# Ladybug High Speed Logger User's Guide

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Introduction

This document applies to the LadyBug's "High Speed Logger" or HSL application. This application is intended to be useful both as an end application and to demonstrate the capabilities of the LadyBug sensors. This application can use any of LadyBug's current sensors. We provide the application and the source code. You are free to modify the source code as you see fit for use with LadyBug sensors. The application and source code are "as is." As such, no warranty or guarantee of any type is implied.

Before installing this application, ensure that you have installed the most recent power meter or pulse profiling applications. These installations install the drivers onto your operating system. Then, using normal procedures install this application (i.e. run setup). The previously mentioned source code is available in a separate directory. The project is a C#, VS2005 project.

Overview

After you complete the installation ensure that you can run the power meter application. If so then you are ready to run this application (High Speed Logger or HSL). Assuming you have a single power sensor attached, when you start the application you will see a window similar to the one shown below:
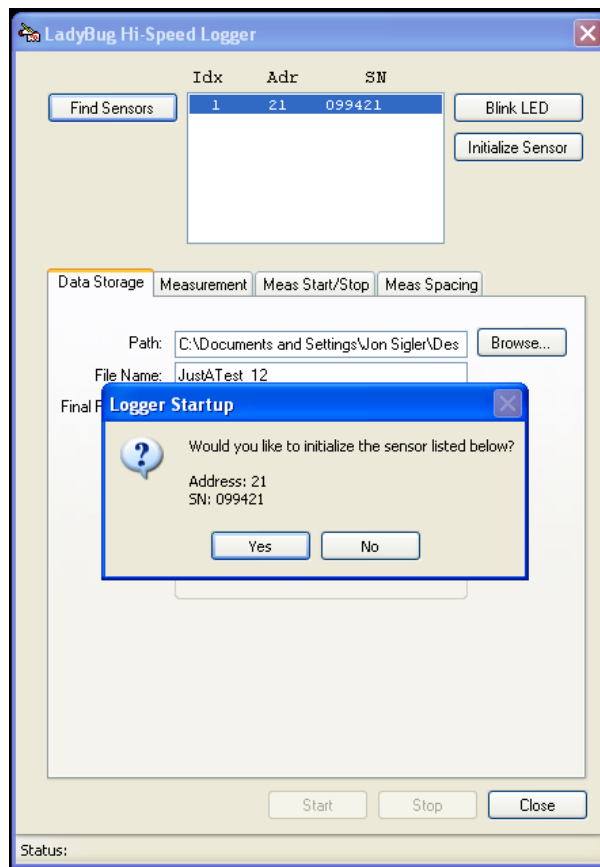
By clicking "Yes" the sensor will be initialized and you will be ready to start making measurements. The window you see next is below:
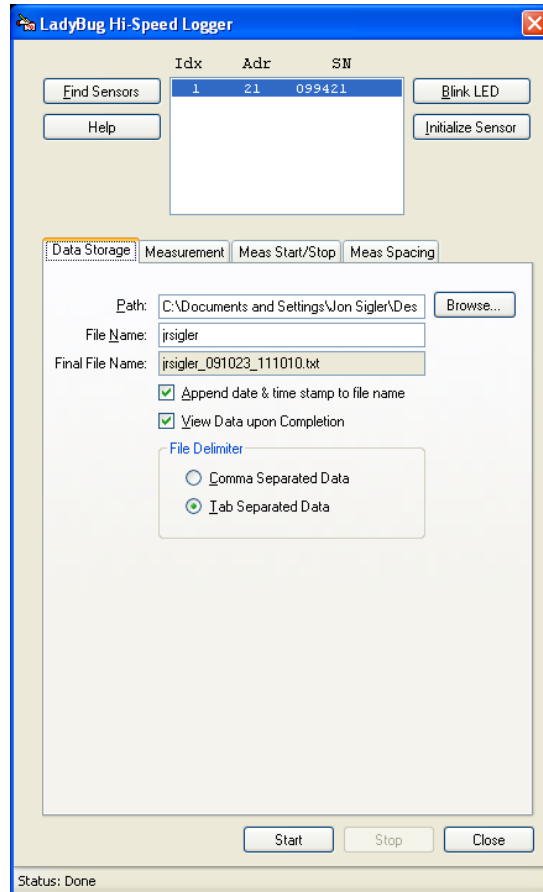
Note that the sensor that is highlighted. In the event that you have multiple sensors you will need to select a sensor and click initialize. You may initialize several sensors. The ***selected and initialized*** sensor is the sensor used to make the measurements. The window above shows four tabs. The first tab (Data Storage) specifies:

- Where files will be stored – type in the directory directly or click browse to search for a directory
- Date and time stamp modifications to the file name – type in the file name. If you check "Append date and time to the file name the file", the date and time is appended to the specified file name is modified each time a new set of data is taken. This allows you to take several sets of data without having to specify a new name. It also groups the files together in the file browser.
- Checking "View data upon completion" causes the data to be displayed in NotePad (by default) when the measurements are completed.
- Finally, you may also select the format of the files (tab or comma delimited). Tab delimited works well with spreadsheet applications like Microsoft Excel.

The second tab (Measurement) is shown below:
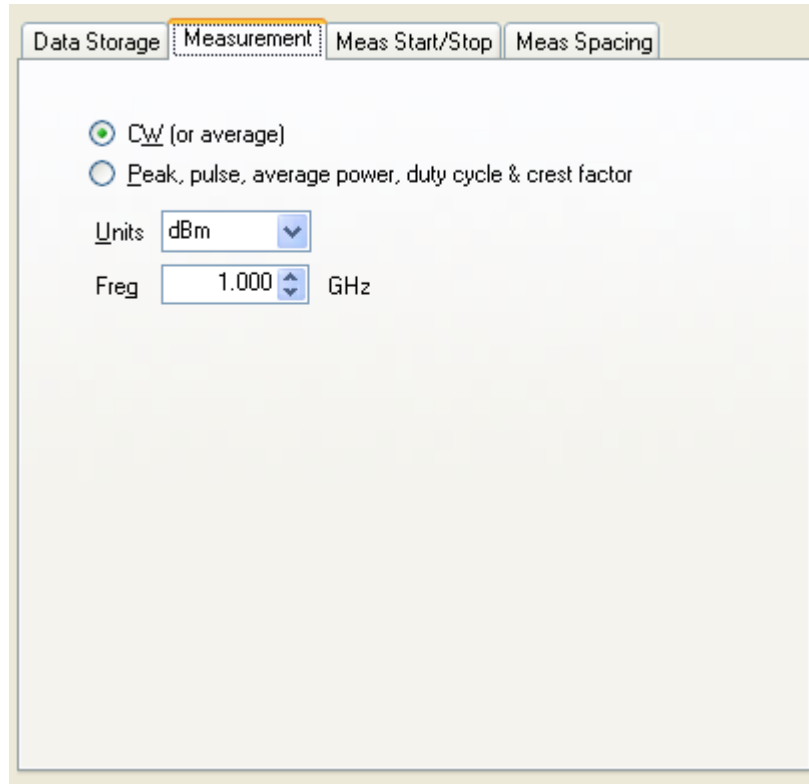
This tab allows you to select the type of measurement, the units and the frequency. In order to get accurate measurements you will need to set the frequency. If CW is selected, only the average or CW power is recorded. If Peak, pulse… is selected then all of those parameters are recorded. The following text is from CW measurements. The data are tab delimited.

```
index   time (msec)      CW (dBm)
000001  000026.849       -034.387
000002  000027.130       -034.389
:
:
000019  000031.379       -034.387
000020  000031.625       -034.386
000021  000031.878       -034.393
000022  000032.132       -034.399
000023  000032.383       -034.386
```

This data is from peak measurements:

```
index   time (msec)    Pk (dBm)       Pls (dBm)      CW (dBm)       CrF (dB)      DC (%)
000001  000037.097     -034.284       -034.387       -034.387       000.103 100.000
000002  000037.967     -034.274       -034.390       -034.390       000.115 100.000
000003  000038.212     -034.317       -034.392       -034.392       000.076 100.000
```

The first column in both instances is the index of the measurement. The second is the relative elapsed time. The remaining data is measurement results. Then next tab (Meas Start/Stop) allows you to specify the starting and stopping criteria.
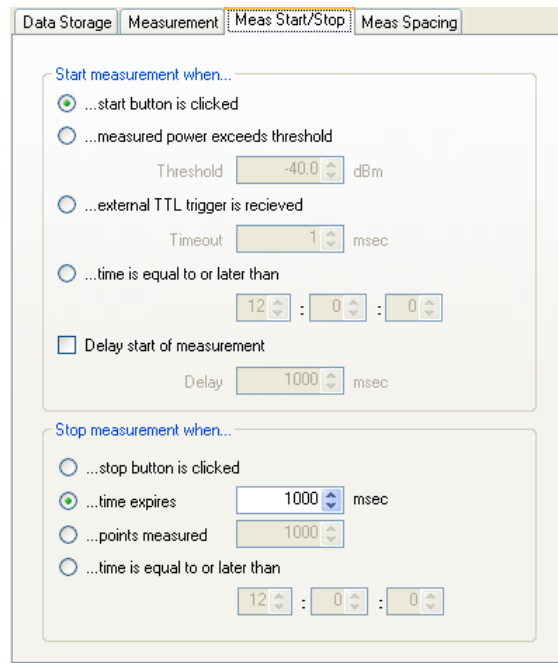
The upper half of this tab is devoted to starting the measurement process. The bottom half is devoted to stopping the measurement process. The measurement process proceeds as follows:

1. Satisfy the start criteria

2. Execute a delay if requested

3. Make the measurements

4. Stop when the appropriate criteria are satisfied

You can that there are four types of start criteria:

- The start button – clicking stat begins the measurement process
- A threshold – clicking start causes the application to monitor the incoming measurements (average power if CW has been selected and peak power if peak has been selected). As soon as the appropriate measurement exceeds the specified threshold the measurement proceeds. The threshold is specified in dBm.
- External TTL trigger - clicking start causes the application to monitor the incoming trigger. When a trigger occurs, the measurement continues. Note that only the first measurement requires a trigger. The trigger timeout is settable. If the timeout occurs before the measurement ensues no measurements will be made.

- Time of day – you can set the start time and the stop time (hours – 24 hour clock, minutes, seconds). Some situations might cause unintended events. The following shows four different arrangements of the start and stop time. Because of the file size some consideration should be taken with regard to measurement spacing.
    - This case is the "normal" case. The specified start time is later than the current time and the stop time is later than the start time. In this example the measurements will start at 2:05PM and continue for 5 minutes until 2:10PM:
        - Start button is clicked: 14:00:00 (or 2PM)
        - Start time: 14:05:00 (or 2:05PM)
        - Stop time: 14:10:00 (or 2:10PM)
    - The specified start time is later than the current time and the stop time is earlier than the start time. In this example the measurements will start at 2:05PM and continue for 23 hours and 59 minutes until 2:04 the following day:
        - Start button is clicked: 14:00:00 (or 2PM)
        - Start time: 14:05:00 (or 2:05PM)
        - Stop time: 14:04:00 (or 2:04PM)
    - The specified start time is earlier than the current time and the stop time is later than the start time. In the example below, the clock will start and run almost a full day until it becomes 1:05 the following day. At this time, it will begin measurements. Measurements will continue for 5 minutes and stop.
        - Start button is clicked: 14:00:00 (or 2PM)
        - Start time: 13:05:00 (or 1:05PM)
        - Stop time: 13:10:00 (or 1:10PM)
    - The specified start time is earlier than the current time and the stop time is earlier than the start time. In the example below, the clock will start and run almost a full day until it becomes 1:05 the following day. At this time, measurements will being. Measurements will continue for 23 hours and 59 minutes and then stop the day after tomorrow.
        - Start button is clicked: 14:00:00 (or 2PM)
        - Start time: 13:05:00 (or 1:05PM)
        - Stop time: 13:04:00 (or 1:04PM)

Now that start criteria is satisfied, a delay can set (milliseconds). The delay begins immediately after the the start criteria has be satisfied and precedes the onset of measurements. The next item is the stop criteria. There are three ways to stop the measurement process:

1. Clicking the stop button (always available)

2. The measurement process ends when the specified time has expired (milliseconds).

3. The measurement process ends when the specified number of measurements is made.

The nature of these options obviates the need for further explanation. The next tab (Meas Spacing) is below:
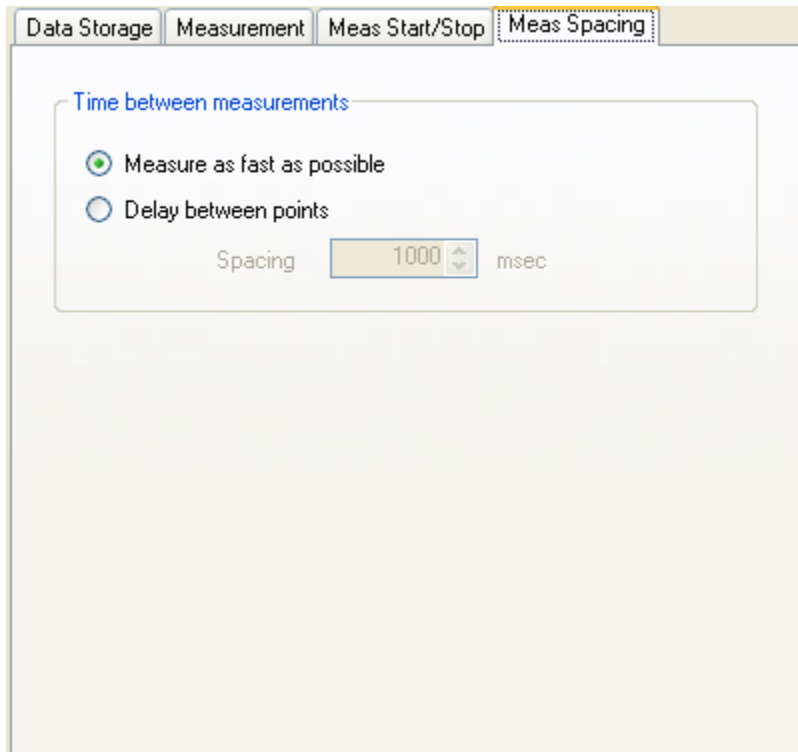
This tab has two selections: as fast as possible: delay between points. The first option (as fast as possible) will measurement at about 350 usec per point on most machines. Some machines will be faster, some slower. However, many other factors may hinder this rate. Virtually any loading on the computer may impose deleterious effects on rate of measurement. The magnitude of the effect is a function of the power of the computer and the demands of the competing applications. However, in most cases the effects are modest. But, these effects should not be ignored.

Delay between points (in milliseconds) is, in a like manner, is negatively impacted by many of the same factors. Again, these affects tend to be modest in most cases and pose little concern. In addition, the resolution and accuracy of the computer clock will have some effect. Below are samples of data. In the first set, the data is as fast as possible.

```
002796  000773.664      -034.323       -034.397       -034.397       000.075 100.000
002797  000773.922      -034.304       -034.393       -034.393       000.089 100.000
002798  000774.163      -034.313       -034.391       -034.391       000.078 100.000
002799  000774.415      -034.313       -034.390       -034.390       000.077 100.000
002800  000774.787      -034.284       -034.397       -034.397       000.113 100.000
002801  000775.040      -034.313       -034.394       -034.394       000.082 100.000
002802  000775.287      -034.330       -034.397       -034.397       000.067 100.000
002803  000775.540      -034.323       -034.395       -034.395       000.073 100.000
002804  000775.792      -034.296       -034.396       -034.396       000.099 100.000
```

```
002805  000777.776      -034.304        -034.402        -034.402        000.097 100.000
002806  000778.041      -034.291        -034.388        -034.388        000.098 100.000
002807  000778.291      -034.300        -034.392        -034.392        000.092 100.000
002808  000778.538      -034.299        -034.394        -034.394        000.095 100.000
002809  000778.793      -034.300        -034.387        -034.387        000.087 100.000
```

A quick look at all the data resulting in the following:

- Maximum time between points = ~1.984msec
- Minimum time between points = ~0.137msec
- Average time between points = ~0.263msec

In the second set, the data is taken with a 20msec delay between points.

```
000131  002702.506      -034.317        -034.382        -034.382        000.065 100.000
000132  002723.005      -034.304        -034.385        -034.385        000.081 100.000
000133  002743.649      -034.315        -034.382        -034.382        000.067 100.000
000134  002764.148      -034.298        -034.387        -034.387        000.089 100.000
000135  002784.649      -034.297        -034.379        -034.379        000.082 100.000
000136  002805.151      -034.293        -034.384        -034.384        000.091 100.000
000137  002825.656      -034.304        -034.380        -034.380        000.076 100.000
000138  002846.177      -034.311        -034.385        -034.385        000.074 100.000
000139  002866.664      -034.283        -034.378        -034.378        000.095 100.000
000140  002887.165      -034.264        -034.376        -034.376        000.112 100.000
000141  002907.667      -034.302        -034.385        -034.385        000.083 100.000
000142  002928.166      -034.298        -034.385        -034.385        000.087 100.000
000143  002948.663      -034.306        -034.383        -034.383        000.077 100.000
000144  002969.174      -034.293        -034.381        -034.381        000.088 100.000
000145  002989.663      -034.280        -034.378        -034.378        000.098 100.000
000146  003010.299      -034.297        -034.380        -034.380        000.083 100.000
000147  003030.789      -034.296        -034.387        -034.387        000.091 100.000
```

A simple analysis of this data showed the following:

- Maximum time between points = 20.644msec
- Minimum time between points = 20.003msec
- Average time between points = 20.505msec

You can see, while there is some variation in timing, it is better I would have anticipated. What is known is that the measured time (using the computer's clock) is generally quite accurate over short periods (less than several seconds).

Usage Issues

If unfettered, this application will chew up a lot of memory and disk space very rapidly. As a result, memory faults can occur. Since this application has a dual purpose, we have minimized error checking. In fact, we have included only the bare minimum error trapping. The errors typically occur in one area but for two different but related reasons. The first will be that you cannot view the text file. This will

probably be because the text file we have written during measurements is too large for the application trying to display the file (probably NotePad). The second reason that the errors may occur is because you have run out of memory. Each measured point requires (roughly) 54 bytes. If don't have sufficient memory (RAM) and you don't do anything to throttle down the memory usage you could just run out of RAM.

The primary means of minimizing the amount of memory is to use the last tab. This tab is the "Meas Spacing" tab. If you measure as fast as possible you will consume about 150-220bytes per millisecond or about 150-200kBytes per second. This translates to about 13MByte per minute or 790MB per hour. On the other hand, if you throttled the measurements down to 10msec you would be at 20MB of RAM per hour.

The 20MB of RAM per hour would be tolerable for most systems. Even in a 24 hour logging event translates to less than 500MB.

However, the text file usage is more problematic because text is less efficient. You can assume about 100kB/sec for CW and 250kB/sec for pulse. This assumes 3-4 measurements per millisecond. Files can get very large very quickly. If you are aware that viewing the files might be a problem, the easiest way to mitigate the issue is to turn off viewing of data. However, you problems not be over just yet.

Spreadsheets also have limitations (number of rows and columns). In each case, you will need to be aware of these limitations and take appropriate action.

Examples of Use

The following outlines how to make a few simple measurements using the HSL. This assumes that a single sensor is connected and you have installed the applications.

Simplest Measurement: Start/Stop buttons.

1. Open or start the HSL.

2. Click "Yes" to initialize the sensor

3. Click "OK" when the "Device Initialized" message is shown.

4. Click the first tab (Data Storage) if it is not shown

5. Click browse button and select Desktop (your desktop) – click OK.

6. Enter "TestFile" into the "File Name" textbox.

7. Ensure "Append …" is checked

8. Ensure "View Data …" is checked

9. Select "Tab Separated…"

10. Click the "Measurement" tab.

11. Select CW

12. Units = dBm

13. Freq = 1.000GHz

14. Click the"Meas Start/Stop" tab.

15. Select "…start button is clicked"

16. Select "…stop button is clicked"

17. Click the "Meas Spacing" tab

18. Select "Measure as fast as possible"

19. Now click start then wait 1-2 second and click stop.

20. Upon clicking Stop a NotePad or text file should appear with data like that shown below. Depending on the time between clicking Start and Stop, you may have a several thousand lines. If you used tab delimited text you should be able to copy and paste portions of this file directly into Excel. Finally, if you used "Desktop" as your path you should see the icon for the file on your desktop. If you examine the name of the file you should see the data and time appended to the file.

```
index   time (msec)     CW (dBm)
000001  000023.444      -034.388
000002  000023.702      -034.384
000003  000023.948      -034.381
000004  000024.198      -034.389
000005  000024.446      -034.388
000006  000024.698      -034.388
000007  000024.945      -034.389
000008  000025.197      -034.383
000009  000025.445      -034.378
000010  000025.698      -034.381
```

Threshold Measurement with Delay & Time Expiration

This measurement example assumes that you have your sensor connected to a CW signal source. It also assumes that your source has an "RF On/Off button." Setup your source for:

- Frequency = 1 GHz
- Power = 0.0 dBm or 1 mW
- RF On/Off = Off

Key in the settings for the "Data Storage" tab and the "Measurement" tab. Then select the "Meas Start" tab.

Select the "…when threshold is exceeded" radio button. Set the threshold to -10dBm.

Check "Delay start of measurement." Set the delay to 5000msec.

Select "…time expires" Stop condition. Set the time for 400msec.

Get ready to observe the following:

- After clicking start, no measurements will be made (status at the bottom of the form should indicate that it's waiting for threshold value)

- When you set "RF On/Off" button to On you'll see a 5 second delay before measurements are made (status at the bottom of the form should indicate a pre-measurement delay.

- Then you'll see measurements made and the results displayed. You should see a brief message indicating the measurements are being made.

If you examine the data you'll notice that the second column, last line indicates a time of about 400msec. On my machine there was about 1500 measurements in that period.

External Trigger, Number of Points, Delay between Points

This setup requires your device to have an external trigger option.

Connect a TTL trigger source to the trigger in (SMB connector) of you power sensor. Set it to 1kHz and TTL levels. Turn the TTL trigger source off or disconnect it at this time.

Connect a CW source to the RF input of the power sensor. Setup your source as you like – make sure the Frequency is set properly on the Measurement tab.

Select the "Meas Start/Stop" tab and setup as follows:

- Select "…external TTL trigger received"
- Timeout = 30000 (30 seconds)
- Uncheck "Delay start of measurement"
- Select "…points measured"
- Set number of points to 100

Select the "Meas Spacing" tab and setup as follows:

- Select "Delay between points"
- Set spacing = 100msec

Recheck to ensure that the TTL trigger source is turn off or disconnected.

1. Click start. You should see status indicate that it is waiting for a trigger.

2. Now, in less than 30 seconds connect or turn on your TTL trigger source. You should see measurement started.

3. Then in about 10 seconds (100 points with 100msec between points for 10000msec) you should see a text file displayed.

4. Examine the end of the text file. It should contain exactly 100 points. The relative time of last point will be about 10000msec.

If you examine the data, you should see the points space at about 100msec intervals.

Start and stop using time of day & measurement spacing

This measurement example assumes only that you have a sensor connected. Key in the settings for the "Data Storage" tab and the "Measurement" tab as required.

Then select the "Meas Start" tab.

Select start measurement when "…time is equal or later than. Set the start time for 10 minutes from now.

Uncheck "Delay start of measurement."

Select stop measurement when "…time is equal or later than. Set the start time for 11 minutes from now.

Select Meas Spacing tab.

Check or select "Delay between points." Set the delay between point to 20 msec.

Get ready to observe the following:

• After clicking start, no measurements will be made until about 10 minutes passes.

• Then measurements will continue for about 1 minute

• Then you'll see measurements made and the results displayed. There will be about 2900-3100 measurements (50 per second for 60 seconds). Each measurement separated from the next by about 20msec.