

MoteScan Help

For Wireless Strain Gauge Sensor System

Version 0.19.1

Last Updated March 2010

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FCC Compliance Statement

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions:

1. This device may not cause harmful interference, and
2. This device must accept any interference received, including interference that may cause undesired operation.

FCC Class B Digital Device

NOTE: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

This Class B digital apparatus complies with Canadian ICES-003.

Changes or Modifications

CAUTION: Changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

CAUTION: This device must not be co-located or operating in conjunction with any other antenna or transmitter.

Detachable Antennas

To reduce potential radio interference to other users, the antenna type and its gain should be so chosen that the equivalent isotropically radiated power (e.i.r.p.) is not more than that permitted for successful communication.

External Antennas

This device has been designed to operate with the antenna listed below, and having a maximum gain of 3 dBi. Antennas not included in this list or having a gain greater than 3 dBi are strictly prohibited for use with this device. The required antenna impedance is 50 ohms.

Approved Antenna Listing

Ceramic Chip Antenna Part No. ANT-916-CHP-x (Manufacturer: Antenna Factor, Inc.)
(Maximum Gain = 0.5 dBi)

External Dipole Antenna Part No. W1063 (Manufacturer: Pulse Antennas)
(Maximum Gain = 3.0 dBi)

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Quick Startup

Starting the Mote

1. Attach the mote to the desired machine section.
2. Remove the magnetic strip.

The mote is now operational.

Starting the Software

1. Connect the coordinator via USB 2.0.
2. Run the program.

The program window will open with a dialog box called "Select a Port".

Select the USB port into which you connected the coordinator (ex.: COM1). Selecting the wrong one will create an exception and error. If you closed the dialog box or connected to the wrong port, open it back up using [File > Connect](#) or the Connect button along the bottom of the program window.

The program will automatically open a live window (see Figure 1), run a mote check to see which motes are connected and in range, group those connected motes together in a group, and display their RSSI (signal strengths) at the bottom of the live window.

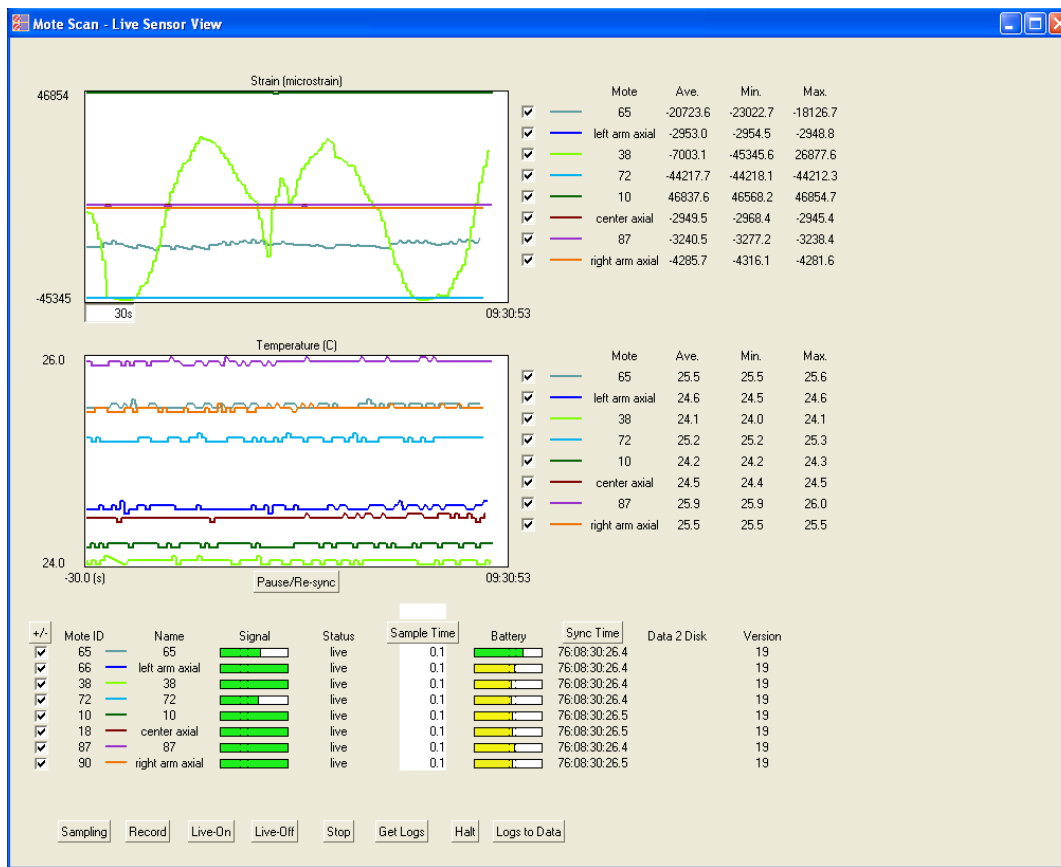


Figure 1: A screenshot of the live window in live view operation

Setup and Recording

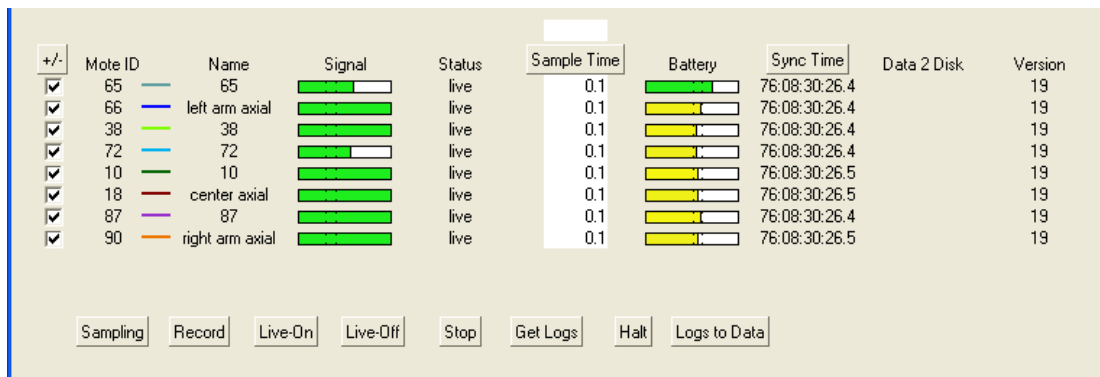


Figure 2: Setup portion of the live window

1. Sync Time

Press the button Sync Time near the bottom of the live window. This will ensure your PC, the coordinator, and all motes are running on the same time.

2. Set Sampling Time

In the text fields beside each of the mote IDs, input the lapse of time (in seconds) at which you would like each of the motes to record data.

3. Record

Press the Record button along the bottom of the live window.

4. Press Live-On

Press Live-On to have the motes send the data they are recording to the program so you can view it in real time.

5. Stop Recording

Once you have finished recording, press the Stop button along the bottom of the live window.

Data Processing

6. Get Logs

To download the data you just recorded, make sure the program is no longer recording, and press the Get Logs button along the bottom of the live window. This will download the log files to your Program Files directory in the Logs folder.

7. Convert to Data

To view the data you have collected (in the log files) in a format that is more manageable, click the Logs to Data button along the bottom of the live window. The log files will be converted into data files, saved to your Program Files directory, under the Data folder.

Basic Operation of the Scanmetrics Mote

Components

The mote system is composed of three components:

1. The mote containing a micro-controller system, a memory unit, sensor conditioning, radio, and a battery unit.
 - a. Microcontroller which controls the mote
 - b. Firmware (control) memory, Flash (data) Memory to record sensor data and optionally record temperature and battery on a timed basis
 - c. Internal Battery

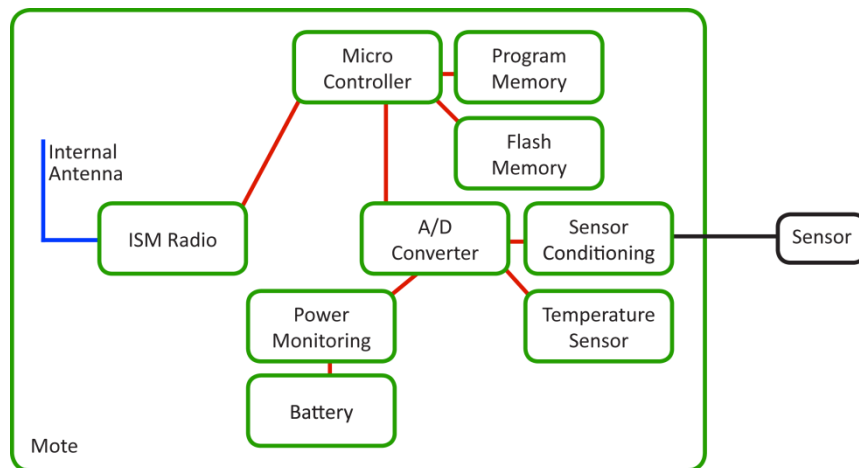


Figure 3: The interior functioning of a Scanmetrics Mote

2. The coordinator (USB connected) manages the motes and coordinates between the computer and the motes.
3. MoteScan Software, Mote Data Analysis Software

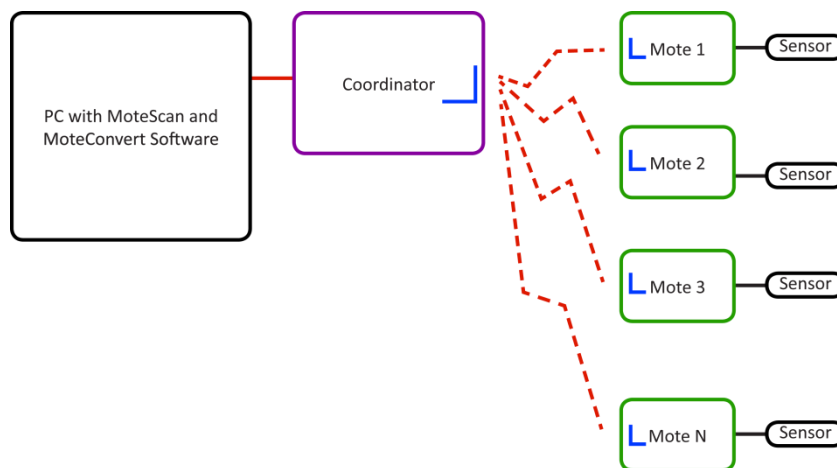


Figure 4: The interaction of the entire Scanmetrics mote system

Memory Capacity and Battery Life

The basic mote will record 16 bits of sensor data at a rate of 0.1 second for approximately 24 hours. The battery under full use will last approximately 36 hours.

Optional extra memory is available as well as power control firmware to enable extended operation in time.

Starting the Mote

3. Attach the mote to the desired machine section.
4. Remove the magnetic strip.

The mote is now operational.

To power down a mote, simply re-attach the magnetic strip.

DISCLAIMER

The system is subject to timing and radio handshaking limits. It is a multi-node radio packet network which is subject to impairments of communications. The system is such that it occasionally does require retries.

Introduction to MoteScan Software

Version 0.19.1

Scanimetrics' MoteScan software is divided into three components:

1. The control for the motes is run on a PC, but commands the motes through a coordinator.
2. The graphics-based user interface (GUI) shows in real time the data collected.
3. MoteConvert (included with MoteScan) converts the log files downloaded from the motes into final data files, performing adjustments to align and format the data for consumption.



Figure 5: The interactions between the motes, the coordinator, and your PC

MoteScan Graphics-Based User Interface (GUI)

For General Use

Version 0.19.1

Starting the Software and Connecting the Coordinator

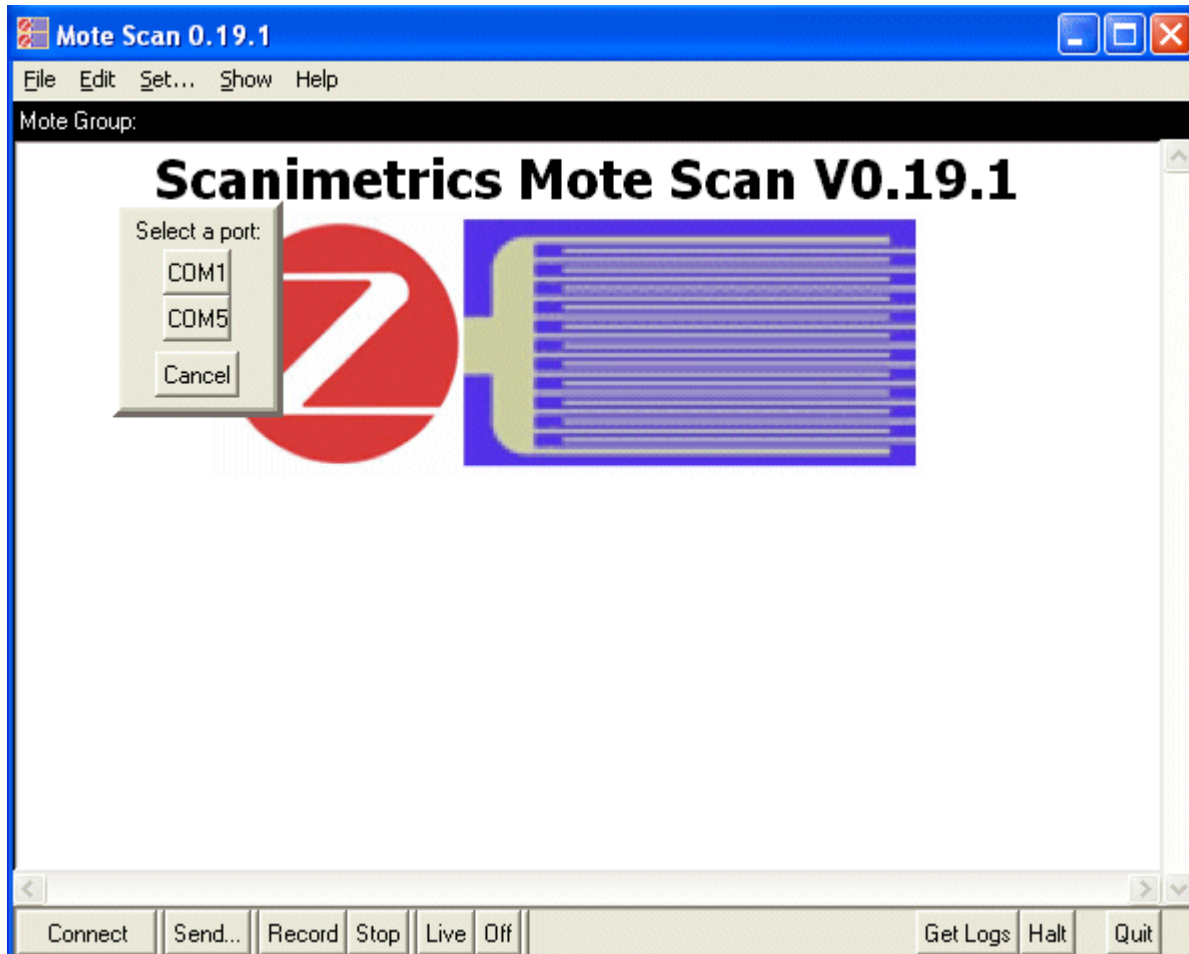


Figure 6: MoteScan 0.19.1 opening window

1. Connect the coordinator via USB 2.0.
2. Run the program.

The program window will open with a dialog box called “Select a Port”.

Select the USB port into which you connected the coordinator (ex.: COM1). Selecting the wrong one will create an exception and error. If you closed the dialog box or connected to the wrong port, open it back up using the [Connect button](#) along the bottom of the program window or File > Connect.

Live Graphics Window

Once the program is running, and the coordinator is connected, the program will automatically open the live window, run a check to see which motes are connected and in range, group those connected motes together in a group, and display their signal strengths ([RSSI](#)) at the bottom of the live window.

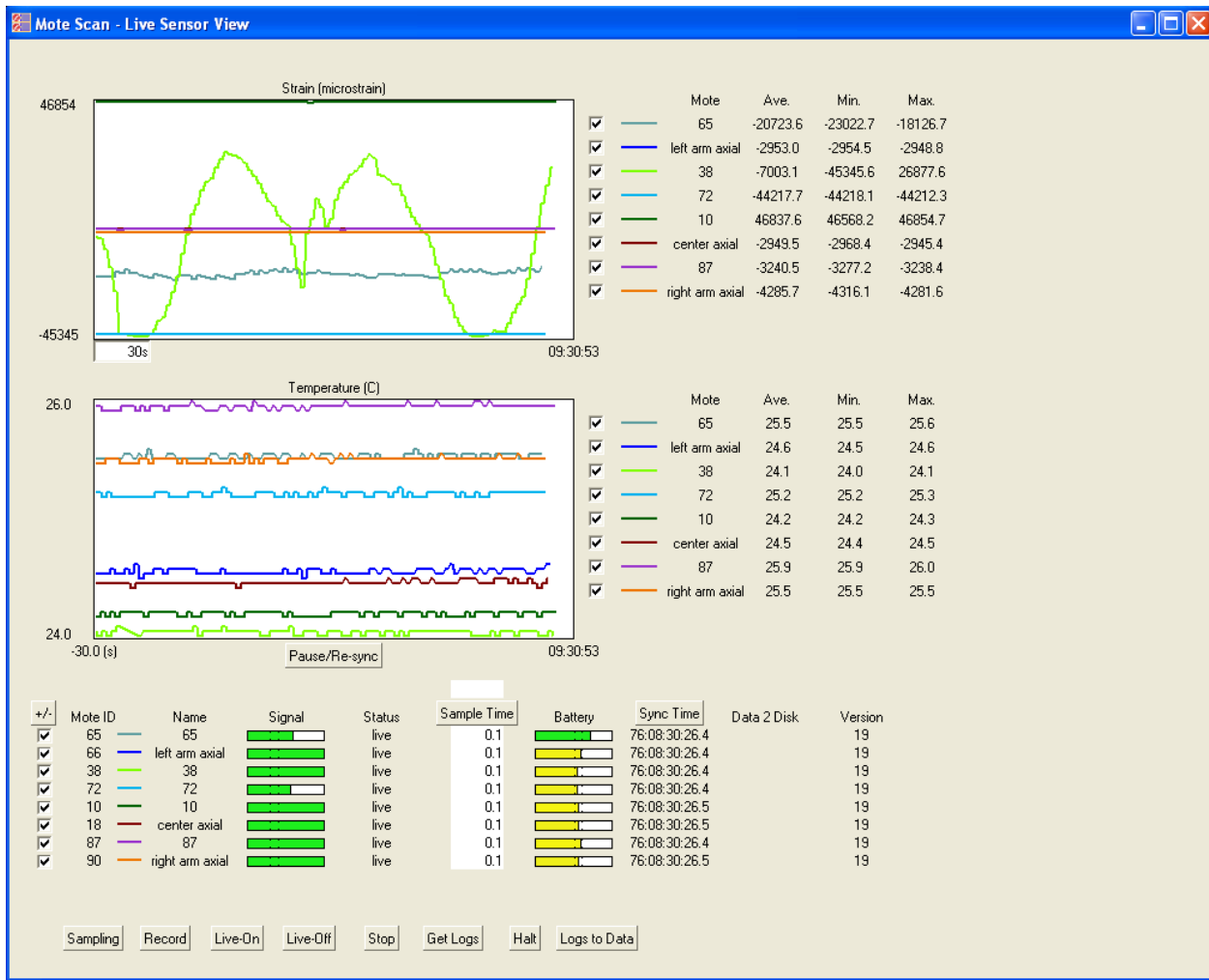


Figure 7: A screenshot of the live graphics window in live view operation

Graphics Window Layout

Signal Strength and Status

The section in the live window near the bottom lists all connected motes in working range.

+/-	Mote ID	Name	Signal	Status	Sample Time	Battery	Sync Time	Data 2 Disk	Version
<input checked="" type="checkbox"/>	65	65	<div style="width: 100%; height: 10px; background-color: green;"></div>	live	0.1	<div style="width: 100%; height: 10px; background-color: green;"></div>	76:08:30:26.4		19
<input checked="" type="checkbox"/>	66	left arm axial	<div style="width: 100%; height: 10px; background-color: green;"></div>	live	0.1	<div style="width: 100%; height: 10px; background-color: green;"></div>	76:08:30:26.4		19
<input checked="" type="checkbox"/>	38	38	<div style="width: 100%; height: 10px; background-color: green;"></div>	live	0.1	<div style="width: 100%; height: 10px; background-color: green;"></div>	76:08:30:26.4		19
<input checked="" type="checkbox"/>	72	72	<div style="width: 100%; height: 10px; background-color: green;"></div>	live	0.1	<div style="width: 100%; height: 10px; background-color: green;"></div>	76:08:30:26.4		19
<input checked="" type="checkbox"/>	10	10	<div style="width: 100%; height: 10px; background-color: green;"></div>	live	0.1	<div style="width: 100%; height: 10px; background-color: green;"></div>	76:08:30:26.5		19
<input checked="" type="checkbox"/>	18	center axial	<div style="width: 100%; height: 10px; background-color: green;"></div>	live	0.1	<div style="width: 100%; height: 10px; background-color: green;"></div>	76:08:30:26.5		19
<input checked="" type="checkbox"/>	87	87	<div style="width: 100%; height: 10px; background-color: green;"></div>	live	0.1	<div style="width: 100%; height: 10px; background-color: green;"></div>	76:08:30:26.4		19
<input checked="" type="checkbox"/>	90	right arm axial	<div style="width: 100%; height: 10px; background-color: green;"></div>	live	0.1	<div style="width: 100%; height: 10px; background-color: green;"></div>	76:08:30:26.5		19

Figure 8: A screenshot of the strength and status section of the live window

Group

Allows you to set the active mote group by checking the boxes beside the mote numbers. See [Set Group](#) for more information.

The +/- button above the check boxes will select all or deselect all motes for the mote group.

Mote ID

Displays the ID number of the mote, followed by a program-assigned colour.

Name

Displays the mote name associated with the mote ID, as set in the config file (see [Adding a Mote Name](#)).

Signal

Represents the RSSI (Received Signal Strength Indicator) or strength of the signal received by the coordinator.

Green signifies operational strength.

Yellow is low signal strength: there is potential for data loss.

Red is very low signal strength: the coordinator is having difficulty talking to the mote, but there is no degradation in the sensor data, nor any loss of storage.

Grey signifies the signal bar is not showing a present reading. If the coordinator does not receive a signal for more than 16 seconds, the signal status turns to inactive.

Status

Indicates the status of the mote.

Inactive: the coordinator has not had communication from the mote in more than 16 seconds.

Active: the mote is in range and ready to receive communication.

Live: the mote is sending data to the program.

Downloading: the mote is downloading its data to the computer.

NOTE: The mote can be recording in any state except when downloading.

Sample Time

Allows you to modify separately the lapse of time between sensor data picked up by each mote. See [Set Sample Time](#) for more information.

Battery

Displays the battery strength of each mote, using the same colour indicators as for the signal strength.

CAUTION: When the battery strength indicator is red, the mote system voltage has dropped below the specified voltage for writing the on-board flash memory. We recommend replacing the mote when the indicator drops into the yellow region.

Sync Time

Displays the time the motes were last synchronized. See [Set Sync Time](#) if each time is not within 0.1 seconds of the others.

Data 2 Disk

Displays the number of data samples that have been downloaded to your computer from a certain mote.

Version

Displays the version of software each mote is running.

CAUTION: All motes and coordinators need to be the same version to ensure the correct operation of the system

Strain and Temperature Graphs

The top section displays strain and temperature graphs using data sent from the motes.

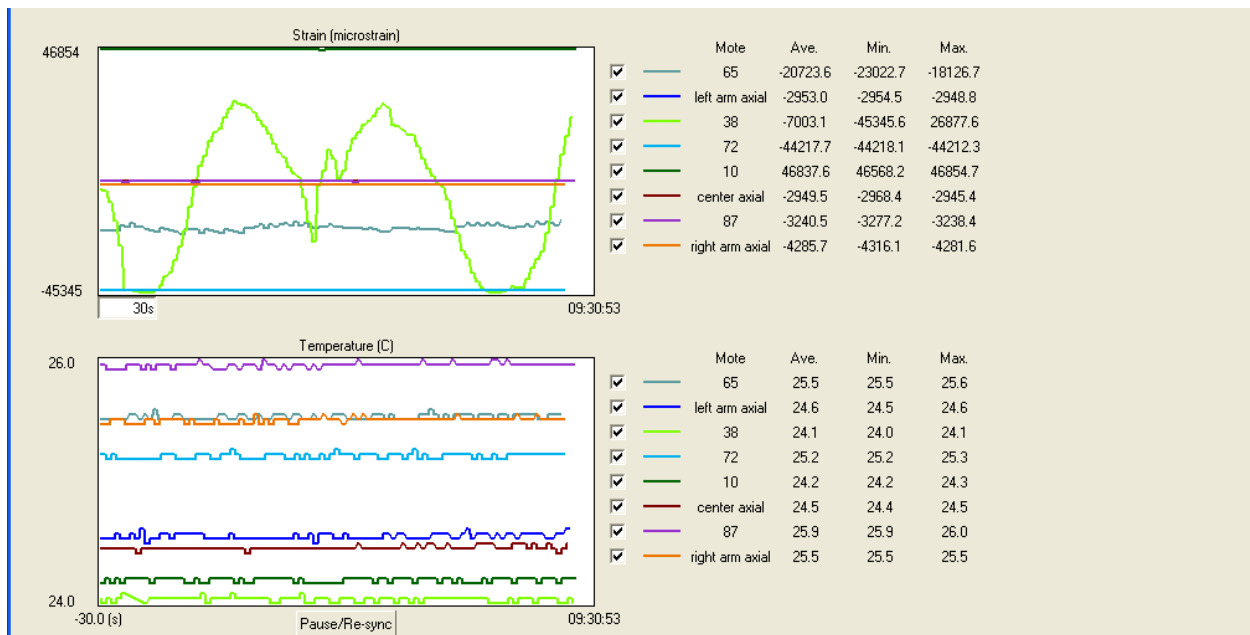


Figure 9: A screenshot of the temperature graph section of the live window

The graphs are kept in synchronization with each other and will automatically resize to the dimensions of the data displayed. The present time is represented at the end of the graph, with the preceding readings shown as recording history. Default history is 30 seconds. See [below](#) for more information.

Column Headings

Mote: Displays the mote name (as set in the mote.config file) and the mote’s colour.

Ave: Displays the average data visible in the graph.

Min: Displays the lowest data sample that mote took.

Max: Displays the highest data sample that mote took.

Basic Operation

For more information on each operation, click the titles to see the sections in Advanced Operation.

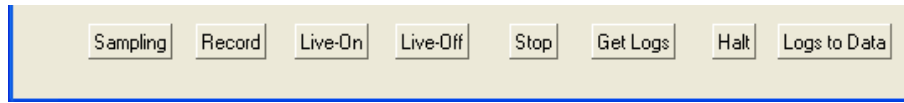


Figure 10: The buttons along the bottom of the live window

1. **Graph > Show**

To open the live window if you closed it.

NOTE: This operation does not start up the live feature. This is not the same as pressing the Live button along the bottom of the program window.

2. **Set Sample Time**

In the live window, enter the sample time you would like each mote to record at. To set all motes to the same sample time, input a sample time into the top-most mote, and press Set All. This will set both Channel A and temperature to the same sample time. If you do not wish to record temperature, please press the [Sampling button](#) along the bottom of the live window.

3. **Set Sync Time**

Before recording, press the Sync Time button in the live window to sync all motes with the coordinator's time. This is very important for post processing of the data to function correctly. For more information on the Sync Time function, see [Sync Time](#) below.

CAUTION: It is very important to remember to sync time before recording for all data to align properly. Be sure to also sync time if any motes have been powered down or lost power.

CAUTION: If you sync time after you start recording, post-processing of data will not function properly, since it relies on the first and last samples having the same time stamp.

4. **[Record](#)**

To record all data sensed by the mote group you presently have set at the settings to which you have programmed that group until you command the group to stop. To program different motes to different settings, see [Set Group](#).

CAUTION: Recording overwrites all data saved to a mote. If you had any data on a mote prior to recording, be sure to download it to your computer first.

NOTE: Record can also be found along the bottom of the program window and in the File menu.

5. **[Live-On Button](#)**

To have a real-time indication of the data being recorded. Click the Live button (along the bottom of the live window) to start the motes sending their data to the program. You must be recording to see any live data. Please see [Record](#) for more information.

NOTE: You can press the Live button even if the live window is not open. The motes will send their data, but you will not be able to see it.

NOTE: If data is not being recorded, using the live feature will not show anything. You must be recording to see the data.

6. Set Time Delay



Figure 11: The set time delay field under the strain graph in the live window

To set the length of time you want to be able to see in the graphs in the live window, enter the time into the text field right below the strain graph in the live window in the following format: `xh ym zs` (ex.: 1h 25m 43s). If you do not wish to see more than 59 seconds, do not enter any hours or minutes. Both graphs will automatically set to that time delay.

7. [Live-Off Button](#)

To stop the incoming data from showing on the graphs.

NOTE: This does not stop the recording process. To stop the recording process, you must press the [Stop button](#) or use `File > Stop`.

8. [Stop Button](#)

To stop recording.

NOTE: Stop can also be found along the bottom of the program window.

9. [File > Get Logs](#)

To download the log files from the mote to your computer.

NOTE: Stop recording before downloading the log files. The files will not download if you have not stopped recording.

NOTE: Get Logs can also be found along the bottom of the program window.

Useful Menus in GUI

Please note that if you click the stitch line (see Figure 12) on the first item on each of the menus in the program window, the menu will pop out as a floating menu (see Figure 13), allowing you to have the commands open all the time.

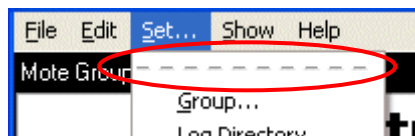


Figure 12: The Set... menu, showing the stitch line

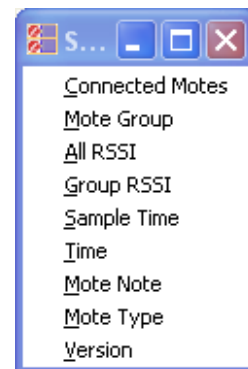


Figure 13: The Show menu as a floating menu

Graph

[Show](#)

Data

[Convert Logs to Data](#)

Advanced Operation

Buttons Along the Bottom of the Live Window

Sampling

To choose the recording settings for the active mote group. This command opens a dialog box (see image to the left).

Under Sample, select Channel A, Temperature, and Battery.

Enter the desired lapse of time between samples sent by the mote in seconds.

Minimum time is 0.1 seconds.

Log Capture indicates the capture to memory settings:

Stop on Full: Recording will stop when memory is filled.

Continuous: Recording will continue from the beginning of the memory (overwriting as it does) once it reaches the end.

CAUTION: Presently, Channels B and C are undefined. Do not select those channels. Selecting those channels will result in visually garbled data in the GUI

NOTE: This setting currently sets the sample time for all channels simultaneously.

NOTE: This function is also located in Set > Sampling....

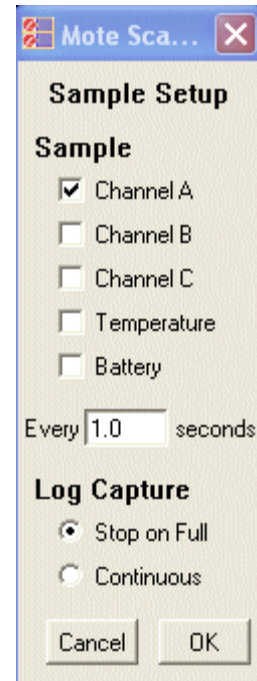


Figure 14: The Sample Setup dialog box

Record

To record all data sensed by the mote group you presently have set at the settings to which you have programmed that group until you command the group to stop. To program different motes to different settings, see [Set Group](#).

Motes will continue recording until you send the command to stop using the [Stop button](#) (of File > Stop), until the battery runs out, or the data reaches the memory capacity (if you set Log Capture in the [Sampling dialog box](#) to “Stop on Full”), regardless of whether the computer and/or coordinator are connected or not.

CAUTION: Recording overwrites all data saved to a mote. If you had any data on a mote prior to recording, be sure to download it to your computer first.

NOTE: Ensure all the motes are programmed with the desired settings before recording.

NOTE: If the battery runs out on a mote before a log is finished downloading, Scanimetrics can extract the data from the mote.

NOTE: This function is also located along the bottom of the program window and in File > Record.

See [the note below](#) to learn about recording different mote groups at different times.

Live-On

To have a real-time indication of the data being recorded. Click the Live-On button (along the bottom of the live window) to start the motes sending their data to the program. You must be recording to see any live data. Please see [Record](#) for more information.

NOTE: If data is not being recorded, using the live feature will not show anything. You must be recording to see the data.

NOTE: The result of pressing the Live button in the [CUI](#) and the Live button in the GUI appear vastly different. In the CUI, the resulting data is displayed in a constantly-updated list, similar to the list in the log file.

NOTE: This function is also located along the bottom of the program window as “Live.”

Live-Off

To stop seeing the data in real time.

NOTE: This does not stop the recording process. To stop the recording process, you must press the [Stop button](#) or use File > Stop.

NOTE: Turning off the live data will not close the live window, but will only stop the data from being sent to the program.

NOTE: This function is also located along the bottom of the program window as “Off.”

Stop

To stop the motes from recording.

Motes will continue recording until you send the command to stop using File > Stop (the Stop button) or until the battery runs out, regardless of whether the computer and/or coordinator are connected or not.

NOTE: This function is also located along the bottom of the program window and in File > Stop.

Get Logs

To download the log files from the mote to your computer. MoteScan will download only one log file at a time. The files are in the .txt format named logfile_moteID#_date (ex.: logfile_M45_2010-03-22.txt) and saved to your program files directory (unless you set an alternate location using [Set > Log directory](#)).

The final line of a correctly downloaded file will read “ELog”. If you do not see that line, try downloading again.

If for any reason you need to stop the download process, press the [Halt button](#) along the bottom of the window..

NOTE: Stop recording before downloading the log files. The files will not download if you have not stopped recording.

NOTE: You can download and re-download a log file as many times as you need to. However, once you record again, the data will be overwritten. For more information see [Record](#).

NOTE: This function is also located along the bottom of the program window and in File > Get Logs.

Halt

To stop the downloading process (for any reason) from the notes to your PC. You can re-start the process at any time (until you record data onto the mote again).

CAUTION: Recording overwrites the data saved on the mote. If you have halted a download, remember to restart it before recording again.

NOTE: Do not confuse with Stop (stops the recording process) or Off (turns off the Live feature).

NOTE: This function is also located along the bottom of the program window and in File > Halt.

Logs to Data

To convert all log files to a single .csv data file. Opens the specified directory that houses your log files. Select all log files you want to combine and click Open. This launches a process in the background to process the data.

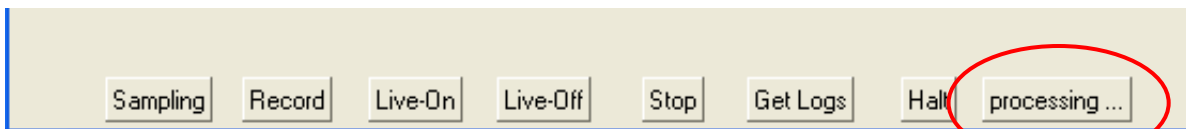


Figure 15: Note the last button has now changed to “processing...”

Once the button is pressed, it will change to read “processing ...” and you will only be able to convert the next set of until the program is finished processing.

NOTE: If you want to process more than one set of logs at a time, you can start another version of the program.

NOTE: This function is also located in Data > Convert Logs to Data.

The converting process converts all selected log files into two separate data files:

- raw: containing the original time stamps from the coordinator

- fixed_step.csv: using linear interpolation on the data to convert the data samples to even intervals of time stamps.

The files will be saved in the Data folder in your Program Files directory.

NOTE: This operation may slow down your system while the process is running.

NOTE: The data files will always be saved to the program files directory. The Set > Log directory will not change the location of the data files.

Important Setting Operations

Sync Time

To synchronize all hardware times, so all systems are running the same time. This operation will first synchronize the coordinator's time with the computer's time, followed by synchronizing the motes' time with the coordinator's time.

CAUTION: It is very important to remember to sync time before recording for all data to align properly. Be sure to also sync time if any motes have been powered down or lost power.

CAUTION: If you sync time after you start recording, post-processing of data will not function properly, since it relies on the first and last samples having the same time stamp.

Set Group

To give commands to multiple motes at once. The default mote group is all connected motes. To set a different the active mote group, check the boxes in the live window beside the motes you want grouped together. This change will take effect immediately once the box is checked.

NOTE: You can send commands to several mote groups, but only the most recent group will be active.

Keep in mind that any commands you send to the coordinator or a mote group will remain active until you send an opposing command, even if you leave the program or the mote's operating range. For example, the commands you send to a group will continue to operate if you change the group. Likewise, the commands sent to one mote group will still operate when the mote group is modified. However, there is only ever 1 active group. Please see the note below.

Note: Different Commands to Distinct Groups

Say you want to set motes 70 and 43 to record at 0.1 seconds sample time and motes 65 and 81 to record at 0.2 seconds:

1. Set > Group to 70 43, then Set > Sample time to 0.1.
2. Set > Group to 65 81, then Set > Sample time to 0.2.
3. Set > Group to 70 43 65 81, then Record.

Say you want to start recording motes 70 and 43 at 1:51 PM and motes 65 and 81 a few seconds later:

1. Set > Group to 70 43, then at 1:51 PM, File > Record. Motes 70 and 43 will continue recording even when you change the mote group.
2. Set > Group to 65 81, then File > Record.
3. Repeat these steps to Stop the recording (pressing the Stop button instead of the Record button) at different times.
4. To stop all motes at the same time, Set > Group to 70 43 65 81, then File > Stop.

This will not affect post-processing (as would happen if the mote and computer times were not synchronized. Please see notes at [Sync Time](#)).

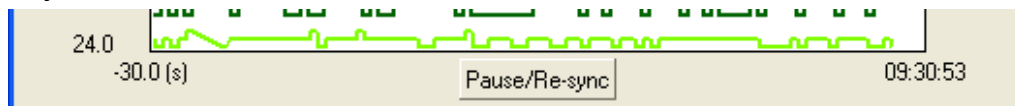
Pause/Re-sync

Figure 16: The Pause/Re-sync button under the temperature graph in the live window

To hold the graphs at the present time to allow you to inspect the incoming data, press the Pause/Re-sync button below the temperature graph in the live window. Pressing the button again will return the graph to the present position in time.

Buttons Along the Bottom of the Program Window.

Figure 17: The buttons along the bottom of the program window

Connect

To connect your coordinator to your computer. The dialog box that is subsequently opened lists all active USB (COM) ports (ports connected to a USB device) on your computer. Choose the correct port to which your coordinator is connected.

Once successfully connected, the button will read "Disconnect."

NOTE: This button will read "Disconnected" if a coordinator is already connected. See next entry.

NOTE: The program will return an error if you try to connect when you are already connected.

NOTE: This function is also located window and in File > Connect.

Disconnect

To disconnect your coordinator.

Displays in the program window "disconnected" when successfully disconnected.

NOTE: This function is also located in File > Disconnect.

Send...

To send a command to the active mote group.

NOTE: This is not the same as typing a command onto the command line in the [CUI](#). That command will be sent to the coordinator.

NOTE: In the GUI, the command will be sent, but you will not receive visual confirmation.

Record, Stop, Live, Off, Get Logs, Halt

See [Record](#), [Stop](#), [Live-On](#), [Live-Off](#), [Get Logs](#), and [Halt](#) along the bottom of the live window.

Quit

To quit the program. The red X in the corner of the program window has the same effect.

NOTE: If recording, this function will not stop the recording process. To stop recording, press the [Stop button](#) along the bottom of the live window or use File > Stop.

Config File

To change the mote names and configure the calculations for strain and temperature.

The configuration file is called mote.cfg and is located in the Config folder in the Program Files directory. The values in the graphs of the live window are calculated based on this file. For any changes made to the config file to take effect in MoteScan, restart the program.

The format of mote.cfg is: moteld, area, variable, value

“area” can be one of “strain,” “temperature,” and “config.”

If configuration for a mote is not specified, moteld is 0.

CAUTION: If programming motes at several sites, the config file MoteScan refers to will be the mote.cfg file on the computer used at the time. If multiple users configure the motes and collect the data, the changes made to the config file should be consolidated into a master mote.cfg file shared among those users for optimal results with MoteScan.

NOTE: The software comes with a configuration example as well as a default mote.cfg file. The example is also located in the Config folder.

Adding a Mote Name

To add a name to the mote ID, open the mote.cfg file and scroll to the end of the section containing lines that start with 0's.

Begin a new line and write the mote ID, “config”, “name”, and the desired name, all separated by “, .” (comma space). For example, inputting “18,config,name,Bob” would name mote 18 “Bob.”

The name will appear in the log file as well as in the live window.

NOTE: A similar operation can be done by inputting a mote note (see [Set > Mote Note](#)).

However, this note will not appear in the GUI live window, although it will appear in the log file.

If you want to quickly set a note, use Set > Mote Note.

Temperature and Strain Calculations

Please refer to the Scanimetrix Calculations reference in Appendix B for more information on the temperature and strain calculations used in MoteScan.

Sample mote.cfg:

Default strain calculation
*(Strain calculation used for all
 notes not specified below)*

Default temperature calculation
*(Temperature calculation used for
 all notes not specified below)*

Mote names

Mote-specific strain calculations

```

0, strain, abs_offset, 32768.0
0, strain, rel_offset, 0.0
0, strain, gain_multiplier, 1.44
0, strain, sample_scaling, 1.0
0, strain, loaded, 1.0

0, temperature, abs_offset, 39389.0
0, temperature, rel_offset, 21.5
0, temperature, gain_multiplier, 0.04
0, temperature, loaded, 1.0

66, config, name, left arm axial
90, config, name, right arm axial
18, config, name, center axial
71, config, name, hi there

26, strain, abs_offset, 32768.0
26, strain, rel_offset, -35.0
26, strain, gain_multiplier, 1.44
26, strain, sample_scaling, 1.0
26, strain, loaded, 1.0

87, strain, abs_offset, 32768.0
87, strain, rel_offset, 137.0
87, strain, gain_multiplier, 1.44
87, strain, sample_scaling, 1.0
87, strain, loaded, 1.0

66, strain, abs_offset, 32768.0
66, strain, rel_offset, -27.0
66, strain, gain_multiplier, 1.44
66, strain, sample_scaling, 1.0
66, strain, loaded, 1.0

70, strain, abs_offset, 32768.0
70, strain, rel_offset, -242.0
70, strain, gain_multiplier, 1.44
70, strain, sample_scaling, 1.0
70, strain, loaded, 1.0

90, strain, abs_offset, 32768.0
90, strain, rel_offset, 253.0
90, strain, gain_multiplier, 1.44
90, strain, sample_scaling, 1.0
90, strain, loaded, 1.0

18, strain, abs_offset, 32768.0
18, strain, rel_offset, 237.0
18, strain, gain_multiplier, 1.44
18, strain, sample_scaling, 1.0
18, strain, loaded, 1.0

```

Figure 18: Example of mote.cfg configuration file.

Debugging

Please see the instructions under the [Command-Based User Interface](#) (CUI) for more detailed information for debugging purposes.

If you need to see the log history for the [GUI](#), it is located in the program files in a file called log_year-month-day.txt (ex.: log_2010-03-10.txt).

MoteScan Command-Based User Interface (CUI)

For Mote Debugging

Starting the Software and Connecting the Coordinator

Please refer to the [graphic-based user interface](#) (GUI) for more information on connecting the coordinator.

Once the program connects, it will show the ID of the coordinator to which you are connected.

Menus

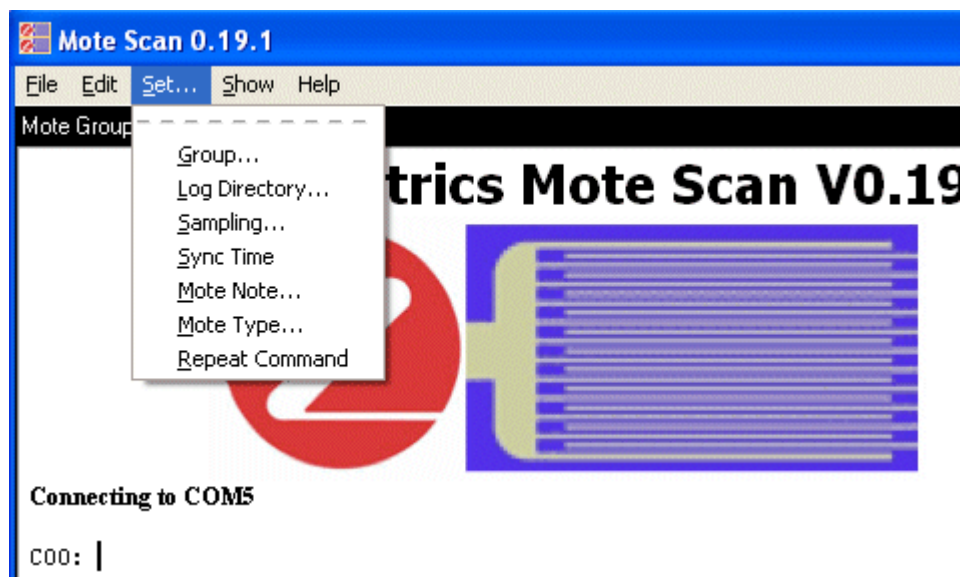


Figure 19: The Set... menu

File	Edit	Set...	Show	Help
Connect	Copy	Group...	Connected Mote	
Disconnect	Paste	Log Directory...	Mote Group	
-----	Copy&Paste	Sampling...	All RSSI	
Record		Sync Time	Group RSSI	
Stop		Mote Note...	Sample Time	
Get Logs		Mote Type...	Time	
Halt		Repeat Command	Mote Note	
-----			Mote Type	
Quit			Version	

Basic Operation

For more information on each operation, click the titles to see the sections in Advanced Operation.

Keep in mind that any commands you send will hold until you send a different command, even if you leave the program or the mote's operating range. Please see [Set Group](#) for more information.

1. [Show > Connected Motes](#)

To list the motes in working distance (around 10 m) through the wireless ZigBee network (in order of answer time). This step is necessary to verify that all motes are connected as expected.

2. [Show > All RSSI](#)

To list the signal the coordinator receives from all connected motes. This step verifies that all connected motes are working as expected. RSSI is affected by distance and battery power.

3. [Set > Group](#)

To give commands to multiple motes at once. Enter into the dialog box the ID numbers of the motes you want in a group, separated only by a space (no commas, periods, or other separators). The motes you selected will now be the active mote group.

CAUTION: Without a mote group set, the coordinator will not send any commands to any motes.

Be sure to set a mote group before proceeding with any further commands.

NOTE: You can send commands to several mote groups; only the most recent group will be active.

4. **Set > Sampling**

To set the sample time and channels to be sampled. See [Sampling](#) in the GUI for more information.

CAUTION: Channels B and C are undefined. Do not select those channels.

5. [Set > Sync Time](#)

To synchronize the coordinator's and motes' times with your computer's time, so all systems are running the same time.

CAUTION: It is very important to remember to sync time before recording for all data to align properly. Be sure to also sync time if any motes have been powered down or lost power.

CAUTION: If you sync time after you start recording, post-processing of data will not function properly, since it relies on the first and last samples having the same time stamp.

6. [Live button](#) (along the bottom)

To have a real-time indication of the data being recorded, click the Live button (along the bottom).

NOTE: If data is not being recorded, using the live feature will not show anything. You must be recording to see the data.

7. [Off button](#) (along the bottom)

To stop seeing the data in real time, click the Off button along the bottom of the program window.

NOTE: This does not stop the recording process. To stop the recording process, you must use [File > Stop](#) or press the Stop button.

Advanced Operation

File Menu

See GUI for more information on the [Connect](#), [Disconnect](#), [Record](#), [Stop](#), [Get Logs](#), [Halt](#), and [Quit](#) operations.

Edit Menu

Copy

To copy the highlighted command on the coordinator prompt line.

Paste

To paste the copied command to a new prompt line.

Copy&Paste

To copy the highlighted command and paste immediately to a new prompt line.

NOTE: If you have no command highlighted, you will receive an error prompting you to highlight a command.

Set... Menu

Group...

To give commands to multiple motes at once. Set > Group opens a dialog box: enter the ID numbers of the motes you want in the group, separated only by a space (no commas, periods, or other separators). The motes you selected will now be the active mote group. See [Set Group](#) in the [GUI](#) for more information on setting groups.

If you ever need to clear the remote group (or to send a command solely to the coordinator), simply enter nothing into Set > Group and press OK.

CAUTION: Without a mote group set, the coordinator will not send any commands to any motes. Be sure to set a mote group before proceeding with any further commands.

NOTE: In the [GUI](#), the program automatically sets the mote group to include all connected motes.

Log Directory...

To change the directory in which you store the log files downloaded from the motes. They are stored by default in the Logs folder in the Program Files directory.

NOTE: This operation will not change the location of the post-processed .csv files the [GUI](#) creates with the [Logs to Data](#) button. Those files will continue to be saved to the Program Files directory regardless.

Sampling

See [Set Sampling](#) in the GUI for more information.

Sync Time

To synchronize all hardware times, so all systems are running the same time. This operation will first synchronize the coordinator's time with the computer's time, followed by synchronizing the motes' time with the coordinator's time.

CAUTION: It is very important to remember to sync time before recording for all data to align properly. Be sure to also sync time if any motes have been powered down or lost power.

CAUTION: If you sync time after you start recording, post-processing of data will not function properly, since it relies on the first and last samples having the same time stamp.

Mote Note...

To add information about a certain mote to the log file, such as recording where the mote is located or what it is measuring (ex: truck A axle; truck B horizontal). The dialog box this function opens allows you to first indicate to which mote you are adding the note.

NOTE: When you click the Add button in the dialog box, it will overwrite any previous Mote note you had stored.

NOTE: Unless the note is of a temporary nature, we recommend using instead the [configuration file](#) to name a mote.

Mote Type...

Presently this operation has no function.

Repeat Command

To repeat certain commands at certain time intervals. The dialog box that opens allows you to choose which operation to repeat and how often. Following is a representation of the dialog box (see image below):



Figure 20: the Repeated Operation dialog box

“Send commands to:” will repeatedly send to the mote and coordinator the command you enter.

Repeat command will continue to repeat whichever command you asked it to repeat until you bring up the the dialog box again and press Stop.

Show Menu

Please note that the functions in the Show menu will have no effect in the [GUI](#).

Connected Mote

Lists the motes in working distance (around 10 m) through the wireless ZigBee network. Showing connected motes allows you to verify that the motes you have set up are sending their signals. The list will be ordered only by which mote answered first.

NOTE: MoteScan can presently connect up to 9 motes.

Mote Group

Displays a list of all the motes in the present mote group.

NOTE: In the [CUI](#), the active mote group is also displayed in the black bar right below the menu bar. See [Status Bar](#) for more details.

All RSSI

Displays a list of the signals the coordinator receives from all connected motes. Showing all RSSI allows you to verify that all motes are sending workable signals.

RSSI stands for Received Signal Strength Indicator and is the power present in the radio signal received by the coordinator. RSSI is affected by distance and battery power. The smaller the RSSI number, the farther away or lower the battery power of the mote.

Also displays the LQI to the right of the RSSI. LQI (Link quality indicator) is how much data is transmitted. The highest possible LQI is 255.

NOTE: This step is only necessary in the [CUI](#). The [GUI](#) automatically checks and displays the signals of the connected motes.

Group RSSI

Displays the signal the coordinator receives from all connected motes in the mote group.

RSSI is affected by distance and battery power.

NOTE: See the explanation of RSSI and LQI [above](#).

Sample time

Displays the sample time set for the group. See [Sampling](#) for information on setting the sample time.

Time

Displays the time held by each mote in the following format: day,hour:minute:second.millisecond (ex.: 69,15:56:15.1 is March 10 2010, 3:56 PM and 15.1 seconds)

The first line displays the computer's time, followed by the coordinator's time. Subsequent lines display the computer's time followed by the motes' times. If the times are not within .1 seconds of each other, [synchronize the time](#).

Mote note

Displays the mote note you entered in the [Set > Mote Note](#) command.

Mote type

Presently this operation has no function.

Version

Displays the version of software each mote in the group and coordinator is running.

CAUTION: If all motes and coordinators are not running the same version, we cannot guarantee the software's functioning.

Status Bar

The status bar is the black bar right below the menu bar in the program window. It contains the active mote group and whether that mote group is recording.

NOTE: If you quit the program, leave the mote range, or unplug the coordinator, when you return, the status bar resets and will not display whether or not the motes are recording.

NOTE: In the [GUI](#), the status bar contains only the previous command you entered (ex: if you just pressed Record, it will read "Mote status: Recording")

Common Commands

Text-based commands sent to the coordinator can be entered directly into the program window and text-based commands sent to the motes can be entered via the Send function. Entering commands in this manner is for debug purposes only. For your reference, here are a few common commands:

To the coordinator

lrs: performs the Show > All RSSI

list: performs the Show > Mote Group

words: lists all text-based commands the coordinator recognizes

To the mote:

blt: starts the active mote group recording

elt: instructs the active mote group to stop recording

rb: reboots the motes in the active mote group

Common Errors

Beep!

This error will be returned if you backspace too far in the command line. Simply retype your command.

eh?

This error is returned when the command you enter is unknown to the program.

Appendix A: Cautions and Notes

Re: General Use
Re: Getting Started
Re: Sync Time
Re: Mote Groups
Re: Signal
Re: Sampling
Re: Recording

Re: Live
Re: Downloading Log Files and Converting to Data
Re: Stop, Halt, Off, and Quit
Re: Config File and Mote Notes
Re: Commands
Re: Copying and Pasting
Re: Status

Re: General Use

CAUTION: The system is subject to timing and radio handshaking limits. It is a multi-node radio packet network which is subject to impairments of communications. The system is such that it occasionally does require retries.

CAUTION: All motes and coordinators need to be the same version to ensure the correct operation of the system

NOTE: MoteScan can presently connect up to 9 motes.

Re: Getting Started

NOTE: The program will return an error if you try to connect when you are already connected.

Re: [Sync Time](#)

CAUTION: It is very important to remember to sync time before recording for all data to align properly. Be sure to also sync time if any motes have been powered down or lost power.

CAUTION: If you sync time after you start recording, post-processing of data will not function properly, since it relies on the first and last samples having the same time stamp.

Re: [Mote Groups](#)

CAUTION: Without a mote group set, the coordinator will not send any commands to any motes. Be sure to set a mote group before proceeding with any further commands.

NOTE: You can send commands to several mote groups, but only the most recent group will be active.

NOTE: In the [GUI](#), the program automatically sets the mote group to include all connected motes.

NOTE: In the [CUI](#), the active mote group is also displayed in the black bar right below the menu bar.

Re: [Signal](#)

NOTE: Showing all RSSI is only necessary in the [CUI](#). The [GUI](#) automatically checks and displays the signals of the connected motes.

Re: [Sampling](#)

CAUTION: Presently, Channels B and C are undefined. Do not select those channels. Selecting those channels will result in visually garbled data in the [GUI](#)

NOTE: This setting currently sets the sample time for all channels simultaneously.

Re: [Recording](#)

CAUTION: Recording overwrites all data saved to a mote. If you had any data on a mote prior to recording, be sure to download it to your computer first. If you have halted a download, remember to restart it before recording again.

CAUTION: When the battery strength indicator is red, the mote system voltage has drop below the specified voltage for writing the on-board flash memory. We recommend replacing the mote when the indicator drops into the yellow region.

NOTE: The mote can be recording in any state (i.e.: Live, Active, Recording) except when downloading.

NOTE: Ensure all the motes are programmed with the desired settings before recording.

Re: [Live](#)

NOTE: If data is not being recorded, using the live feature will not show anything. You must be recording to see the data.

NOTE: The result of pressing the Live button in the [CUI](#) and the Live button in the [GUI](#) appear vastly different. In the CUI, the resulting data is displayed in a constantly-updated list, similar to the list in the log file. In the GUI, Live will display the incoming data as graphs.

NOTE: In the [GUI](#), turning off the live data will not close the live window, but will only stop the data from being sent to the program.

NOTE: [Graph > Show](#) does not start up the live feature. This is not the same as pressing the Live button along the bottom of the program window.

NOTE: You can press the Live button even if the live window is not open. The motes will send their data, but you will not be able to see it.

Re: [Downloading Log Files](#) and [Converting to Data](#)

NOTE: Stop recording before downloading the log files. The files will not download if you have not stopped recording.

NOTE: If the battery runs out on a mote before a log is finished downloading, Scanimetrics can extract the data from the mote.

NOTE: You can download and re-download a log file as many times as you need to. However, once you record again, the data will be overwritten.

NOTE: [Set > Log Directory](#) will not change the location of the post-processed .csv files the [GUI](#) creates with the [Logs to Data](#) button. Those files will continue to be saved to the Program Files directory regardless.

NOTE: Converting log files to data files may slow down your system while the process is running.

NOTE: If you want to process more than one set of logs at a time, you can start another version of the program.

RE: [Stop](#), [Halt](#), [Off](#), and [Quit](#)

NOTE: Stop stops the recording process; Off turns off the Live feature, Halt stops the downloading process, and Quit quits the program.

NOTE: If recording Off, Halt, or Quit will not stop the recording process. To stop recording, use the [Stop button](#) along the bottom of the live and program windows or File > Stop.

Re: [Config File](#) and [Mote Notes](#)

CAUTION: If programming motes at several sites, the config file MoteScan refers to will be the mote.cfg file on the computer used at the time. If multiple users configure the motes and collect the data, the changes made to the config file should be consolidated into a master mote.cfg file shared among those users for optimal results with MoteScan.

NOTE: The software comes with a configuration example as well as a default mote.cfg file. The example is also located in the Config folder.

NOTE: Unless the note is of a temporary nature, we recommend using instead the configuration file to name a mote. A mote note will not appear in the [GUI](#) live window, although it will appear in the log file.

NOTE: When you click the Add button in the Mote Note dialog box, the new note will overwrite any previous note you had stored.

Re: [Sending Commands](#)

NOTE: Typing a command onto the command line will be sent to the coordinator. Typing a command into the Send button dialog box will send the command directly to the active mote group.

NOTE: In the [GUI](#), a command typed into the Send button dialog box will be sent, but you will not receive visual confirmation.

Re: [Copying and Pasting](#)

NOTE: If you have no command highlighted when you use the File > Copy or File > Copy&Paste feature, you will receive an error prompting you to highlight a command.

Re: [Status Bar](#)

NOTE: In the [GUI](#), the status bar contains only the previous command you entered (ex: if you just pressed Record, it will read "Mote status: Recording").

NOTE: If you quit the program, leave the mote range, or unplug the coordinator, when you return, the status bar resets and will not display whether or not the motes are recording.

Appendix B: Strain and Temperature Calculations

Strain Calculation

$$\text{data} = \text{gain_multiplier} * ((\text{sample_scaling} * \text{raw_data}) - \text{abs_offset}) + \text{rel_offset}$$

Temperature Calculation

$$\text{data} = \text{gain_multiplier} * (\text{raw_data} - \text{abs_offset}) + \text{rel_offset}$$

Abbreviations

abs_offset: Absolute Offset

rel_offset: Relative Offset

gain_multiplier: Gain Multiplier

sample_scaling: Sample Scaling