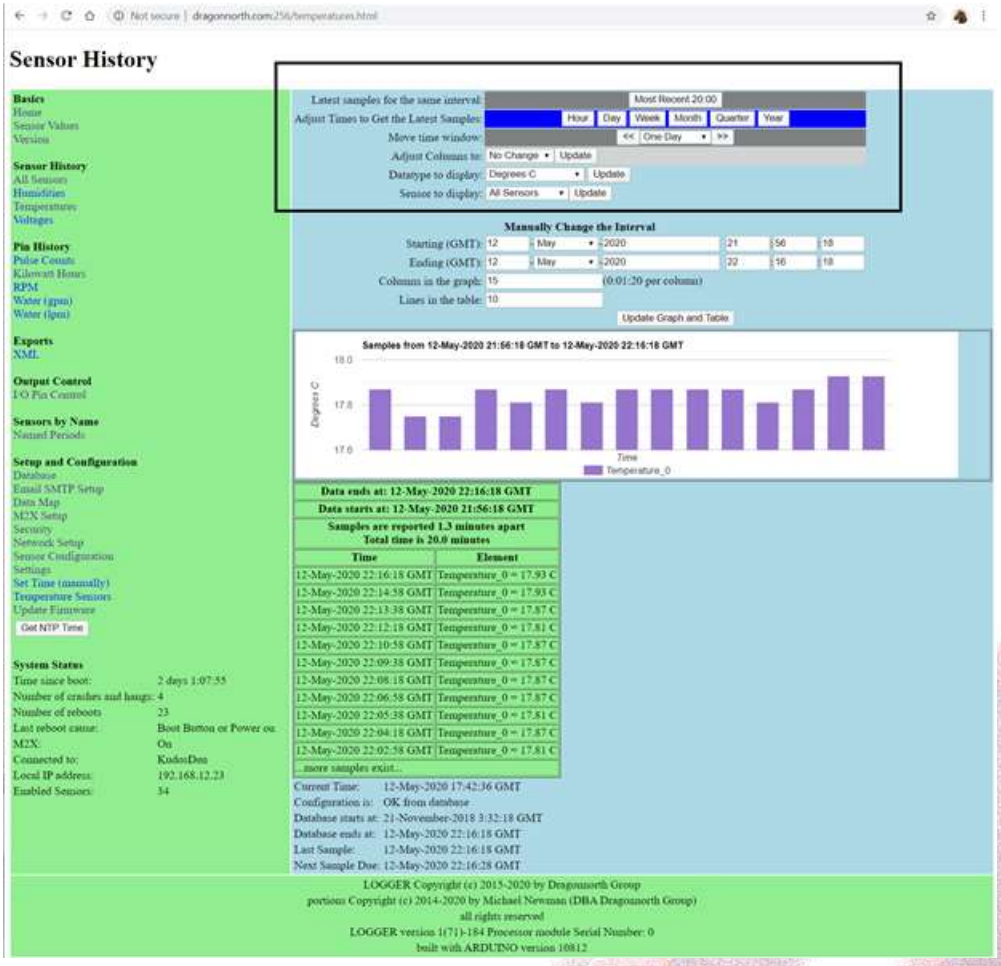
Click on **Temperatures** in the menu to get this page.



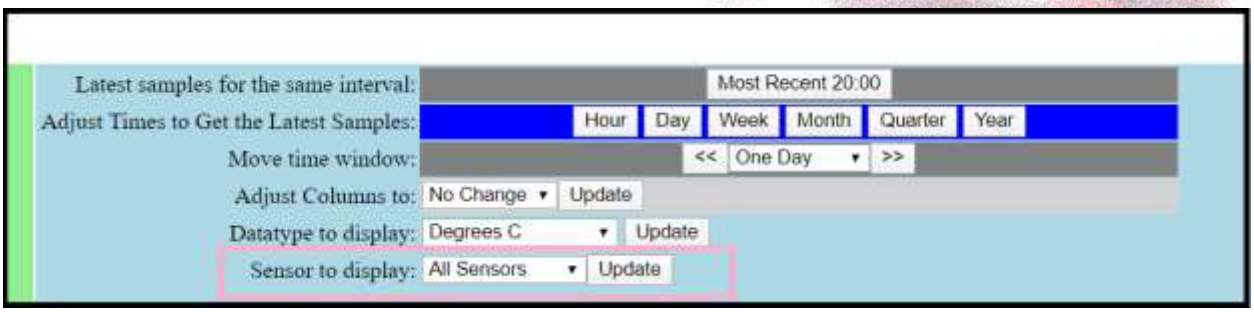
The section of the page outlined in black is the Menu. There are a number of headings in the menu that group the menu items by their purpose. Clicking on the **Temperatures** link brought up this page. The example page has only one temperature sensor. Your system may have several temperature sensors

Below the menu is system status information.

This Section of the page allows you to select what you are seeing in the graph and table below it.

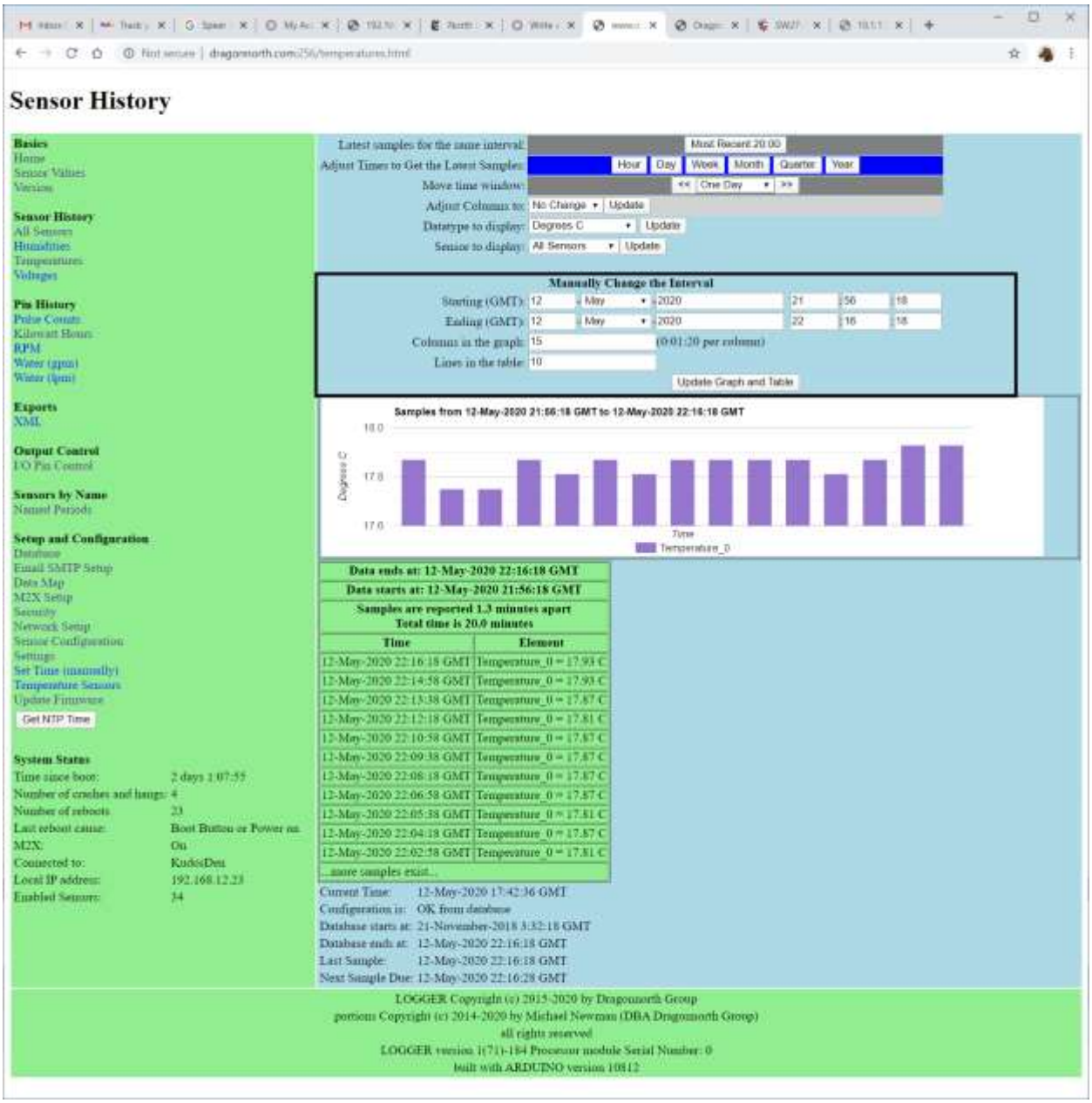


To keep this discussion simple, pull down the “Sensor to Display” field, choose Temperature_0 and press the Update button next to that field.



The next section of the page shows what is currently being displayed in the graph and table below it.

The graph shows temperature readings over the selected time period. The table shows some of these readings. You control how many readings are in the table by adjusting the “Lines in the table:” field. Date time and columns are all user selectable fields. Change any of the fields and then click the update button to refresh the display.



5 Sampling and Logging Strategy

Sensors are read and the values are appended to the log every sampling period (10 second default). The data recorded each sampling period is a fixed size, always the same size. Finding an element at a particular time is just going to the correct place in the log file. This is much faster than a database search and makes the LOGGER possible on a tiny inexpensive processor.

This also means that the amount of time it takes to display 100 elements is the same no matter what date and time those elements come from.

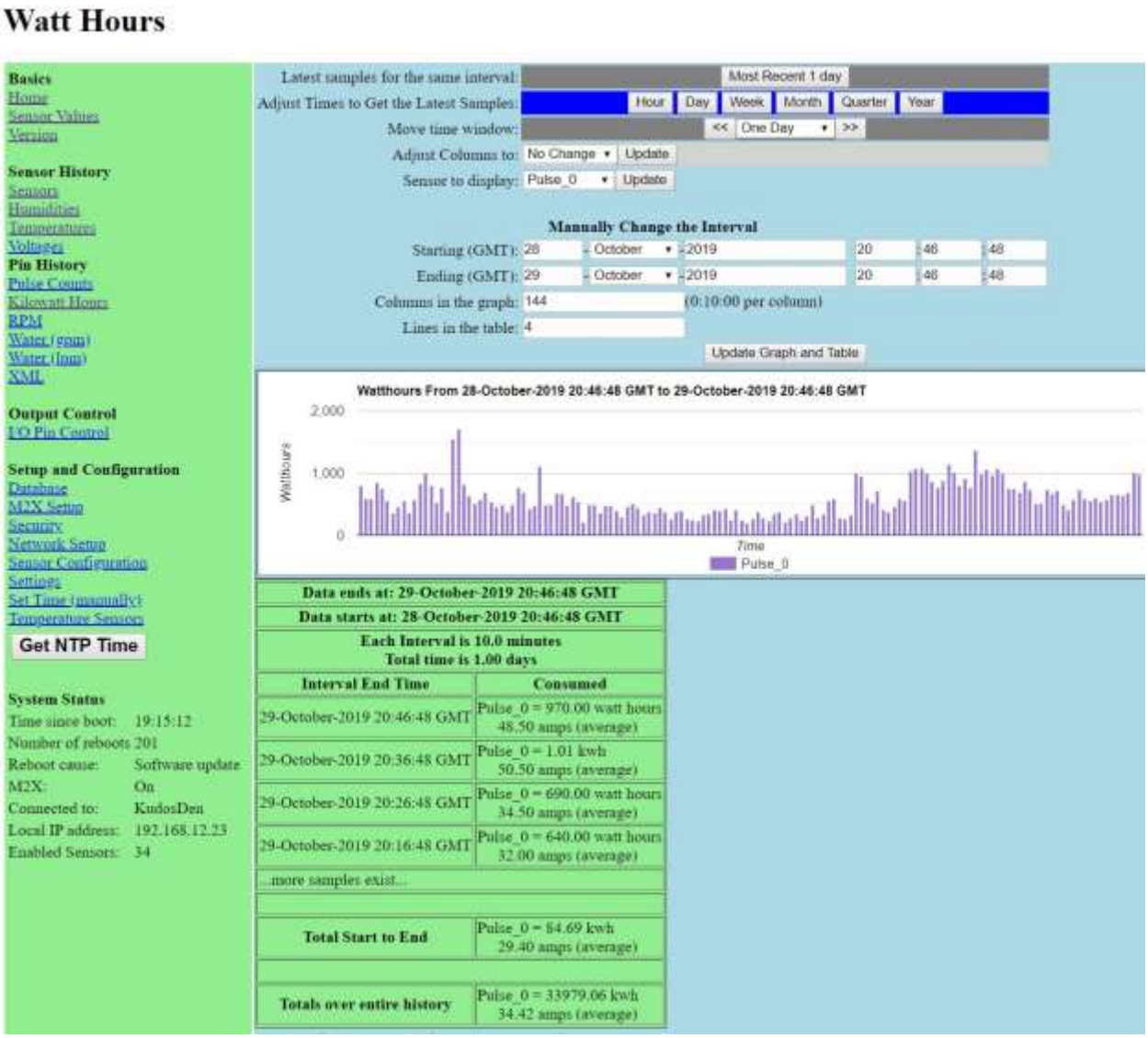
The strategy of logging every sample period is especially important when recording liquid flow or kilowatt hours. Each of these are measured by a counter that counts an exact number of times per gallon (or kwH). The count keeps going up all the time. What is logged in the data file is the current value of the counter. If you want to know how many kwH were used between 12:05 and 1:33 read the counts for each of those times and subtract! Keeping counts of usage to date makes knowing how much was used in any interval possible and makes the display of the usage data independent of the time period. Report on how much was used each day or every 13 minutes without any difficulty and no performance difference. The time period of the summary period is chosen at the time of display, NOT the time of data logging.

6 Power Consumption Measurement

The LOGGER can compute Kilowatt Hour usage. Any pulse meter or a Continental Control Systems WattNode Modbus https://ctlsys.com/product/wattnode-modbus-wide-range/ meter can be used.

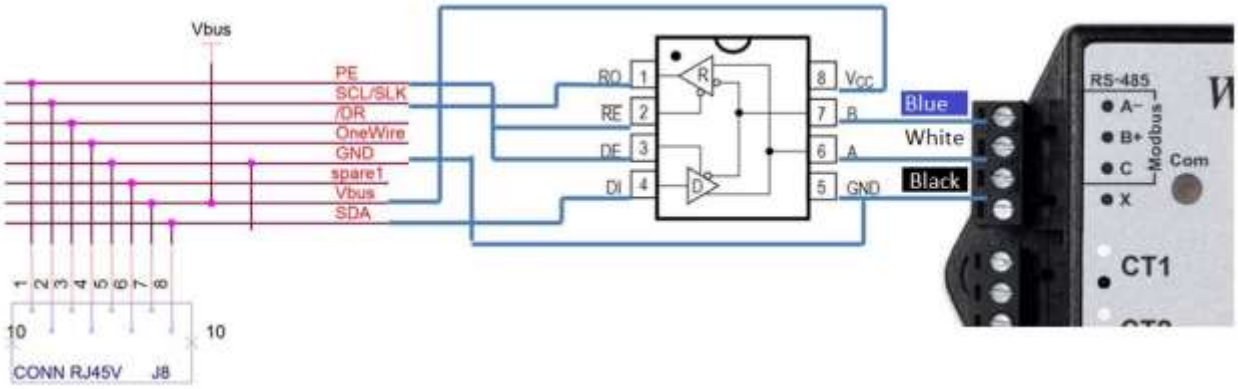
Put the **Local IP address** noted when the system was set up into your browser. This brings up a page on the LOGGER acting as a web server.

Click on **Kilowatt Hours** in the menu to get this page:



6.1 Modbus Interface

An interface to the WattNode Modbus meter is a relatively new feature, just completed in Q3 of 2021. A Modbus adapter cable



LOGGER to MAX3485				
Cat-5 to MAX3455				
Purpose	**Cat-5 name**	**Cat-5 pin and color**	**MAX3485 name**	**MAX3485 pin**
Enables output to Modbus	PE (Peripheral enable)	1 White/Orange	~RE (not receiver enable>	2 (also goes to 3)
	PE (Peripheral enable)	1 White/Orange	DE (driver output enable>	3 (also goes to 2)
Serial data out (from GPIO2)	SCL/SLK	2 Orange	RO (Receiver output to ESP)	1
Ground	GND	5 White/Blue	GND	5
Power (4 to 4.5V nominal)	Vbus	7 White/Brown	Vcc	8
Serial data in (GPIO4)	SDA	8 Brown	DI (serial data from ESP)	4

MAX3485 to WattNode Modbus meter		
Wattnode Pin	**MAX3485 name**	**MAX3485 pin**
A-	B inverting receiver input	7
B+	A noninverting receiver input	6
C	Ground	5
Note: In spite of the naming this will not work if A and B are reversed.		

is necessary to interface to the WattNode Modbus meter. A Modbus interface chip is contained in the cable.

A LOGGER I/O module is not needed to interface to a Modbus meter.

6.2 Pulse Interface

A LOGGER I/O module is necessary to connect a pulse meter.

For many years good success has been achieved with the WattNode Pulse meter from Continental Control Systems:

https://ctlsys.com/product/wattnode-pulse/

Connecting pins P1, P2, P3 of this meter directly to Pulse Counting pins of the LOGGER I/O module is all that is necessary (the COM pin connects to ground on the I/O module.

Similar to setting the flow count rations the number of pulses per milliwatt is adjusted on the **Settings** page. Here too the Set button must be pressed after each field is changed. If two or more fields are changed prior to pressing Set all but one of the numbers changed will be forgotten.

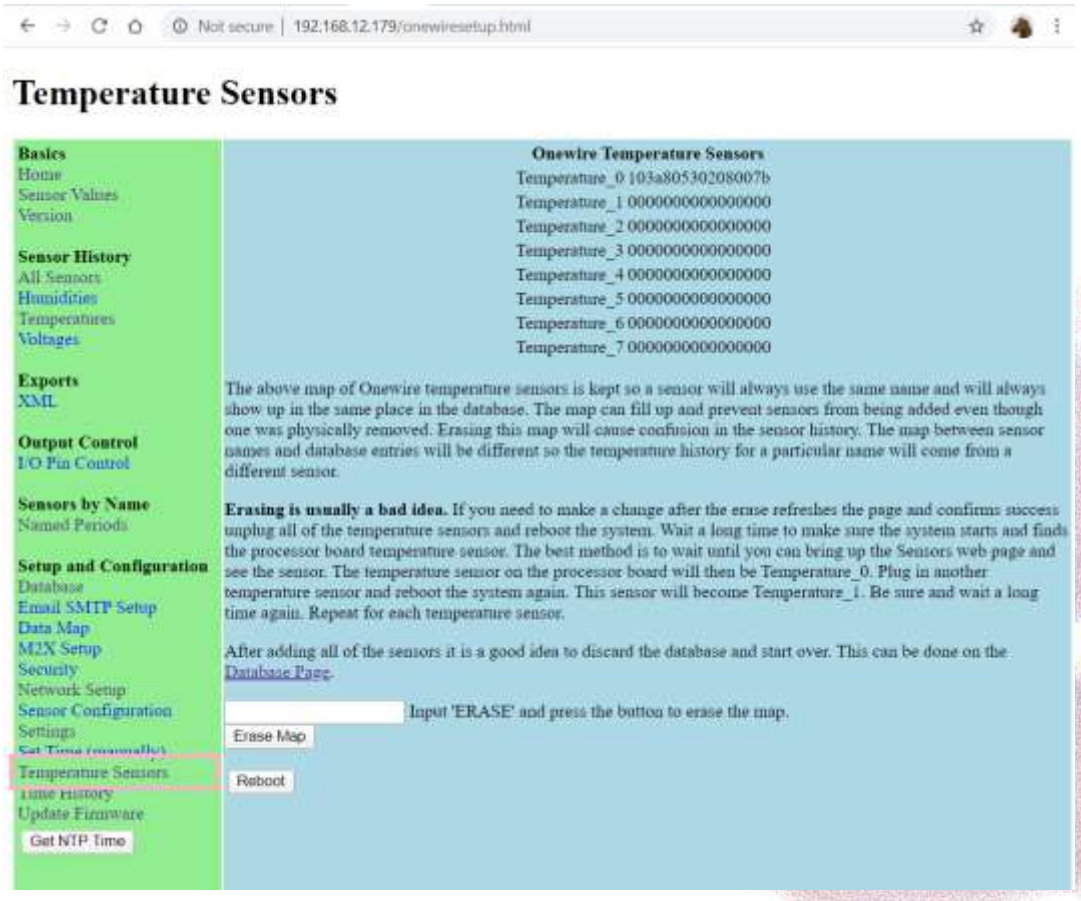
KWH Pulse Counters

mWatt_HR_per_Pulse_0	375	Set
mWatt_HR_per_Pulse_1	375	Set
mWatt_HR_per_Pulse_2	2500	Set
mWatt_HR_per_Pulse_3	2500	Set
mWatt_HR_per_Pulse_4	2500	Set
mWatt_HR_per_Pulse_5	2500	Set
mWatt_HR_per_Pulse_6	10000	Set
mWatt_HR_per_Pulse_7	10000	Set

7 Identifying Temperature Sensors

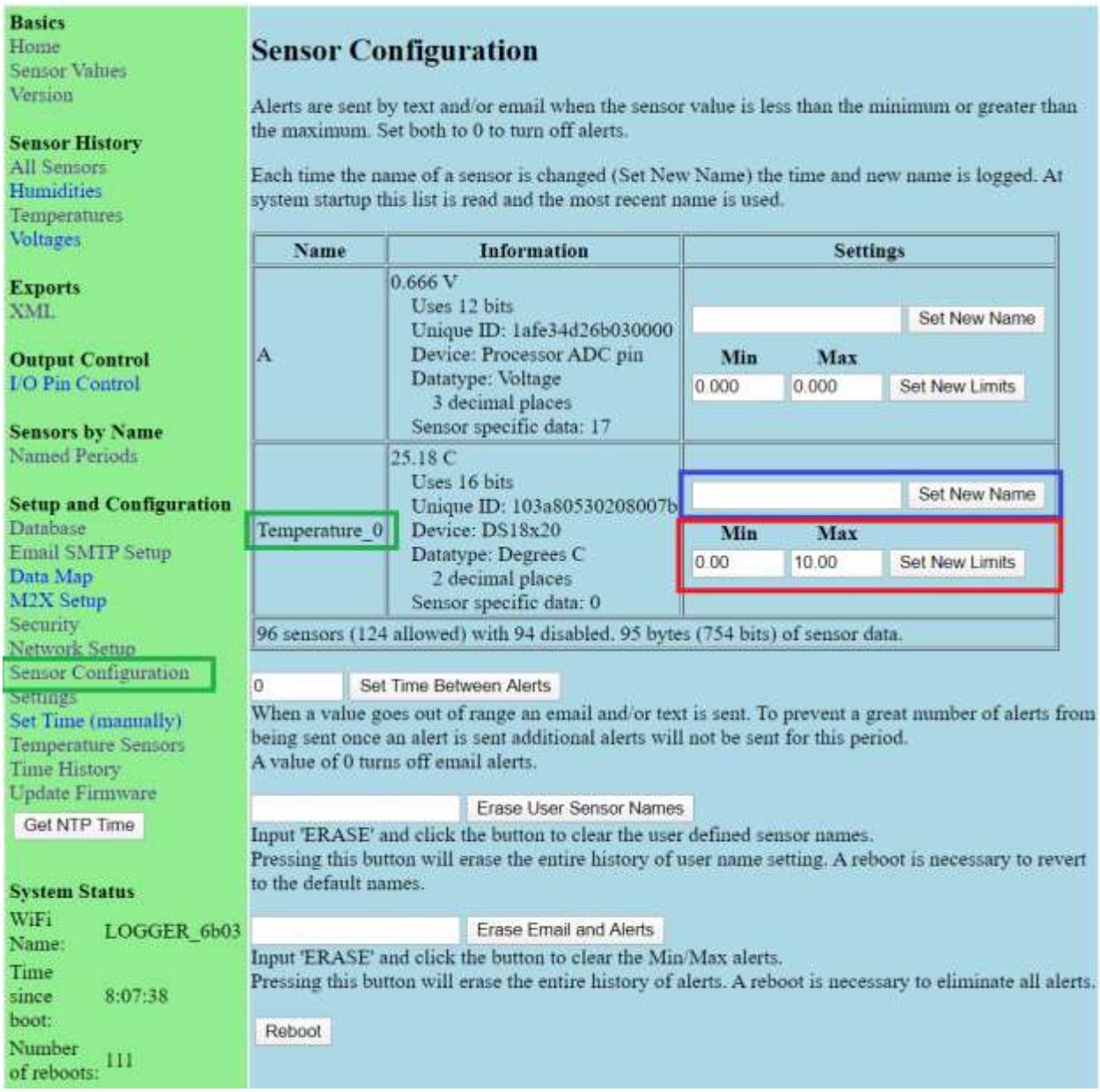
7.1 Default Temperature Sensor Names

The temperature sensors used by the LOGGER are OneWire devices and each sensor has a unique serial number. The LOGGER remembers these devices and gives each of them a name. The same sensor will always be given the same name. This map of names can be erased. The LOGGER will give the sensors names in the order it sees the sensors. To start over type ERASE in the field and then press the Erase Map button. Then power off the LOGGER and unplug all of the temperature sensors. Power the LOGGER on and the on-board temperature sensor will be found and called Temperature_0. Power the LOGGER off and plug in the next temperature sensor. Power it on and that will become Temperature_1. Do this one at a time and all of the sensors get names that are known.



7.2 User Defined Names

It is also possible to create your own names to replace the LOGGER's default names. Any sensor can be given a user defined name, not just temperature sensors (shown here). User defined names are created on the Sensor Configuration page. Put your own name in the field under the New Name column (blue box). Click the Set New Name button. The LOGGER will start using your name instead of the system default name (green box) on this page and on all other pages. The user defined names are recorded in a file called `usersensornames.bin` on the LOGGER's SD card. It is possible to erase all of the user defined names and revert to the default names. Input ERASE in the box and press the Erase User Sensor Names button. Although the user sensor names are forgotten this will not change until the LOGGER is restarted. This can be done by pressing the Reboot button.



8 Software Updates

Software updates are downloaded from the dragonnorth.com server. Sourcing the update from a local computer is not allowed for security reasons. To update the LOGGER firmware to the latest version simply go to the Update Firmware page and click on the 

button.

A poor network connection or congestion between the LOGGER being updated and the **dragonnorth.com** server can result is a failure in the update process. These failures are not easily noticed except by checking that the version number of the software has been properly updated.

Updates are safe, an update failure will not damage a LOGGER. When an update fails the LOGGER simply continues to run the old software.

9 Additional Sensors

The LOGGER understands many additional sensors. These sensors come in separate boxes and plug in to the processor box the same way the temperature probes plug in to that box. The LOGGER understands several of the common interfaces used by microprocessors; OneWire, I2C and SPI. Serial ports are also available.

Currently available as standard plug in sensors are:

9.1 Analog to Digital conversion.

There is one A to D sensor built in to the LOGGER processor. In addition, the Analog to Digital plug in box adds eight more.

9.2 Digital Inputs and Outputs.

16 channels (pins) of I/O are available on each of two plug in boxes. 8 of these channels count pulses and can be used for liquid flow or kilowatt hours measurements.

9.2.1 Temperature and Humidity or Temperature Humidity and Atmospheric Pressure.

There is a plug-in box with a combination Temperature and Humidity sensor.

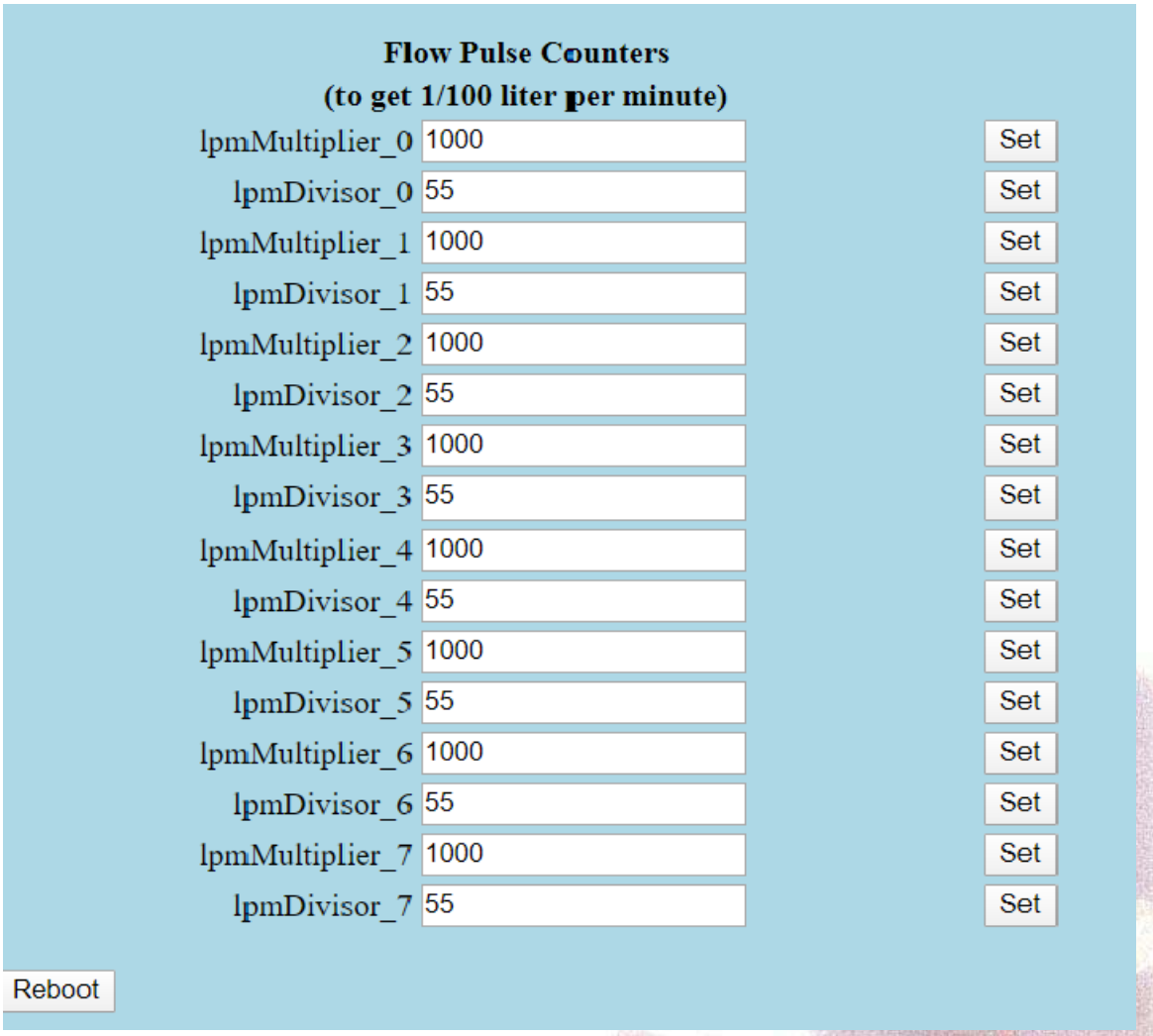
There is also a plug-in box with a combined Atmospheric pressure, Temperature and Humidity sensor.

9.3 Water Flow Measurement

This FS400A water flow sensor (and many others) can be plugged directly into the I/O modules of the LOGGER.

The conversion ratio from the pulses put out by the sensor to liters per minute are built in to the LOGGER. This ratio can be adjusted by the user on the Settings page. Gallons per minute are derived from the liters per minute conversion. Put a new multiplier or divisor in place for one of the pulse-

counting pins. The Set button must be pressed after each field is changed. If two or more fields are changed prior to pressing Set all but one of the numbers changed will be forgotten.



10 Future Capabilities

The Dragonnorth Group is constantly improving the LOGGER features. Some of these features show up in the LOGGER when only part of the capability is completed.

10.1 Text Alerts

Sending Alerts by text messages is a planned future capability.

10.2 SparkFun Qwiic Sensors

LOGGER engineering is actively engaged in adding the SparkFun I2C sensors that use the Qwiic interface.

11 Advanced Features

Many advanced features are controlled on the Settings page. This page is called Permanent Variables at the top because the value of these settings is remembered when power to the LOGGER is shut off. The values are also remembered when the LOGGER reboots.

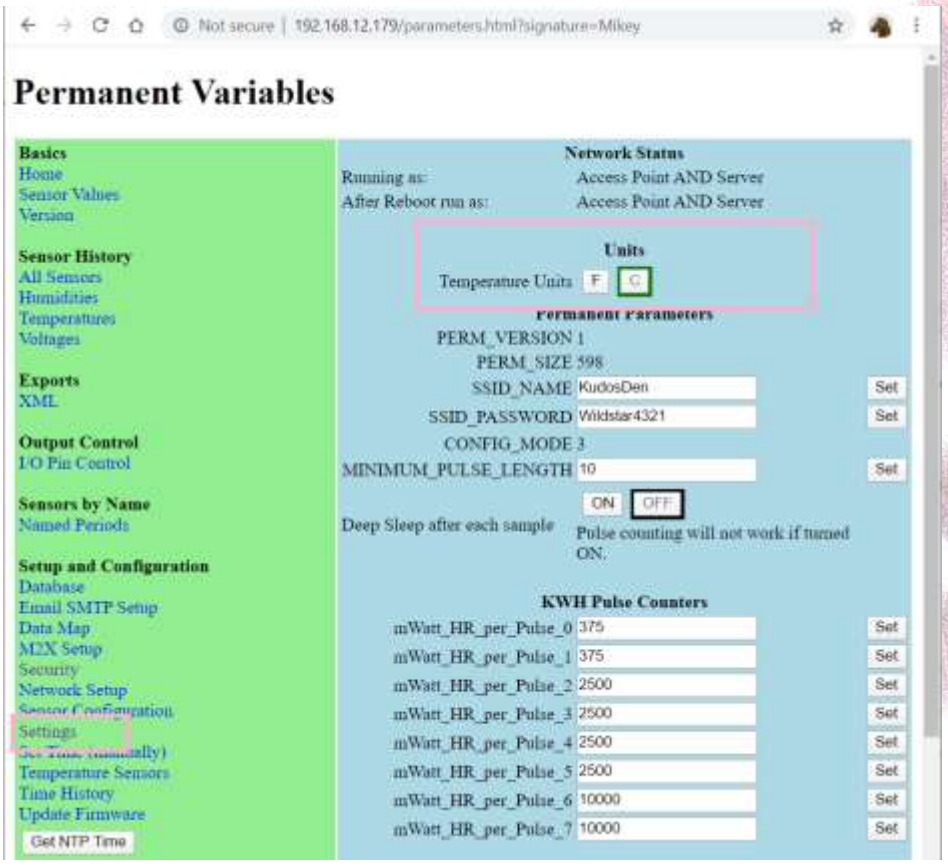
Internally the LOGGER counts some times in milliseconds. These counts turn into negative numbers after about 25 days and wrap around after about 50 days. To keep from getting confused the LOGGER automatically reboots when the millisecond counts become too large (every 25 days).

11.1 Choosing Engineering Units

Some sensors present values in engineering units that people understand, Volts, degrees, liters and gallons are examples of engineering units. For some values the LOGGER can be told what type of units to present.

11.1.1 Centigrade vs Fahrenheit

The presentation of temperatures can be in degrees Centigrade or degrees Fahrenheit. On the Settings page click the appropriate button to change the units.



11.2 Database Control

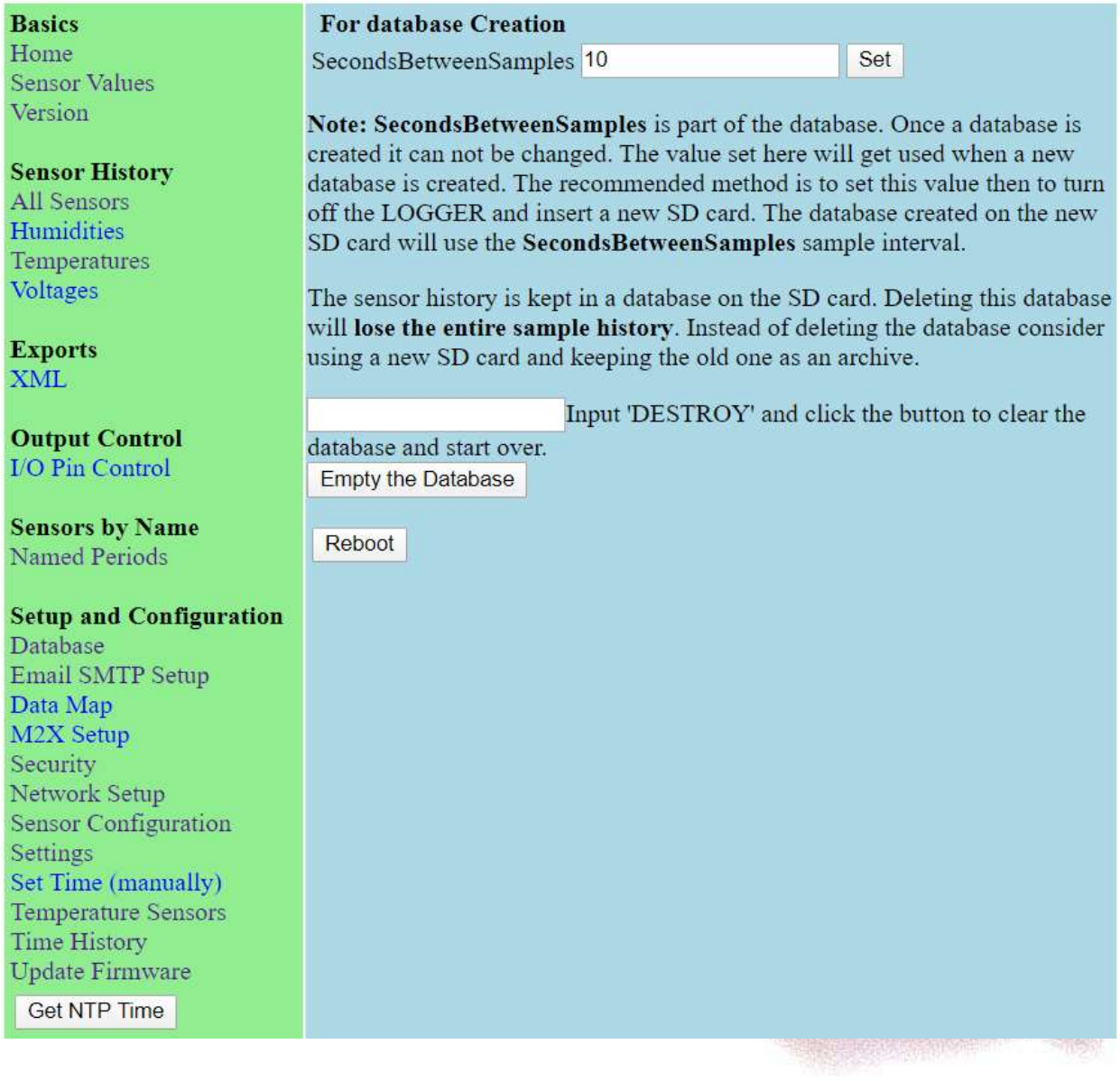
Samples are taken at a periodic rate and stored in a file on the SD card. The periodic rate is set when the file is first created and cannot be changed. Changing the **Seconds Between Samples** effects the next time a database file is created. Emptying the database file will lose all data. If a new sampling rate is desired the recommended procedure is to set the new sampling rate by putting the number of seconds between samples in the field and press the Set button. Then remove power from the LOGGER and remove the batteries. Put in a new blank SD card and restore power to the LOGGER. The database file on the new card will use the new sampling rate. Preserve the old card as a backup of your previous sample history.

It is possible to tell the LOGGER to empty the database by putting DESTROY in the field and pressing the Empty the Database button. This is dangerous since all previous samples will be lost.

The LOGGER can display samples at any desired interval, there is no need to slow down the sampling rate to display samples at a longer interval. The only reason to change the sampling rate is to save power when the LOGGER is used in Battery Operation. See the

Battery Operation Section for details about putting the LOGGER to sleep between samples.

Database Control



11.3 Email Alerts

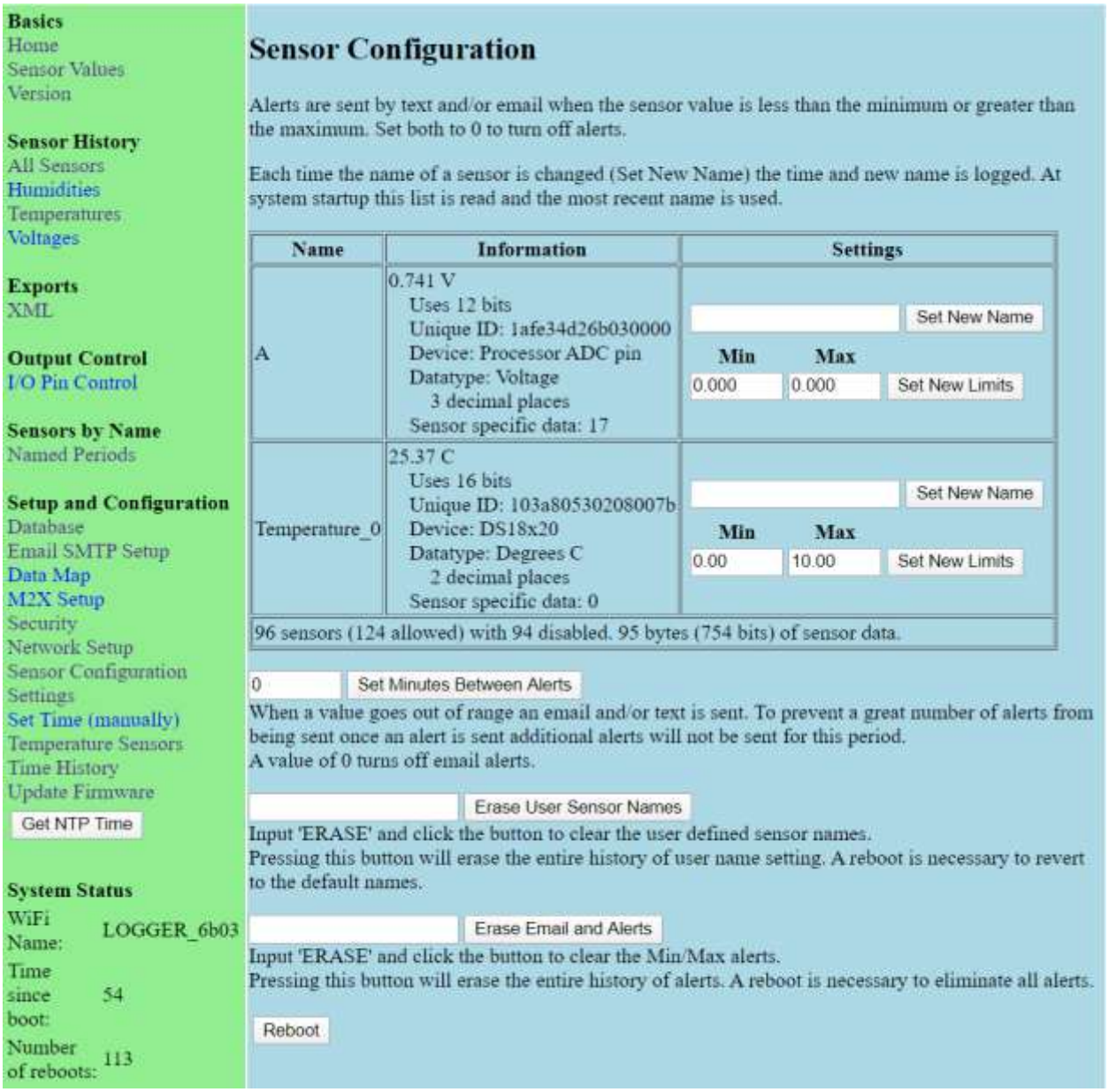
Sending email alerts when a sensor gets out of range is feature of the LOGGER. In order to send emails you must have an SMTP account that is capable of sending emails from the IP address where the LOGGER is located. For spam security protection most ISPs have security issues that prevent email from sending from the LOGGER. Dragonnorth Group gets around this issue by using an account at https://www.smtp2go.com/. The server port account and password are set to values associated with that account.

11.3.1 Set up SMTP Server

Once you have an account that is capable of sending email from a 'remote' location set up the SMTP email account on this page and use the Send Test Email button to verify that the LOGGER is capable of sending emails.

11.3.2 Set Sensor Limits

Sensor limits can be set up at any time. It makes the most sense to set them up after email is properly configured and tested. The limits are stored in a file on the SD card called `sensoralerts.bin`. Also stored in this file is the time between alerts. Each time new limits are set the new value is appended to the file. The time that the limits were set is also logged in the file. The file is read when the LOGGER boots and the last entry in the file is used. When a sample is taken the sensor value is checked to see if the value falls between the Min and Max values for that sensor. An Alert email is sent when the sensor value is first observed outside that range. Another email will not be sent until the number of minutes between alert has elapsed.

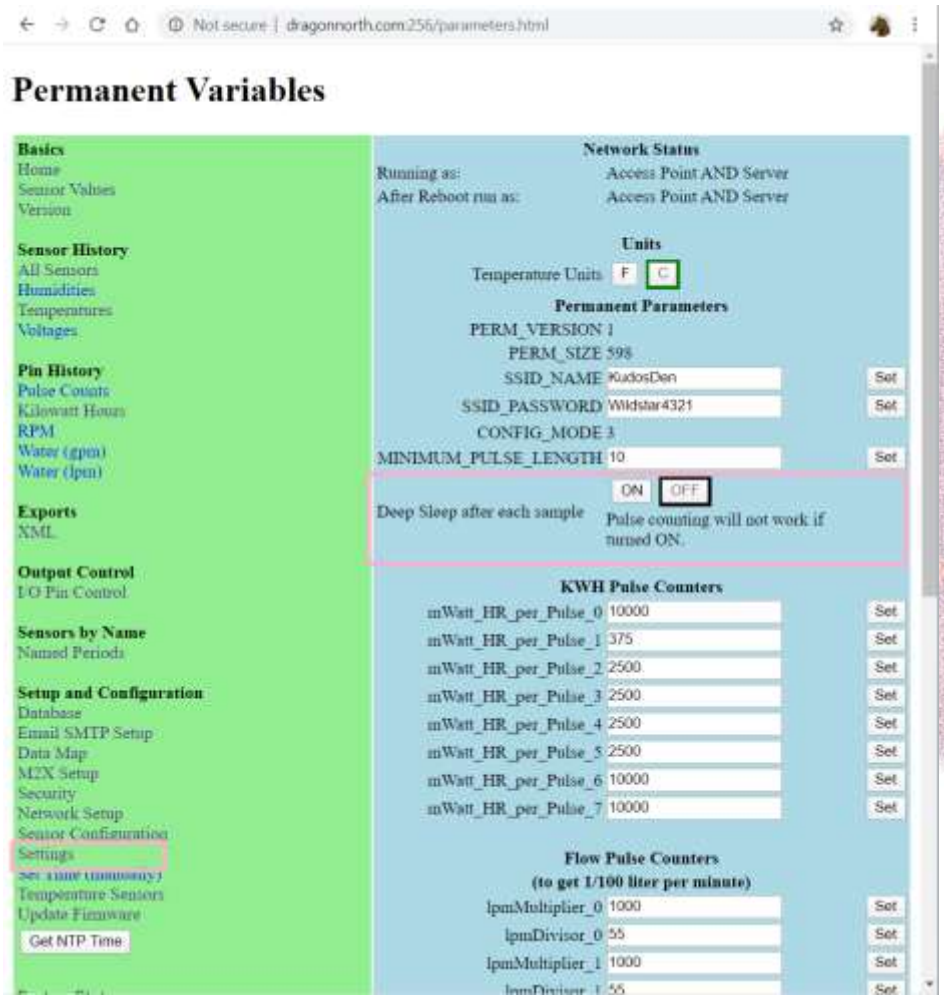


11.4 Battery Operation

The LOGGER is capable of running on batteries. It will run several days on three AA cells. If longer battery life is desired the LOGGER can be configured to collect samples and sleep between samples to save power. The LOGGER will run for about a year when taking a sample every 10 minutes and sleeping between samples. NOTE: While sleeping the LOGGER will not respond as a Web Browser. Also while sleeping the LOGGER does not count pulses thus it will not record water flow, pulse counts or kilowatt hour usage.

Go to the settings page and configure the LOGGER to “Deep Sleep after each sample”. The LOGGER will stop responding to your browser a short time once this is done.

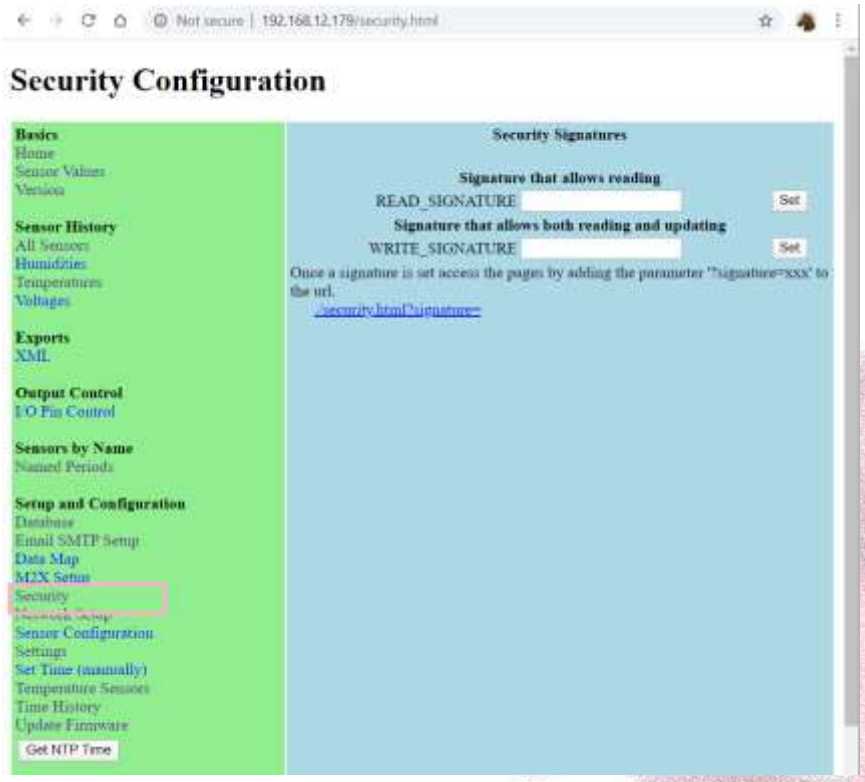
Once it has started sleeping to wake the LOGGER up disconnect any USB power and take out the batteries. When power is restored the LOGGER will stay awake for several minutes and the web pages can be used normally. Every time a web page is read or refreshed this time is reset and the LOGGER will stay awake for another few minutes. Turn off sleeping to keep it awake if desired.



11.6 Security

The LOGGER has a simple signature-based security scheme. There are two signatures (passwords), one for reading data and another for making changes. When the signatures are blank any request is allowed. If the read signature is set and the write-signature is not the read signature must be supplied to make changes.

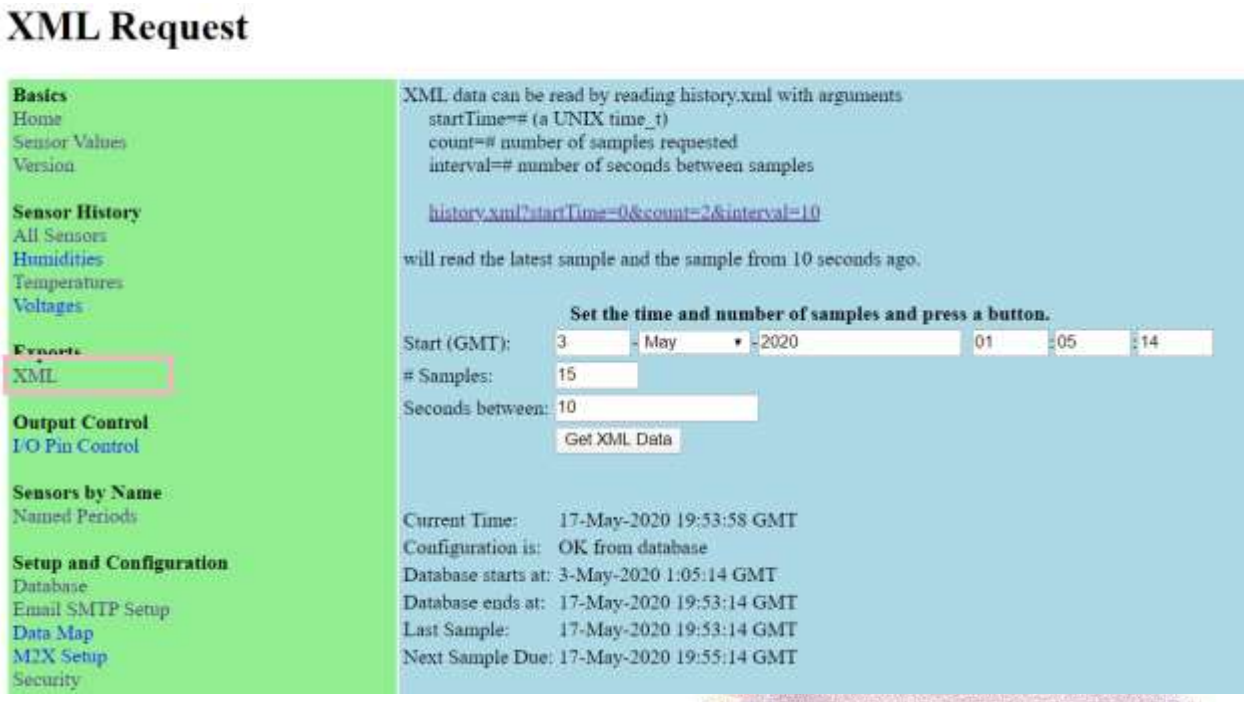
Once a signature is set every web page request must also supply the signature. An example link is provided on the Security Configuration page. After setting a signature be sure and bookmark this link to be able to access the LOGGER in the future.



11.7 Exporting Data

XML is a standard way of transferring data between computers on the Web. LOGGER supports reading sample data in XML format. This can be used by computer programs to read data from the LOGGER and

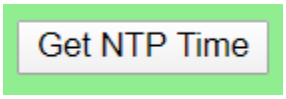
can also be used by creating the XML data in your browser and saving the file. The history.xml link on this page is an example for a computer program. The Get XML Data button.



12 Time Synchronization

When connected to the internet the LOGGER automatically updates time from **pool.ntp.org** servers, the same time servers that most computers use. These time servers in turn keep time synchronized with the time services provided by the National Institute of Standards: https://www.nist.gov/pml/time-and-frequency-division/time-services.

Pressing the "Get NTP Time" button:



Tells the LOGGER to fetch a time update from these time servers. There are rules about how often a time update can be performed so the LOGGER may not be able to immediately comply with the request.

When the internet is not available the LOGGER gets time from its internal clock chip. The clock chip is updated periodically from the internet when that becomes possible.

The LOGGER records time to the nearest second. While connected to the internet times logged by a LOGGER can be expected to be within two seconds of the NIST standard. Most of the time they will be within one second of that standard.

Without the internet the LOGGER will maintain time to within 2 minutes per month at 25 degrees C. This is based on the clock chip (a Maxim DS2417) specification.

Battery powered systems read time from the internal time chip. This will have a drift in time of up to 2 minutes a month as noted above.

13 Data Storage

Several files are kept on the SD card inserted into the logger.

The SD card uses a normal file system and can be plugged into any computer to copy the data for backup purposes.

File	Purpose
datalog.bin	History of all sensor readings.
namehistory.bin	A report of names for periods of data.
timehistory.bin	A report of when the LOGGER adjusted the clock.

The LOGGER reads sensors and creates a permanent record of what it has observed. This data is stored in the file called datalog.bin. The frequency of sampling is user adjustable, but can be changed only when a new datalog.bin file is created which destroys all of the previous data. By default, the LOGGER reads all sensors every 10 seconds and stores that data on the SD card. At that sampling rate a 32Gb card will store at least 20 years of data.

Reading the sensors less often is desirable only if the LOGGER will be battery powered. Reading four temperature sensors every 10 minutes should be able to run for a year on three AA batteries. Note that

running on batteries requires special configuration and that a LOGGER does not act as a web server when configured for long life running on batteries.

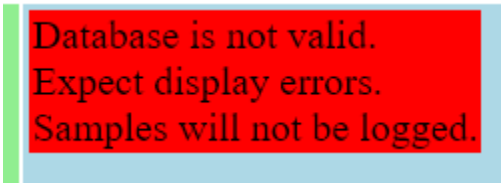
As the LOGGER fills the SD card with data access to the file slows down. The symptom of this is that pages will be slower to display. The slowdown is most noticeable when reading hundreds of samples over a long period (i.e. a sample each day for a year). This effect can be observed after a year or two of data has been accumulated. The slowdown is due to fragmentation of the space on the SD card. Periodically copying the data to a new SD card will restore the speed of the LOGGER. It is recommended that this be done at least once a year. The old SD card becomes a backup of your data.

Performance will also be restored if you copy the file to a computer, quick format the SD card, and copy the data back. It is believed that a simple copy of the file to a computer deletion of the file on the SD card and copying the file back will also restore the speed, but, this has not been verified.

14 Troubleshooting

14.1 Missing Database

This indication appears on many pages including the Sensor Values page when the SD card is missing or has a problem.



Check that the SD card is inserted and insert a good SD card if necessary.

14.2 Can Not See the LOGGER

One of the most common problems is that the LOGGER is no longer visible on your network. The first thing to do is to power cycle the LOGGER (be sure and remove the batteries too the LOGGER will not turn off until both USB power and the batteries are disconnected).

If power cycling the LOGGER does not help try connecting to the LOGGER using the LOGGER as your WiFi network (see section 3.1.1 Connect to the LOGGER). It is possible that the LOGGER has forgotten your WiFi network name and password.