



Ultra-Low Power Precision Sensing & Wireless Communication

*SenScope*TM

Software Manual (V.4.3)

Ultra-Low Power Precision Sensing & Wireless Communication

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I. Introduction of SenScope™

SenScope™ software is the control panel developed by Resensys which is capable of data collection, visualization, and processing. It can either work in online mode or offline mode to adapt to different scenarios.

In the online mode (Remote Mode) the data come from the Resensys servers and can be accessed anywhere with the Internet access. However, there may be a delay for real-time data depending on the reporting rate of the SeniMax™.

In the offline mode (Live Mode or Local Mode), the data are collected on site. Therefore the USBSink™ dongle is needed instead of the SeniMax™ and the dongle should be close enough (<=950m in the open space) to the device.

II. Installing SenScope™

1. Open the box to find the USBSink™ and the SenScope™ License Dongle **(the license dongle is required for versions before 2.2.0.0)**.



2. Download the SenScope™ software and other required software packages from the following links. <http://www.resensys.com/Software/SenScope/SenScope.zip>
.Net framework 4.7 runtime
package: <https://dotnet.microsoft.com/download/dotnet-framework-runtime>
OpenXML package: <https://www.microsoft.com/en-us/download/details.aspx?id=30425>
3. Install the SenScope™ and all other necessary packages.
4. Insert the USB License Dongle and the USBSink™ to the computer.
5. Install the Driver for the USBSink™. When the Internet is available, the installation should be completed by Windows automatically. If not, visit the link below to download it.

<https://www.silabs.com/products/mcu/Pages/USBtoUARTBridgeVCPDrivers.aspx>

III. Live/Local Mode (Offline Mode)

A. Live? Local?

The only difference between the live mode and the local mode is that in the local mode the data (packets from SenSpot™) are stored in a local database on the computer's hard drive so that SenSpot™ data are accessible after SenScope™ is closed. However, in the live mode the data are deleted after the SenScope™ is closed. All the other operations are almost the same.

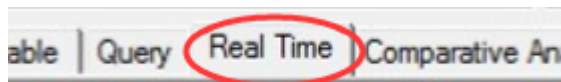
B. Viewing the data in the live/local mode

- **Opening the port**

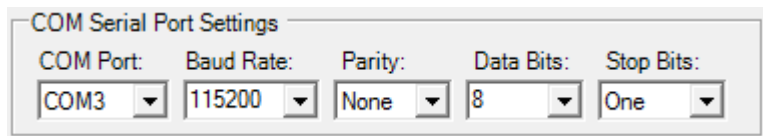
1. Open SenScope™ and switch to offline mode by pressing the middle button at the top-left corner of the window (the Internet access is not required and the username and the password are needed here).
2. Select "Local" mode or "Live" mode from the "Data Source" area (top-left corner).



not



3. Switch to the "Real Time" tab if it's not the current tab.
4. Select the COM port the USBSink™ is connected to in the "COM Serial Port Setting" area (bottom-left corner). If the port number is unknown, go to the device manager of Windows to look it up. The device name should be CP210X.



5. Make sure there is at least one working SenSpot™ or SeniMax™ near the USBSink™. Click "Open" button (top-left corner). The packets should appear in the display area and the device IDs should appear in the "Sensor List" after some time (according to the transmission interval of the SenSpot™, it may take as long as 6 minutes).

- **Viewing the data and graphs in the live/local mode**

1. Switch to the "Graph" tab.
2. Select one or several devices in the "Sensor List".

3. Select the data type in the “Quantity” table.

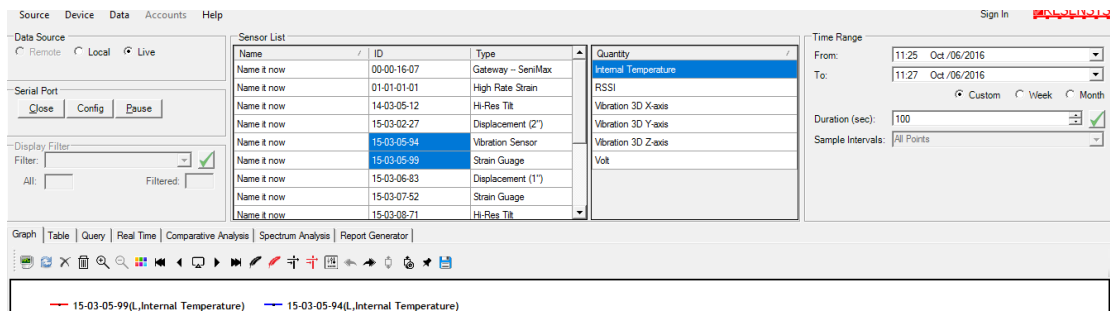




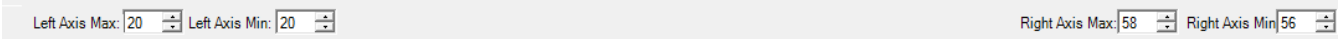










Figure 2.1 the control panel of live mode

4. Click  to draw the figure.
5. The display duration can be adjusted by entering the desired time duration in **Duration (sec):** . Click  to apply the change.

6. The Y-Axis range is automatically adjusted by default. If it's in the Manual Axis mode, click  and it will become grey , indicating the Auto Axis mode is on. Click  to switch to Manual Axis mode and adjust the range manually by typing the range in the text boxes at the



- bottom side of the window.
7. SenScope™ also supports dual Y-Axis display. The Y-Axis's position can be adjusted by using  . For example, click  and it becomes grey . At this time if  is clicked to draw a figure, the Y-Axis of the figure will be on the left side. Similarly, after clicking  the next figure's Y-axis will be on the right side. Both Y-Axis can be shown in the same figure and they can have different data types and scales.
8. Click  to delete all the figures or click  to delete the figure of the currently selected item.

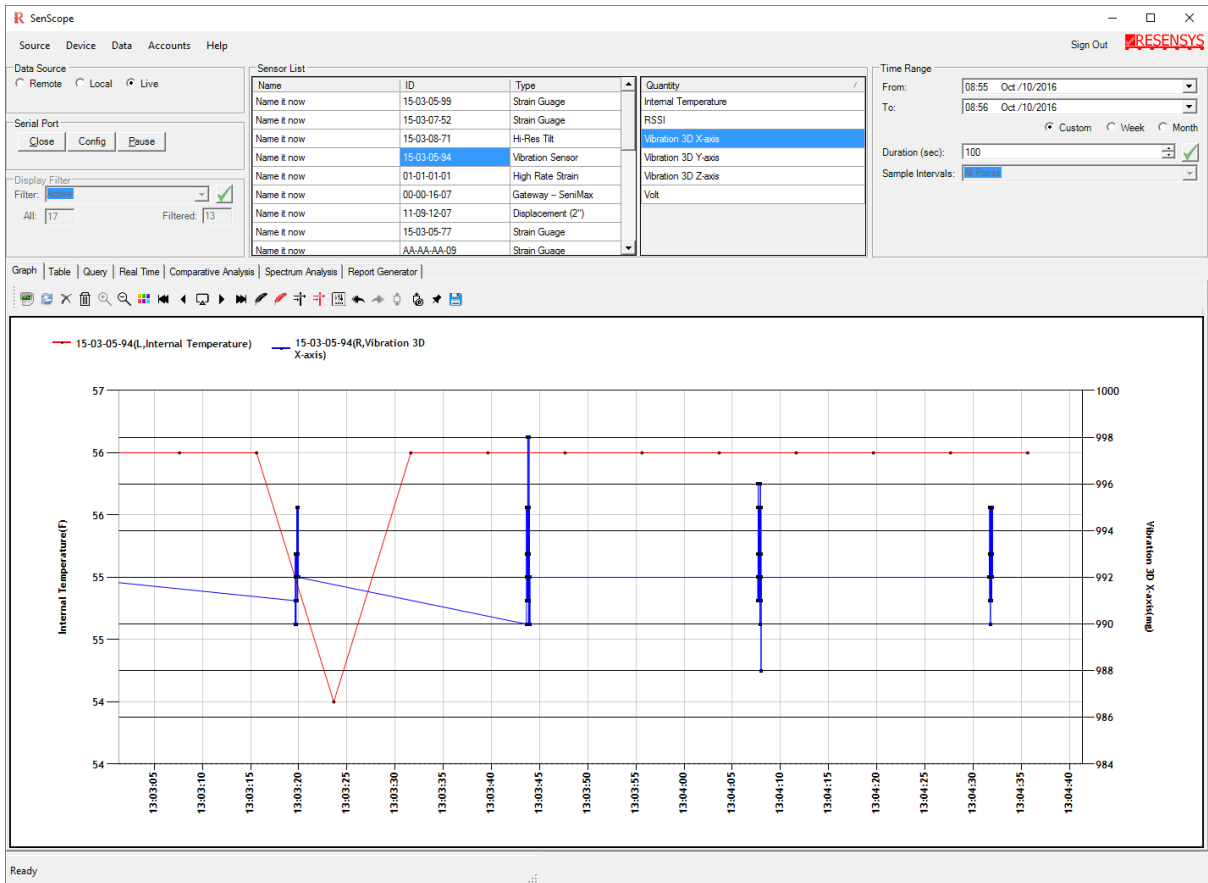


Figure 2.2 Screenshot of the live mode

C. Setting Offsets, Coefficients, and Reference

It should be noted that in order to visualize the raw data on the graph an offset and a coefficient is applied to the raw data. For each type of quantity, there are some default values which can be changed by user for further fine tuning. These numbers can be accessed through the Calibration tab in the Device's Properties windows (right click the device in the "Sensor List" and click "Properties". This window is shown in Figure 2.3.

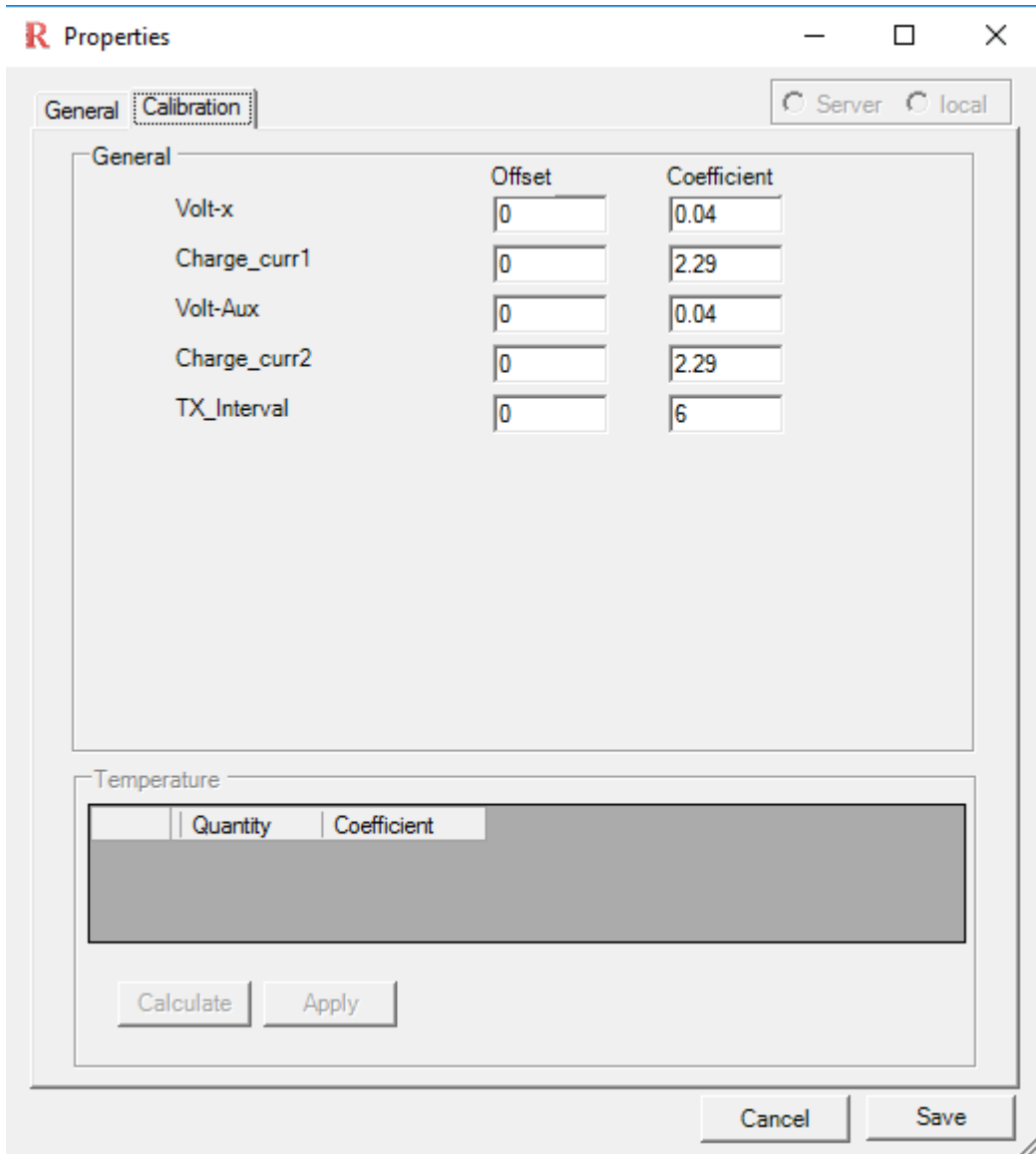


Figure 2.4 Calibration Tab

D. Air Update

▪ What's Air Update?

Air update is the procedure to change certain parameters of the SenSpot™ or the SeniMax™ without reprogramming them. Air Update is only available in the live/local mode.

Caution! This function is only for advanced customers. Inappropriate operations may lead to malfunction in the system. Before doing an Air Update, make sure the document is read thoroughly and the function of each parameter is known by the user.

▪ **Air Update steps for SenSpot™**

1. Make sure SenScope™ is in the local/live mode and the COM port is opened
2. Click “Device”->“Air Update” in the menu bar.
3. Input the Device ID and make sure the ID is correct.
4. Check the boxes in front of the parameters that need to be updated. All the parameters without a check will remain unchanged during the update.
5. Input the value of the parameters and click apply.
6. The green ones are successfully updated. The yellow ones are being updated. The white ones are in the queue. The red ones fail the update because of timeout. The parameters with the blue bold font are the ones modified in this Air Update.
7. **Tip:** If a device is selected (highlighted) in the “Sensor List”, the parameter textboxes will show

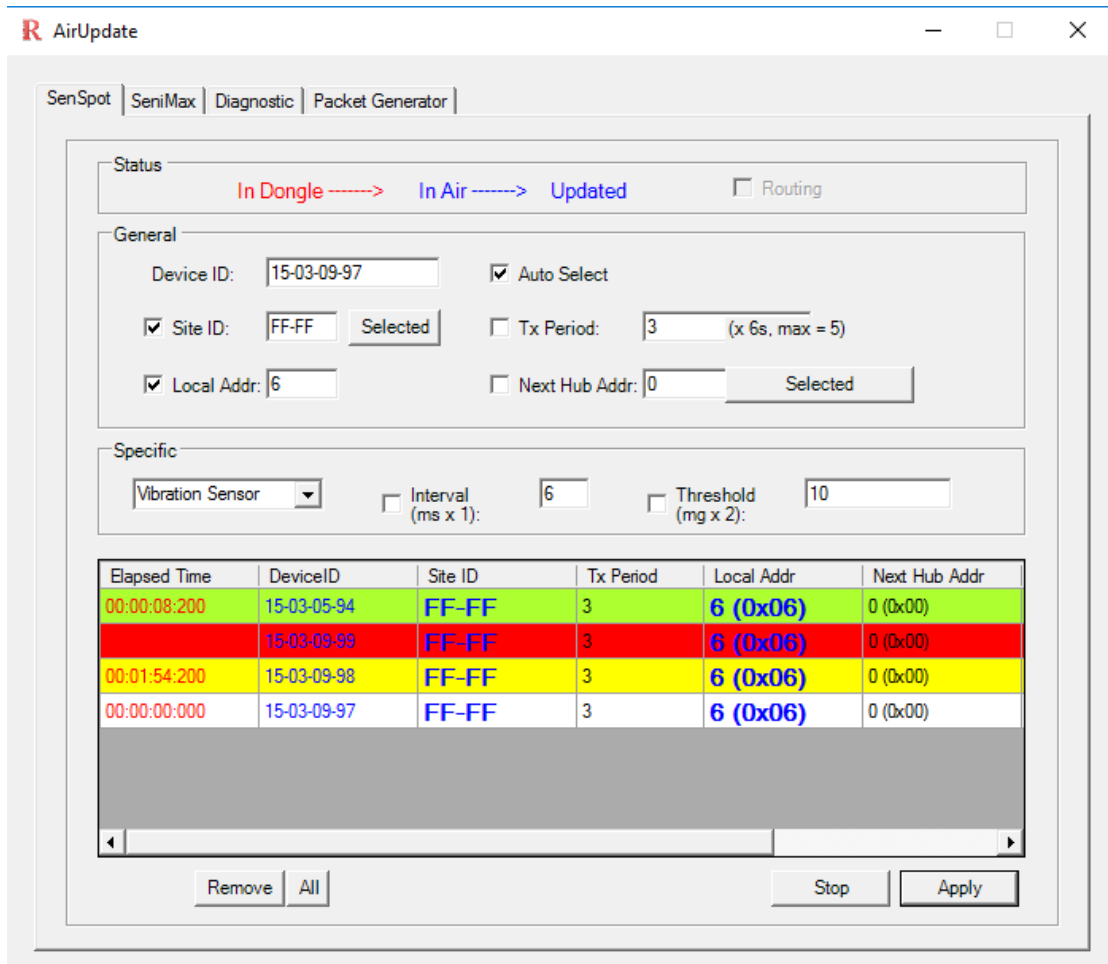


Figure 2.4 Air Update Panel: SenSpot Tab

its current value when the Air Update panel is opened.

- **Parameters and their functions for SenSpot™**

- 1. General parameters**

- Device ID:** It's the unique identifier of each device.

- Site ID:** It's the unique identifier for each sensing system. Usually it's the last four digits of the Device ID of the SeniMax™. This parameter determines which SeniMax™ is responsible to collect the data from that device. It should be noted that each SeniMax™ has a built-in Site ID which needs to match to that parameter to each device in a site. In the case that a SenSpot™ is assigned a Site ID different from the SeniMax™, the data packet from that device will be ignored. In other words, this parameter is used to filter out the SenSpot™ which are not part of the sensing group in a corresponding site.

- Local Address:** This parameter allows the devices which belong to the same site get registered with the SeniMax™ in that site. In other words, in order to have a spot in the network to perform data transmission each device must have a unique local address. It should be noted that although we have currently assigned a one byte length local address to each device there is not theoretical limit on the number of devices which are registered in a network. There is no specific way to assign a local address to a device and as long as every device has a local address the data link is potentially created. It should be noted that the LA of SeniMax™ is conventional assumed to be 0. Therefore, this LA is reserved and it cannot be assigned to any other devices.

- Next Hub Address:** This parameter determines the LA of the next node to which data transmission will happen. In case that the span of a network is small such that each device can directly communicate with SeniMax™ the NA will be set to 0 as it is the LA of SeniMax™. However in many cases where the span of a network is relatively large or a device's signal is blocked (e.g. thick concrete block) the use of Repeaters is inevitable. In such cases, a device needs to know how to reach SeniMax™ in the multi hop manner. Figure 11, shows the single hop and multi hop network configurations for a small network (single hop) and a larger one (multi hop). It should be noted that using the multi hop feature networks of relatively large span can be produced.

- 2. Specific Parameters:** Depending on the type of SenSpot™, this field has different functions.

- Vibration SenSpot™:** **Interval (ms)** decide the sampling interval while **Threshold (2*mg)** determines the smallest acceleration that can be detected. The default value is Interval=20, Threshold=80. Please be care that the actual Threshold is doubled ($80*2=160\text{mg}$).

- Strain Gauge SenSpot™ with event-detecting function:** **Threshold (4*μS)** determines how much the change in the measurement will trigger the fast sampling mode of the SenSpot™. The ACTUAL threshold equals to 4 micro-strains multiply by the number entered in this area. **Sampling Interval** determines the time interval between 2 samples in the fast sampling mode.

▪ **Air Update steps for SeniMax™**

1. Input and make sure the Device ID is correct.
2. Choose the Connection Type (Cellular or Wi-Fi) according to the type of the SeniMax™.
3. Just like Air Updating SenSpot™, check the boxes in front of the parameters need to be updated.
4. Click “Apply” to start the Air Update.
5. When **Updated** becomes red **Updated**, the Air Update is finished.

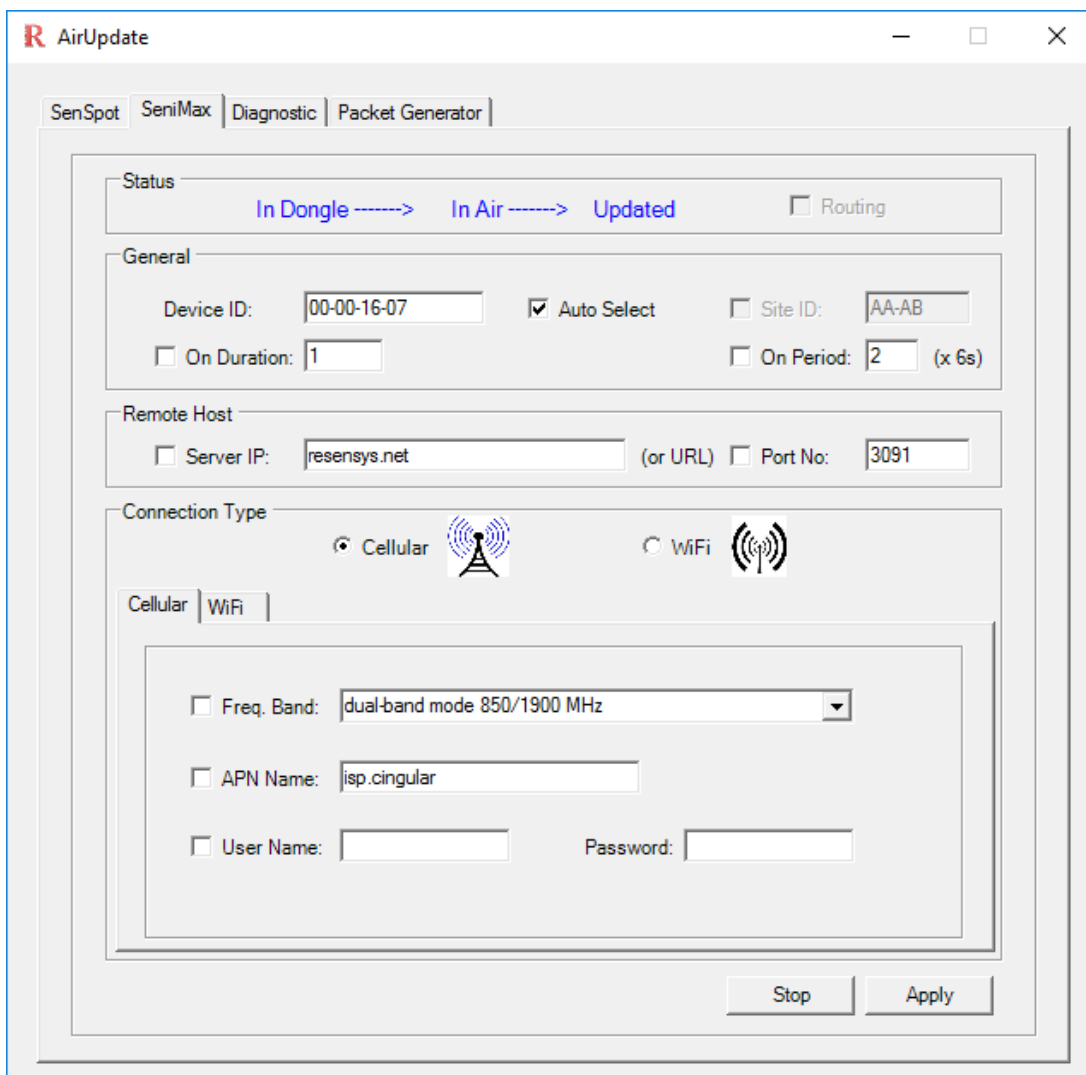


Figure 2.5 Air Update Panel: SeniMax Tab

▪ **Diagnostic mode**

Diagnostic is used to show the raw packets and/or their equivalent ASCII message. One usage for the mode is to check if the SeniMax™ is connected to the server is using the remote mode to check the data. However, normally it takes some time (like 1 hour) before the data show up in the database. A

quicker method is using the diagnostic mode.

1. Open the Air Update panel and switch to the “Diagnostic” tab.
2. Input the device ID
3. Click “Tune”
4. Check the box in front of the “Text”. Check the box in front of the “Hex” if raw data is also needed.
5. Now reset the SeniMax™.
6. It’s very likely that random characters show up in the display area. Keep searching the stream and some readable text can be found (like the text in the red circles in Figure 5).
7. If some message like “OOK OOK OOK” (double circled part in Figure 5) appears, the SeniMax™ has successfully connected to the server.
8. If the “OOK” cannot be found, please verify the network settings again and reset the SeniMax™. If the problem still exists, please record the information in the display area and contact

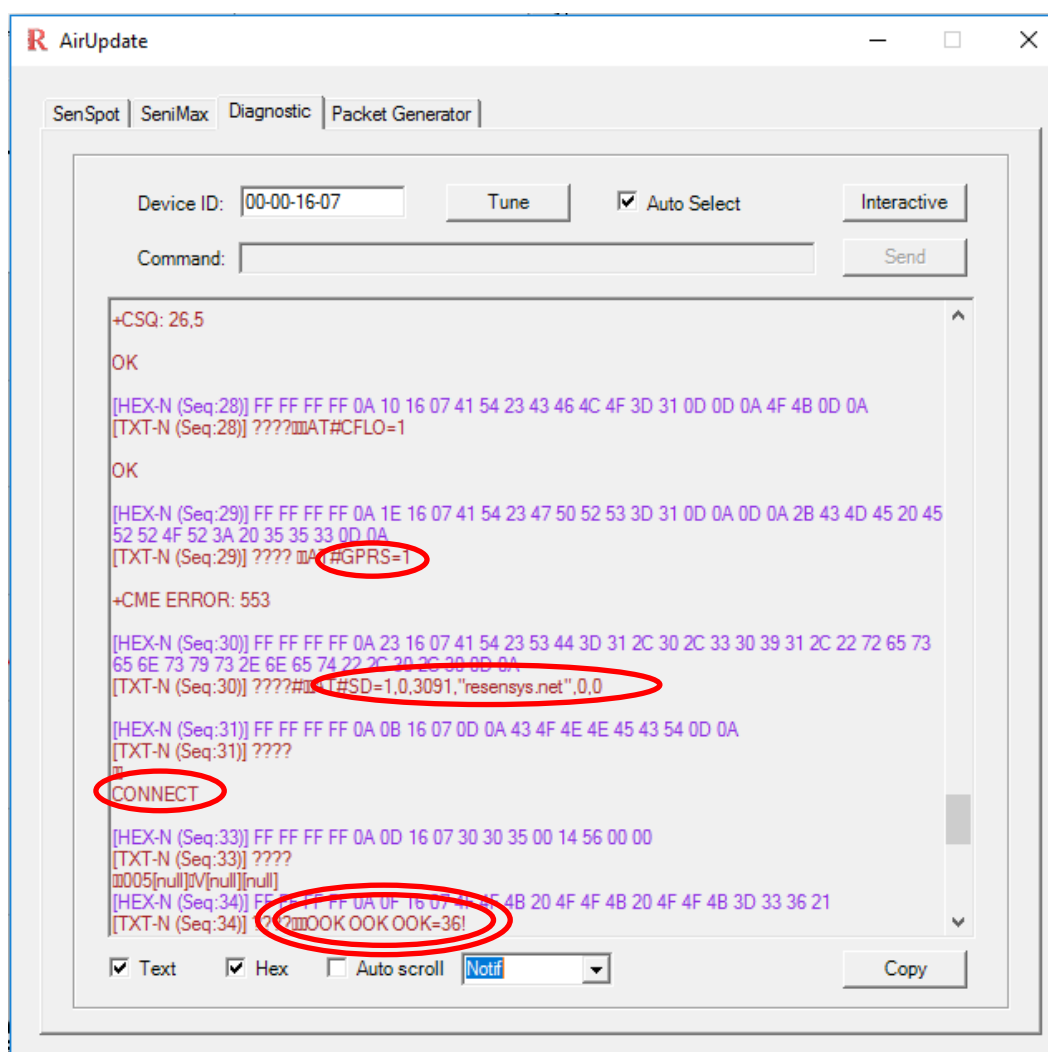


Figure 2.6: Diagnostic

Resensys.

- **Packet Generator and Fast sampling mode**

Packet Generator can send specific packets at a fixed rate. Like diagnostic mode it is used mostly for debugging. An application for the function is to make the SeniMax™ enter the fast sampling mode in which the transmission interval (of the SenSpot™) can be shortened to a desired value to show the data more frequently. This mode is useful in the deployment to verify the connection between the SenSpot™ and the SeniMax™.

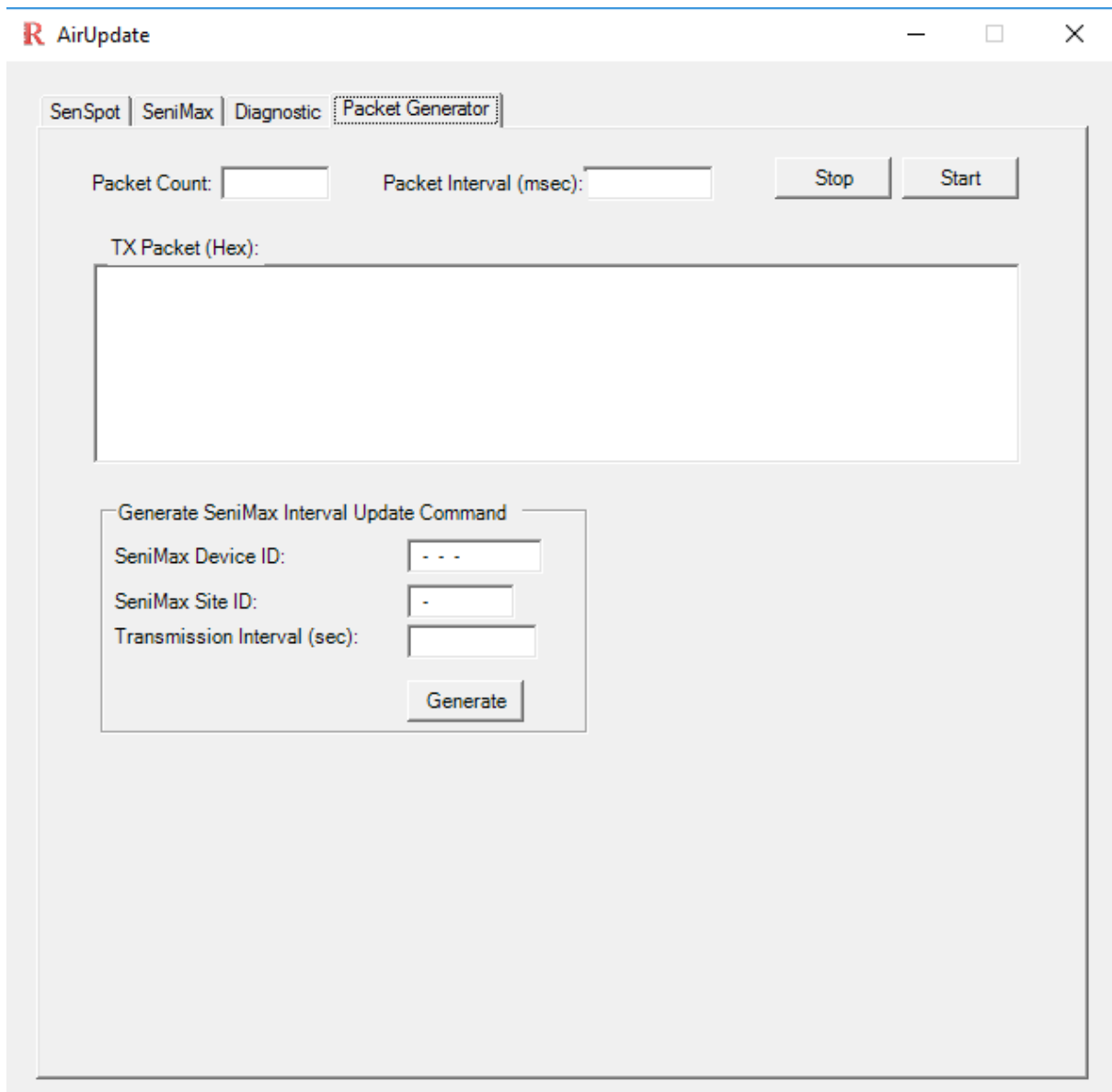


Figure 2.7: Packet generator panel

1. Open the “Packet Generator” tab in the Air Update panel.
2. Clear the “TX Packet (Hex)” area (choose any contents and hit “delete” on the keyboard).

- Input the Device ID, Site ID and the new transmission interval. **The interval should be a multiple of 6 seconds!** The interval of 30s is recommended if there is no specific requirement from the customer.

Generate SeniParam Interval Update Command

SeniParam Device ID:

SeniParam Site ID:

Transmission Interval (sec):

- Click "Generate" button to generate the command packet.
- The packet should appear in the "TX Packet (Hex)" box.

TX Packet (Hex):

```
FF FE FF FE FE FE 20 01 00 00 16 07 31 00 16 07 00 00 00 3C 31 00 00 00 06 00 0D 0D 0D 0D 00 00
```

- Input the packet count and the packet interval. These parameters determine the command packets' number and frequency sent from the computer. It is recommended that the packet count be some large number (like 2000) and the packet interval be 500ms.

Packet Count:

Packet Interval (msec):

- Click and plot the quantity "Tx Interval" of the SeniParam™ in the live mode. Please refer to the SenScope™ User Manual for how to show the data in the SenScope™.
- Check the "Tx Interval". As soon as the "Tx Interval" changed to the desired value, click .
- After finishing the test, remember to change the "Tx Interval" back to normal value since the power consumption of the SenSpot™ is high in fast sampling mode.

E. Data Menu

In the "Data" menu there are three options will allow the user to manipulate the collected data in the memory. In the following, these options are explained. Please note that this function is available both in Remote Mode and Live/Local mode.

Download

User can export data to '*.xlsx' format which can be opened using Microsoft Excel. In order to do so, the user may select (highlight) several devices by holding ctrl and clicking on the device name and choosing Download->Excel->Selected or can export all devices' data using Download->Excel->All. In either case, the data is exported from the memory and stored in the format of *.xlsx in the directory: SenScope\Data\Log. Alternately, Right click on the plotted graph and choose "Export Graph to file" to export the data.

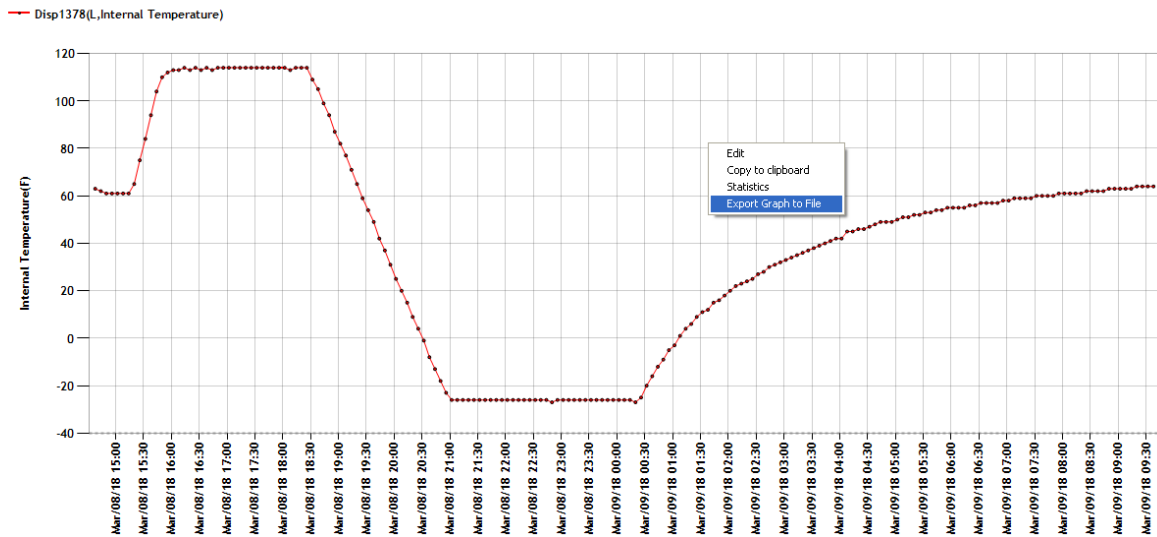


Figure 2.8: Exporting data into an Excel sheet

The screenshot shows an Excel spreadsheet with the following data:

Measurement	Coefficient	Offset	Record No
Date		3/12/2018 10:21	
File Version		1	
Device ID	15-03-13-78		
Site ID	10-50		
Name	Disp1378		
Firmware Version		2	
Measurement	Coefficient	Offset	Record No
Displacement (1")	-0.006079	4096	0
Internal Temperature	1.0465	-22.5778	573
RSSI	1	0	0
Volt	0.0268	0	0

Figure 2.9: Exported data in an Excel sheet

Figure 2.9 shows a sample exported file from a device which has the ID of 15-03-13-78. The first sheet of the log file is named “Info” and it contains some information about the device from which the data is collected. For example, in addition to the date and time that the file is created, file version, Device ID, Site ID, customized name of the device, firmware version and measurement of the device are shown in this sheet. It also contains the calibration offsets and coefficients of the measurements. The number of records which have been collected by the time of exportation is shown under “Record No” for each measurement.

The detailed collected data for each measurement is stored in other sheets. For example in the above sample file, the Displacement (1”), RSSI, Volt and Internal Temperature are stored in the corresponding sheets. Figure 2.10 shows the logged internal temperature data for the same device. The table consists of three columns and multiple rows depending on the number of samples exist. The first column “A” is a one byte data which shows the sequence number of the data packet which contains the sample. This number varies from 0 to 255. The second column “B” is the time at which the sample is collected or the time of the machine at the packet arrival time and the third column “C” contain the raw data. In order to calculate the actual value of the sample the following equation can be used.

It should be noted that the offsets and coefficients of the measurements can be found in the Info sheet.

ID	Time	Value
32	3/8/2018 19:37	38
33	3/8/2018 19:43	37
34	3/8/2018 19:49	36
35	3/8/2018 19:55	36
36	3/8/2018 20:01	36
37	3/8/2018 20:07	36
38	3/8/2018 20:13	36
39	3/8/2018 20:19	40
40	3/8/2018 20:25	49
41	3/8/2018 20:31	58
42	3/8/2018 20:37	67
43	3/8/2018 20:43	77
44	3/8/2018 20:49	83
45	3/8/2018 20:55	84
46	3/8/2018 21:01	85
47	3/8/2018 21:07	85
48	3/8/2018 21:13	86
49	3/8/2018 21:19	85
50	3/8/2018 21:25	86
51	3/8/2018 21:31	85
52	3/8/2018 21:37	86
53	3/8/2018 21:43	85
54	3/8/2018 21:49	86
55	3/8/2018 21:55	86
56	3/8/2018 22:01	86
57	3/8/2018 22:07	86
58	3/8/2018 22:13	86
59	3/8/2018 22:19	86
60	3/8/2018 22:25	86
61	3/8/2018 22:31	86
62	3/8/2018 22:37	86
63	3/8/2018 22:43	86
64	3/8/2018 22:49	86
65	3/8/2018 22:55	86
66	3/8/2018 23:01	86
67	3/8/2018 23:07	85
68	3/8/2018 23:13	86
69	3/8/2018 23:19	86

Figure 2.10: Showing the data in an excel sheet

■ Delete

In order to delete all data received from one device, the device ID must be highlighted from the “Sensor List” and then the “Delete One” option from the “Data” menu is selected. To delete the data received from all devices shown in the sensor list the user needs to click on button “Delete All”.

■ Table

This option can be used to quickly fetch data from the memory or the server for a selected device in the given “Time Range”. For this purpose, after highlighting the device name “Table” can be chosen from the “Data” menu. To retrieve data from memory the user needs to select “In Memory” and to do that from the server “Server Query” needs to be selected. An example of each is shown in Figure 2.11 and 2.12. To copy data to clipboard the corresponding buttons should be selected.

Source Device Data Accounts Help Sign Out RESENSYS

Data Source: Remote Download Upload Delete Table Server Query

Site Selection: 10-50 Alaska-50

Display Filter: Filter: Active All: 21 Filtered: 21

Name	ID	Type	Quantity
LGHR-2	15-03-13-51	Inclinometer 2D	Displacement (1")
Server Query	15-03-13-52	Inclinometer 2D	Internal Temperature
In Memory	15-03-13-53	Inclinometer 2D	RSSI
LGHR-5	15-03-13-54	Inclinometer 2D	Volt
Disp1378	15-03-13-78	Displacement (1")	
HGLR-5	15-03-13-66	Inclinometer 2D	
Disp1377	15-03-13-77	Displacement (1")	

Time Range: From: 10:28:16 Mar/08/2018 To: 10:28:16 Mar/09/2018
 Custom Week Month
 Duration (sec): 86400
 Sample Intervals: All Points

Graph | Table | Query | Real Time | Comparative Analysis | Spectrum Analysis | Report Generator | Status | Lab

Report: 192 row(s) were returned for this query None Clear Refresh

Time	SeqNo	Value	Optional
3/8/2018 7:37 PM	32	38	30030
3/8/2018 7:43 PM	33	37	30030
3/8/2018 7:49 PM	34	36	30030
3/8/2018 7:55 PM	35	36	30030
3/8/2018 8:01 PM	36	36	30030
3/8/2018 8:07 PM	37	36	30030
3/8/2018 8:13 PM	38	36	30030
3/8/2018 8:19 PM	39	40	30030
3/8/2018 8:25 PM	40	49	30030
3/8/2018 8:31 PM	41	59	30030
3/8/2018 8:37 PM	42	67	30030
3/8/2018 8:43 PM	43	77	30030
3/8/2018 8:49 PM	44	83	30030
3/8/2018 8:55 PM	45	84	30030
3/8/2018 9:01 PM	46	85	30030
3/8/2018 9:07 PM	47	85	30030
3/8/2018 9:13 PM	48	86	30030
3/8/2018 9:19 PM	49	85	30030
3/8/2018 9:25 PM	50	86	30030
3/8/2018 9:31 PM	51	85	30030
3/8/2018 9:37 PM	52	86	30030
3/8/2018 9:43 PM	53	85	30030
3/8/2018 9:49 PM	54	86	30030

Ready

Figure 2.11: Showing the data from the server in a table

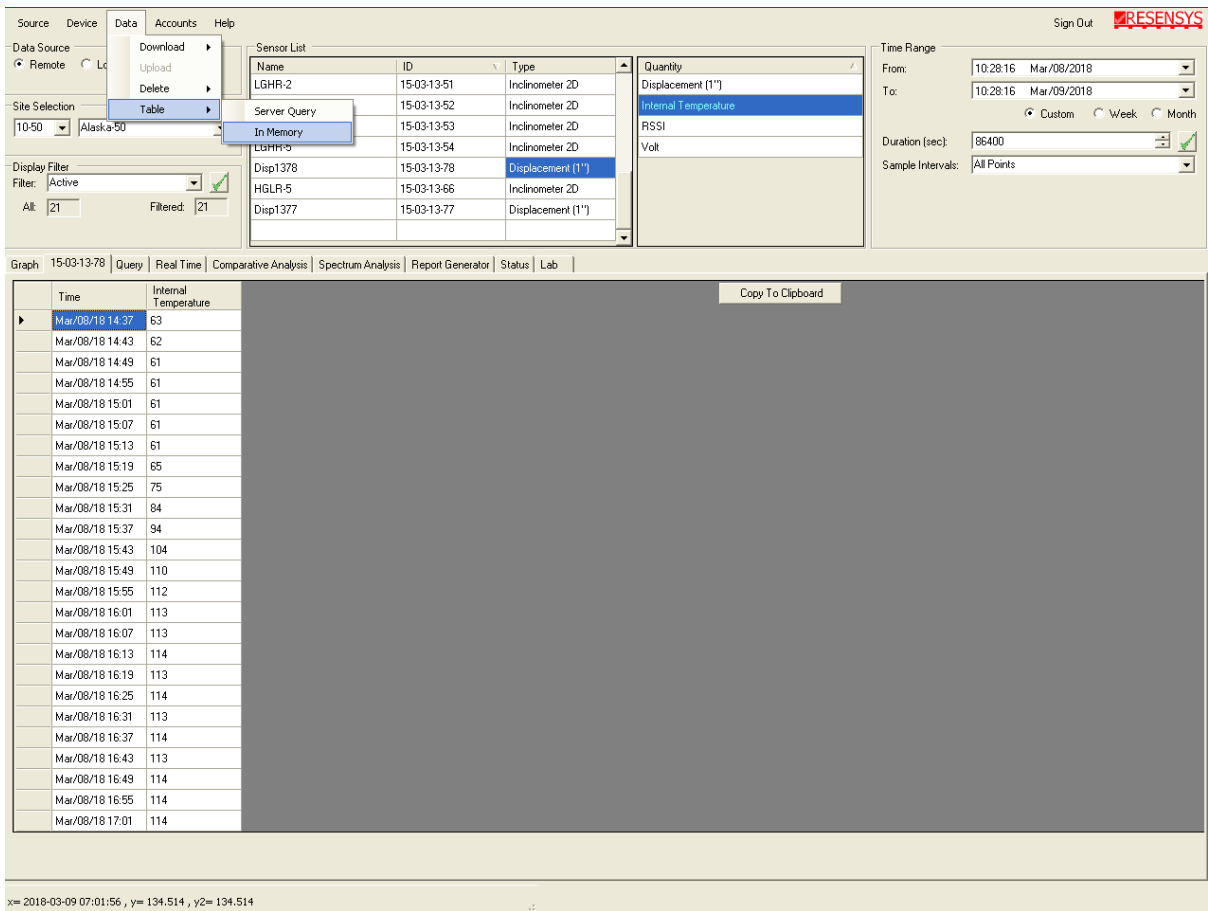


Figure 2.12: Showing the data from the memory in a table

IV. Remote Mode (Online Mode)

A. What is the remote mode?

Remote mode is for viewing the data from the remote server rather than from the local devices. Therefore, the Internet access is necessary. Also the username and the password are needed. Should the user not have them, please contact Resensys.

B. Viewing the data in the remote mode

1. Enter the username and the password provided by Resensys then click "OK".
2. Choose the "Remote" mode in the "Data Source" area
3. Select the desired Site ID from the drop down menu.
4. In the Time range area, enter the time period of the data.
5. Select the devices and the data type to create a figure similar to the Live/Local Mode.

Username:
Password:
 Remember Password
OK Cancel

Site Selection: 10-29 Legislature
Time Range: From: 10:31 Oct /04/2016 To: 10:31 Oct /05/2016
Custom Week Month

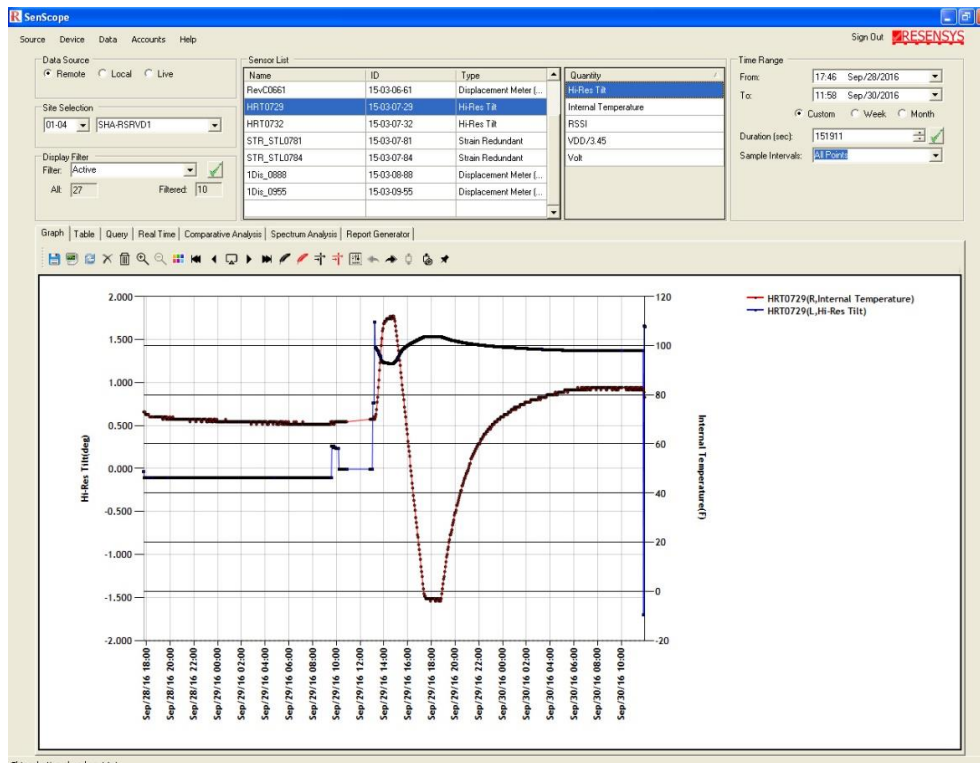


Figure 3.1 Screenshot of the remote mode

6. Remember to click “Refresh”  after changing the time period to apply it.

C. Modifying the figure

Usually the data from a long period of time consists of a trend and some fluctuations or spikes. SenScope™ provides several functions to smoothen or sharpen the figure according to the user’s needs. Figure 3.2, which is the original figure, is used as an example to show different effects of these

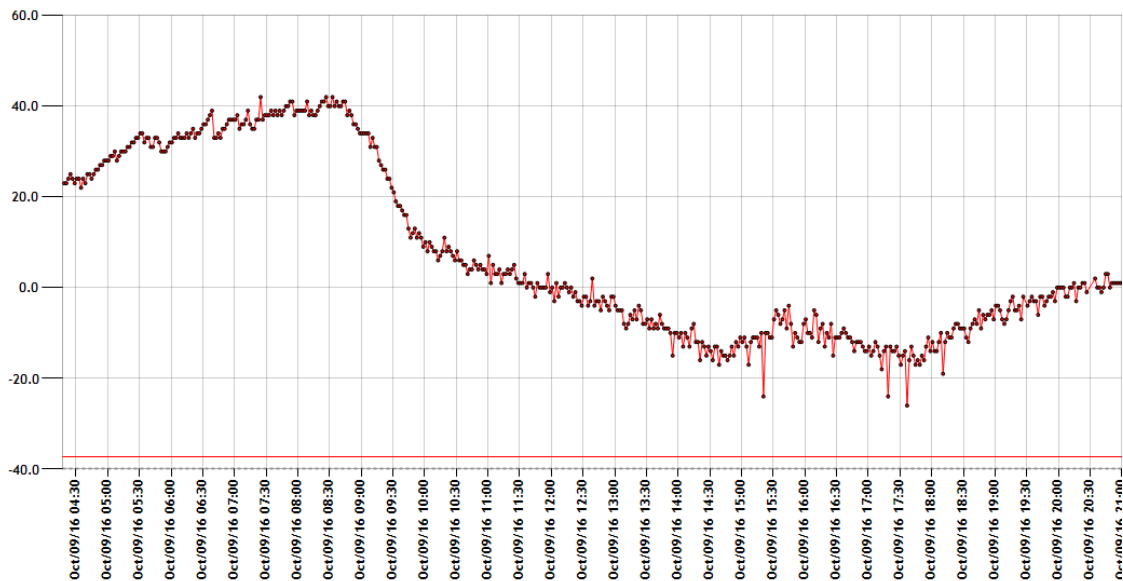



Figure 3.2 the original figure

functions.

- **Removing spikes**

By clicking  “Remove Spikes” (the icon is black), all the data points that drop far from the main trend will be removed. However, small fluctuations will be kept unchanged.

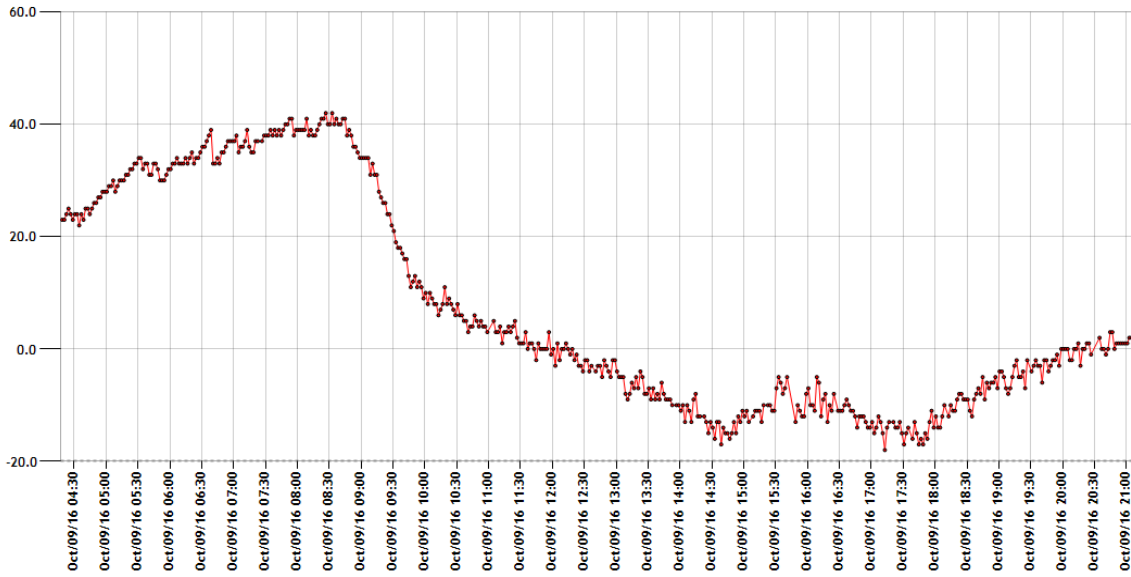



Figure 3.3 the figure after using “Remove Spikes”

- Showing spikes only

By clicking  “Show Spikes” (the icon is red), ONLY the data points that drop outside the main trend

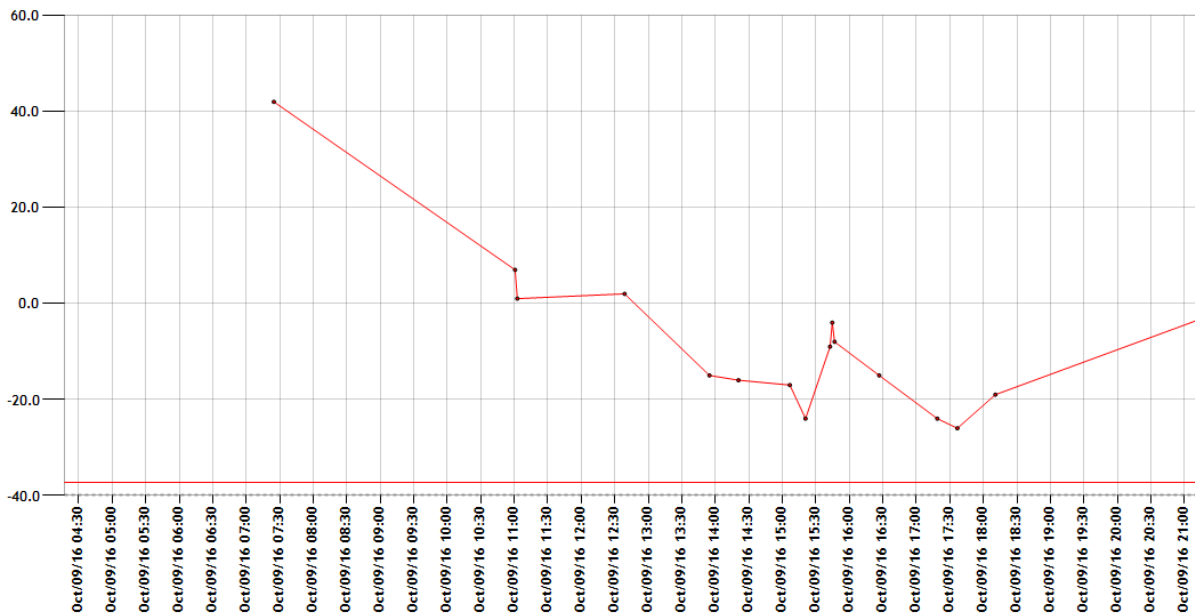



Figure 3.4 the figure after using “Show Spikes”

will be shown.

- Applying a filter

By clicking  "Apply Filter" (the icon is black), the figure is further smoothed. Only the main trend

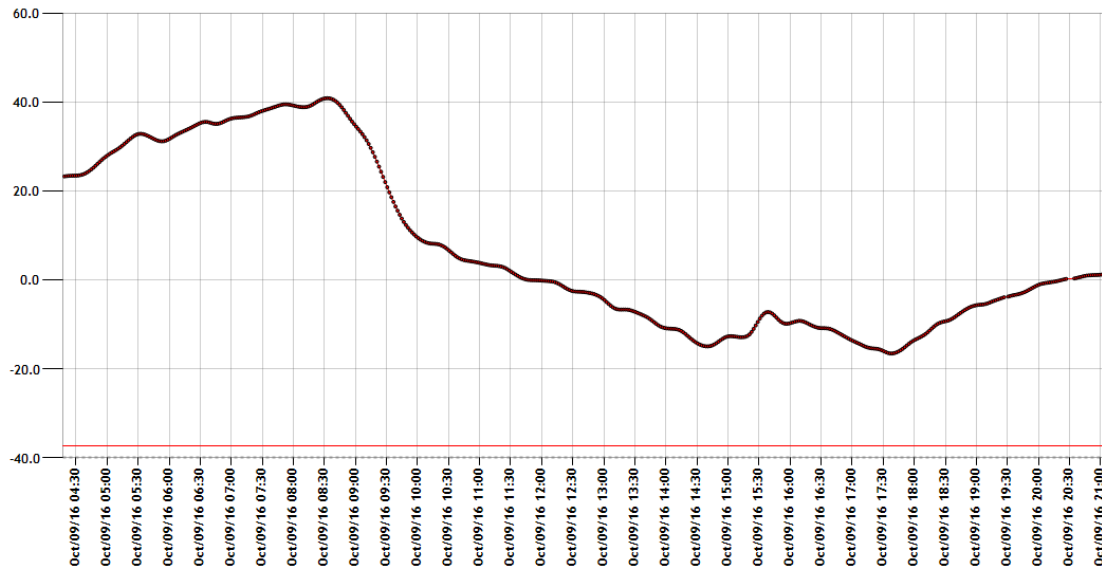


Figure 3.5 the figure after using "Apply Filter"

will be shown.

- **Removing the trend**

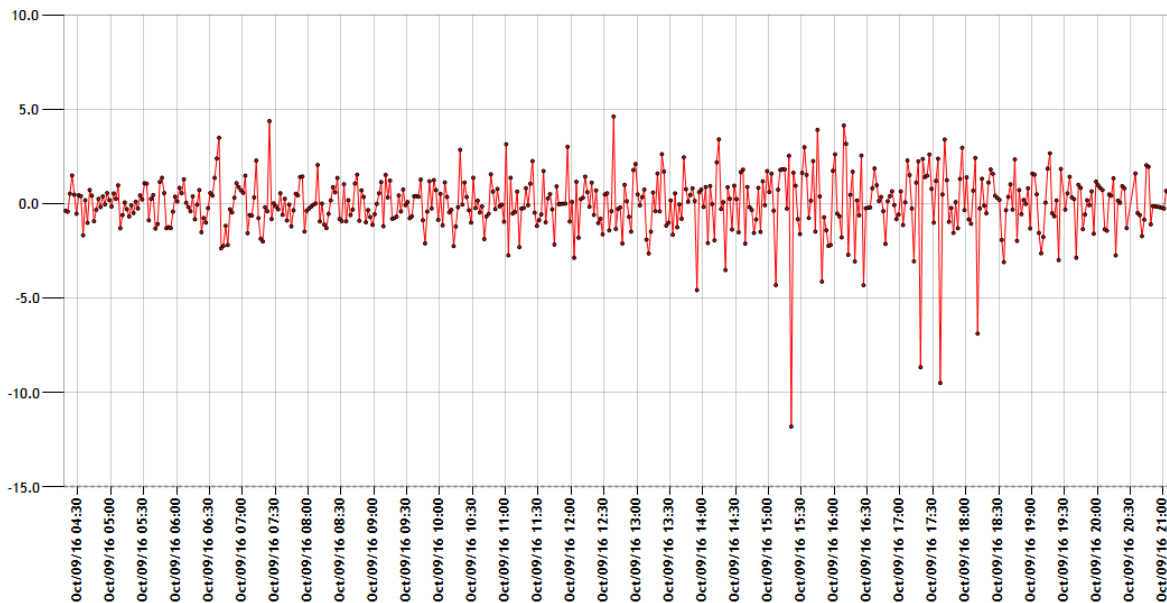





Figure 3.6 the figure after using "Apply Filter"

By clicking  "Remove trend" (the icon is red), ONLY the fluctuations and the spikes are shown.

- **Returning to the original figure**

It's very simple. Just click  "Refresh".

- **Customizing the filter**

The parameters of the filter can be customized in the  "Filter Options". Make sure the function of each parameter is well-known by the user before changing any of them.

- **Change the properties of the figure**

1. Right click the figure area and select "Edit".

2. The style (color, font, etc.) of the figures can be changed on the panel shown below.

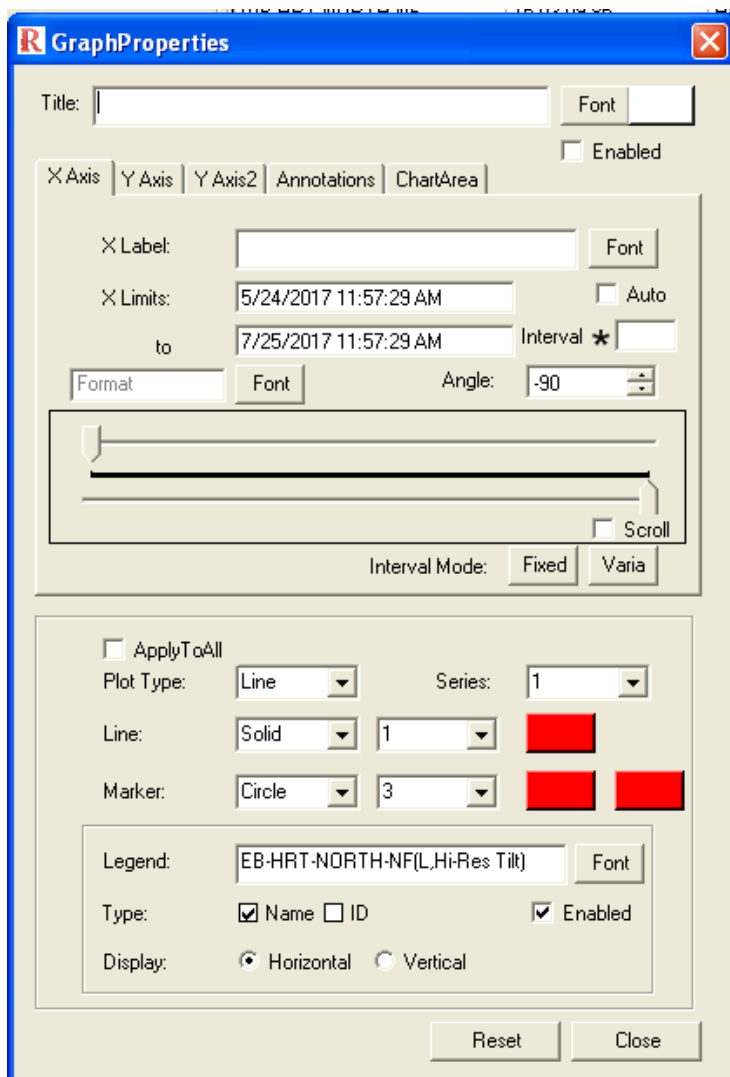
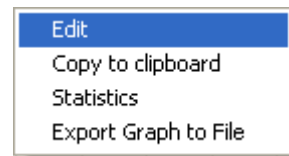
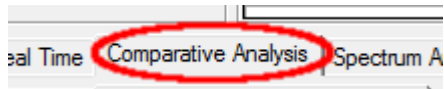


Figure 3.7 Graph Properties panel

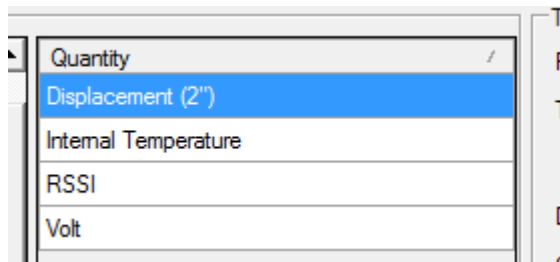
D. Comparative Analysis

Comparative Analysis is the best way to show the statistical relationship between different quantities. To start a comparative analysis, the data must be imported.

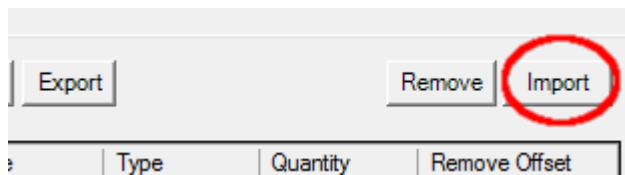
1. Click the “Comparative Analysis” tab under the “Devices” area.



2. Select the quantity that needs to be analyzed.



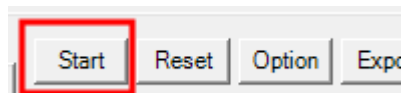
And click “Import”:



3. The imported quantity will appear in the list below. Import all the quantities needed.
4. Select all the quantities needed to be analyzed by checking the box in front of them (usually 2 quantities).

	ID	Name	Type
<input checked="" type="checkbox"/>	15-03-08-88	2" _1D_Dis_...	Disp
<input checked="" type="checkbox"/>	15-03-08-88	2" _1D_Dis_...	Disp

5. Click “Start” to start analysis.



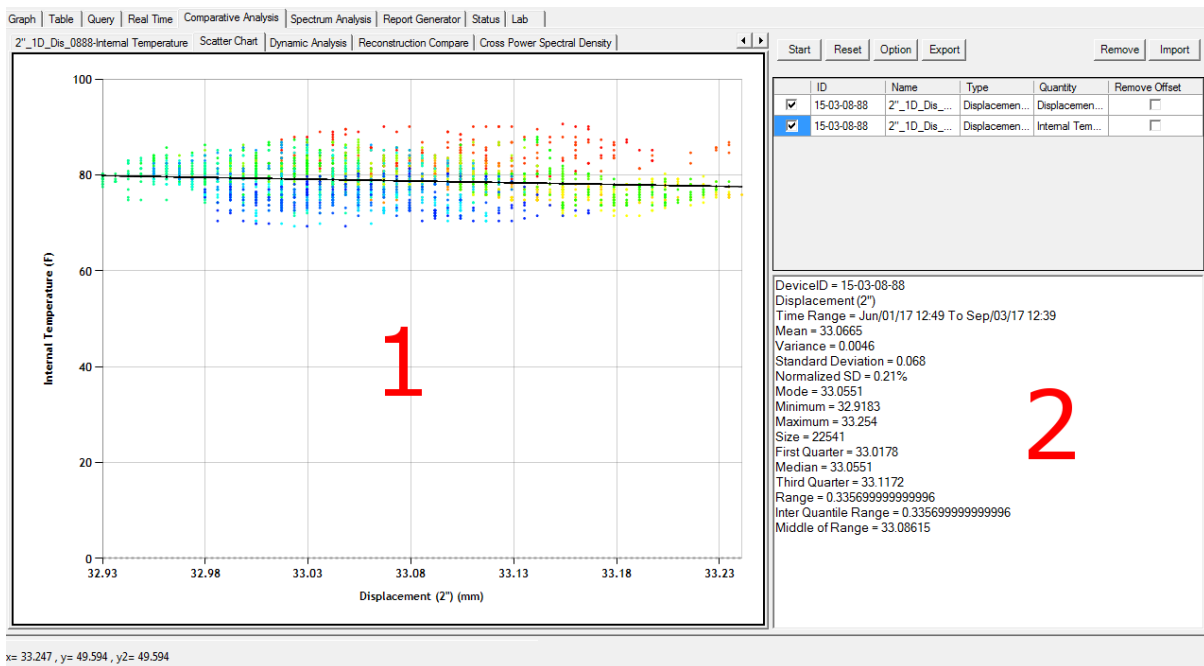


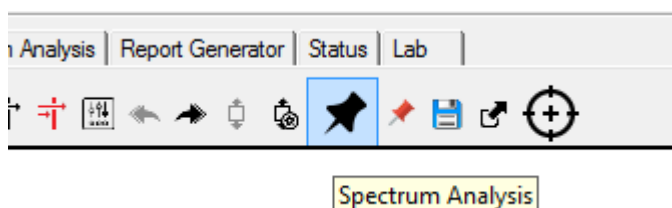
Figure 3.8 the Comparative Analysis tab

- See the figure in the plotting plain (area 1) by selecting a tab and see the statistical data in the bottom-right area (area 2). For Scattered Chart, the data points marked with blue are most recent while the red ones are the oldest.

E. Spectrum analysis

Spectrum analysis converts the data from time-amplitude plain to frequency-amplitude plain. In this way the natural frequency can be clearly shown in the figure.

It is easy to start a spectrum analysis. First, plot the data of a period of time. What to do next is hitting the “Spectrum Analysis” button in the toolbar.



After the icon is selected, drag the selection box to cover all the data points that need to be analyzed. To do this you might need to do some zoom-ins and/or zoom-outs.

Then the spectrum of the data will be shown in the plotting area like this:

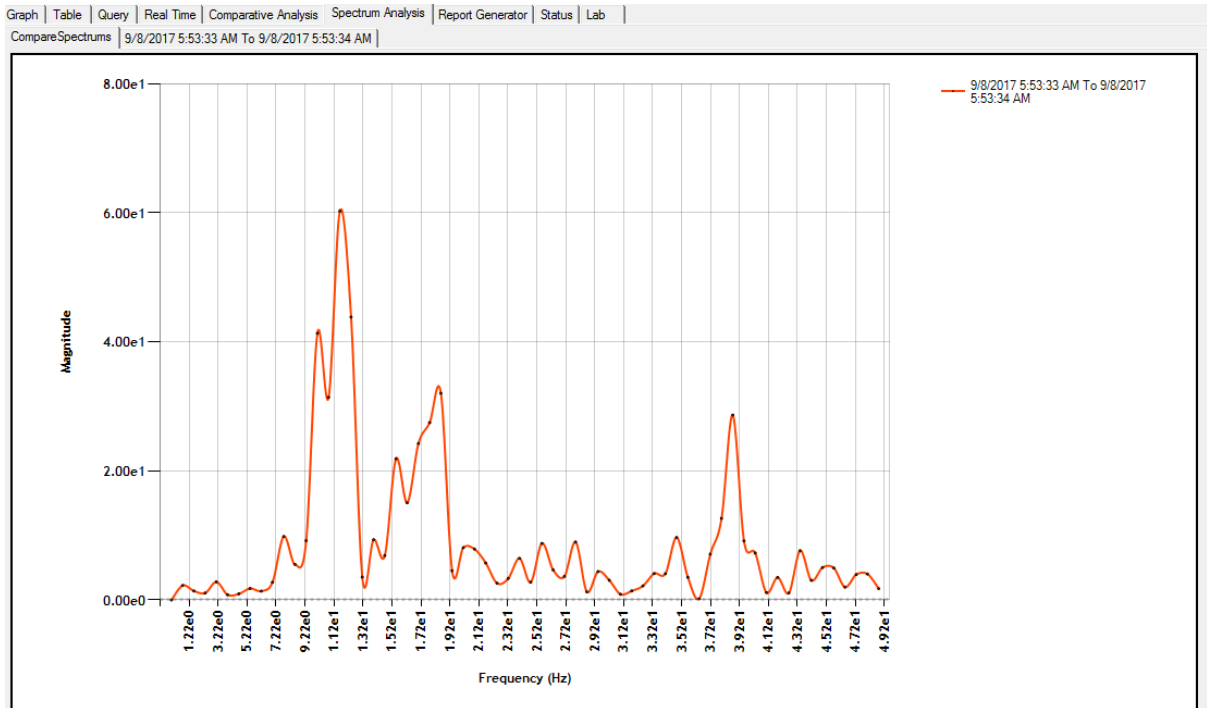


Figure 3.9 the Spectrum Analysis Result

F. Registration

Caution! This function is only for advanced customers. Inappropriate operations may lead to malfunction in the measurement of the system. Please contact Resensys before modifying the registration of your system.

- Adding a device using the “Clone” function

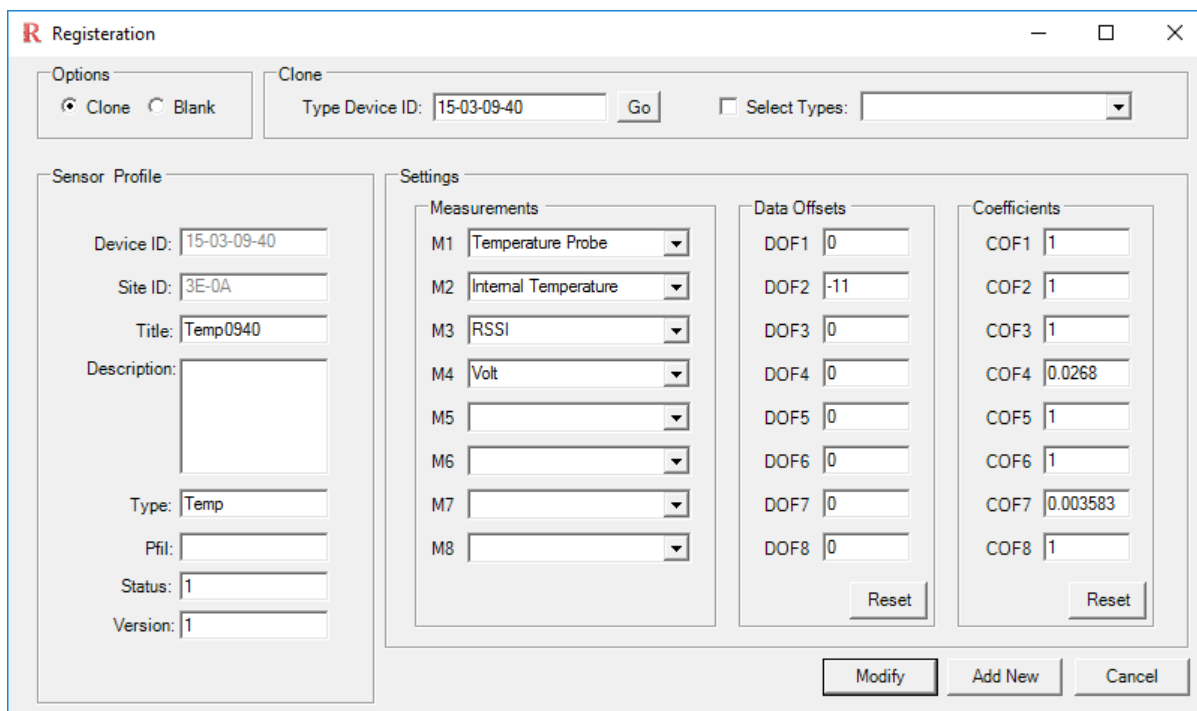
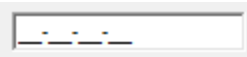

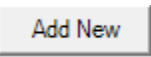
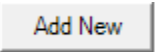


Figure 3.13 the Registration panel

1. Click “Device”->”Registration” in the menu bar. And the following panel will appear.
2. Select “Clone” in the “Options” area (top-left corner of the panel).
3. Get a “Clone” by inputting the Device ID of a device of the same type in  and hit “Go”. Or alternately, check the box in front of the drop down menu  and select a type in the drop down menu.
4. Modify the information in the “Sensor Profile” area. Make sure both the “Device ID” and the “Site ID” are correct. Then please check the “Status” box. Make sure the value is 1 (“Active”) unless it is desired to be inactive.
5. Input them the data offsets and/or the coefficients if known. Otherwise, leave them as default.
6. Click  to add the device.


▪ **Adding a device from scratch (not recommended)**

1. Click “Device”->”Registration” in the menu bar.
2. Select “Blank” in the “Options” area (top-left corner of the panel).

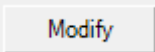
3. Input the information in the “Sensor Profile” area. The “Device ID” and the “Site ID” are mandatory, the rest are optional. The “Status” should be “1” (“Active”) if the new device should be seen in the “Sensor List”.
4. Select appropriate data types from the drop down menus in the “Measurement” area and input the “Offset” and the “Coefficient”.
5. Click  to add the device.

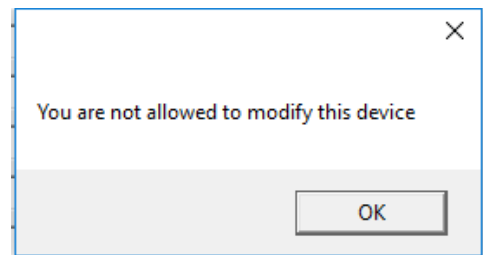
- **Modifying an existing device**

1. Click “Device”->”Registration” in the menu bar.
2. Select “Clone” in the “Options” area (top-left corner of the panel).

3. Input the Device ID of the device and click go 

4. INPUT the Device ID and the Site ID (the new one if modified) in the “Sensor Profile”.
5. Modify the other information if needed.

6. Click  to apply the changes.
7. If you see the following dialog please check if the Device ID and the Site ID have been correctly typed in.



- **Modifying parameters without using registration**

Right click any device in the Sensor List and click “Properties”. Modify the parameters and click “Save” to confirm the change which is the same as the live/local mode.

- **Refresh to see the changes**

Every time after changing any setting in the registration, re-select the site ID to refresh the display so that the change can be seen.

G. Exporting Data

Exporting the data can be done in the same way as in the Live/Local mode. Please refer to the previous sections for the information.

H. Alert Management

Resensys provides a comprehensive alert management service to notify users when unusual measurements or data loss are observed. The user should contact Resensys first to set up the service

(because not all users require this service). Then the alerts can be managed by the user with the following steps.

- **Introduction of the alert management panel**

In remote mode, click on the “Device” Tab in the menu and then click on “Alert Generation”. Then you should see the Alert Management panel as shown in Figure 3.14.

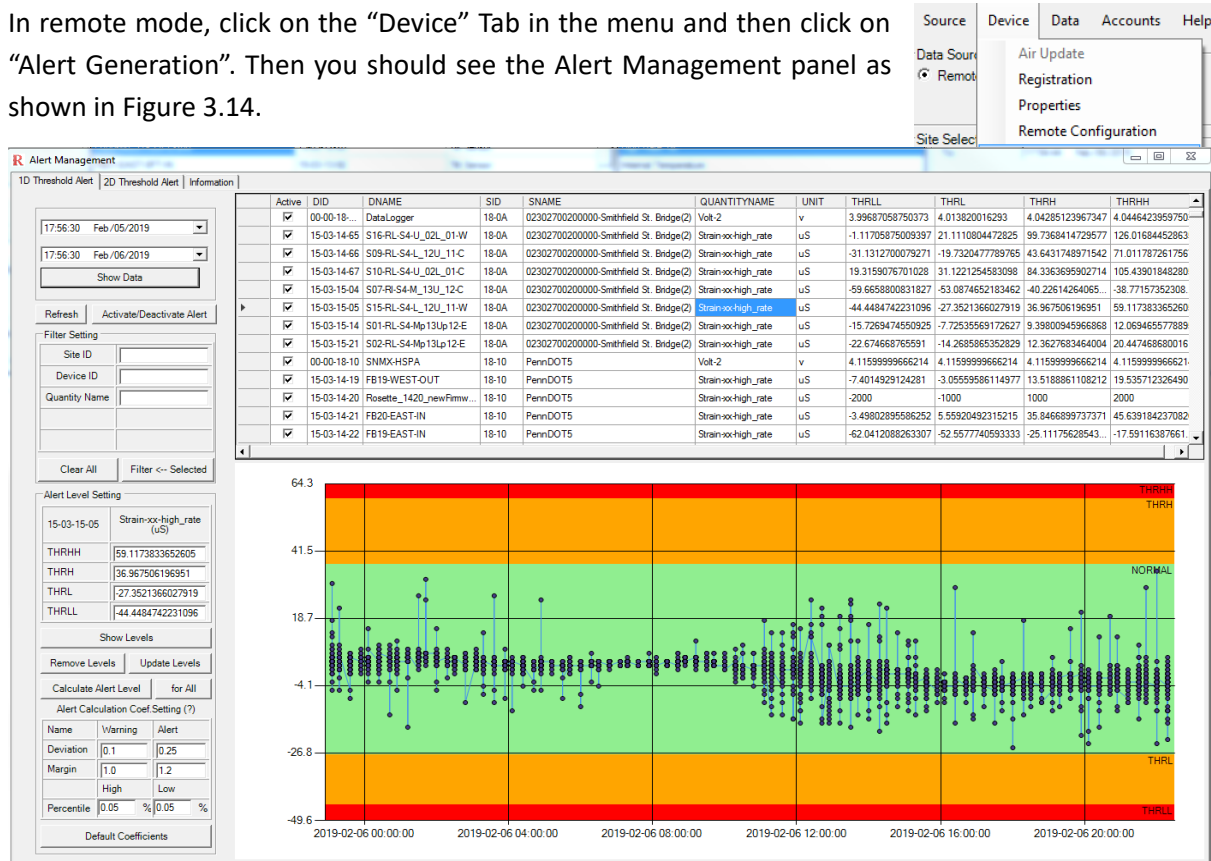
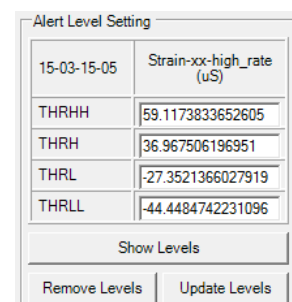


Figure 3.14 the Alert Management panel

The panel consists of 3 tabs. The first one is for configuring single-quantity-alerts (1D Threshold Alert). The second tab is for dual-quantity-alerts (2D Threshold Alert) and the last one is for changing the E-mail addresses that the alert will be sent to. All these tabs will be introduced separately in the following section.

- **1D Threshold Alert**

This kind of alerts only monitor one quantity per alert and trigger warning when the corresponding measurement drops out of the normal range defined by the thresholds. There are four thresholds per alert. Low Measurement Warning or THRL means the measurement is low enough to pay attention to but not seriously off the normal range. Low Measurement Alert or THRL means the measurement is too low and actions should be taken immediately. Similarly, High Measurement Warning (THRH) and High Measurement Alert (THRRH) are the high-measurement notifications

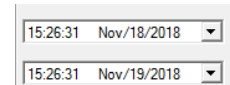


respectively.

Adjust thresholds

To adjust the alarm thresholds (there should be preset thresholds already), just change the numbers in the “thresholds area” (shown on the right) and click “Update Alert Levels” above it. However, this is only feasible when the user clearly know the value of thresholds needed. If the user is not aware of the preferred thresholds, there is a more intuitive way available as well. Simply follow the following steps:

1. Pick the data used as the reference for setting the thresholds with the time range adjusting tool.
2. Choose a device. Then click on “Show Data” button to plot the data. Some figure like the one shown in Figure 3.14 should appear.
3. The user can change the thresholds manually by input numbers into the textboxes.
4. If it is difficult to find good thresholds, click on “Calculate Alert Level” button below “Show Data” and suggested levels will be calculated for all selected quantities.
5. The automated alert level calculation is done as listed below:



$$THRHH = [DataAverage + DataStandardDeviation * Deviation(Alert) + Margin(Alert) * (AdjustedDataMax - DataAverage) - CalibOffset] * CalibCoef$$

$$THRH = [DataAverage + DataStandardDeviation * Deviation(Warning) + Margin(Warning) * (AdjustedDataMax - DataAverage) - CalibOffset] * CalibCoef$$

$$THRL = [DataAverage + DataStandardDeviation * Deviation(Warning) + Margin(Warning) * (DataAverage - AdjustedDataMin) - CalibOffset] * CalibCoef$$

$$THRLL = [DataAverage + DataStandardDeviation * Deviation(Alert) + Margin(Alert) * (DataAverage - AdjustedDataMin) - CalibOffset] * CalibCoef$$

Explanation:

The “Deviation” and “Margin” are listed in the textboxes respectively.

The “DataAverage” is the average of all the measurement values within the time range.

The “DataStandardDeviation” is the standard deviation of all the measurement values within the time range.

AdjustedDataMax/Min are the measurement values whose percentile rank matches the ones in the “Percentile” textbox.

6. The calculated levels will be marked in the bold-orange font.
7. After changing the thresholds levels (either with manual input or suggest levels), click on “Show

Levels” in the thresholds area to replot the figure. The new ranges will be shown. The red areas are the alert ranges while the amber areas are the warning ranges.

8. If the user is unsatisfied with the thresholds, fine tuning and replotting can be done as many times as needed by using the manual input textboxes.
9. After finishing the adjustment, click on “Update Alert Levels” to save the change to the server. Make sure the ones need to be updated are selected.

Screening alerts

In Alert management panel, all the alerts of the devices which the user has access to will be listed. The user can either manually input the parameters in the “Filter Setting” area or click on

The screenshot shows a web interface for alert management. On the left is a sidebar with a date range selector (18:50:02 Feb/05/2019 to 18:50:02 Feb/06/2019), a 'Show Data' button, and a 'Filter Setting' section. The 'Filter Setting' section includes input fields for Site ID, Device ID, and Quantity Name, with the DNAME field populated with 'S14-RL-S4-M_13L_12-W'. Below these are 'Clear All' and 'Filter <-- Selected' buttons. The main area is a table with the following data:

Active	DID	DNAME	SID	SNAME	QUANTITYNAME	UNIT	THRLL	THRL	THRH	THRHH
<input checked="" type="checkbox"/>	15-03-14-62	S14-RL-S4-M_13L_12-W	18-08	02302700200000-Smithfield St. Bridge(1)	Strain-ox-high_rate	uS	-26.8948036823807	-15.3661129664453	16.9319214806043	25.7027827249218
<input type="checkbox"/>	15-03-14-62	S14-RL-S4-M_13L_12-W	18-08	02302700200000-Smithfield St. Bridge(1)	Internal Temperature	F	-40	-13	122	130
<input checked="" type="checkbox"/>	15-03-14-62	S14-RL-S4-M_13L_12-W	18-08	02302700200000-Smithfield St. Bridge(1)	RSSI	dBm	-126	-100	127	255
<input checked="" type="checkbox"/>	15-03-14-62	S14-RL-S4-M_13L_12-W	18-08	02302700200000-Smithfield St. Bridge(1)	Voltage	volt	2	2.5	3.2	4

Figure 3.15 Filter Setting and the filtered result

“Filter<--Selected” after selecting a cell in the table to filter the result. For example, to check the alerts for a single device, choose one of the device ID (DID) and click on “Filter<--Selected”. In this way only the alerts related to the chosen device will be listed.

Activate/Deactivate alerts

Select multiple cells (or rows) and click on “Activate/Deactivate Alert”. After confirmation, the status of all selected alerts will be toggled.