High-Speed Logger

for

SPS USB Power Sensor

User Guide

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About this document

This document explains how to use the High Speed Logger application to record measurement results and metadata from the SPS USB Power Sensor.

Intended audience

Persons engaged in the design and manufacture of RF and microwave sub-systems and modules, or the installation and maintenance of those systems.

Familiarity with the terms used in RF and microwave measurements is assumed.

Associated publications

- SPS USB Power Sensor Quick Start Guide
  (PDF version 47090/177, printed version 47000/177)
- SPS USB Power Sensor Operating Manual
  (PDF version 47090/178, printed version 47000/178)
- SPS-8 CW and Pulse USB Power Sensor data sheet

Contents

Introduction

This document applies to the High Speed Logger (HSL) application. This application is intended to be useful both as an end application and to demonstrate the capabilities of the SPS power sensors. We provide the application and the source code. You are free to modify the source code as you see fit for use with SPS power 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 (run the setup). The source code is available in a separate directory. The project is a C#, VS2005 project.

Using the HSL application

After you complete the installation, ensure that you can run the power meter application. If so, you are ready to run this HSL application. Assuming you have a single power sensor attached, when you start the application you see a window similar to the one shown below:

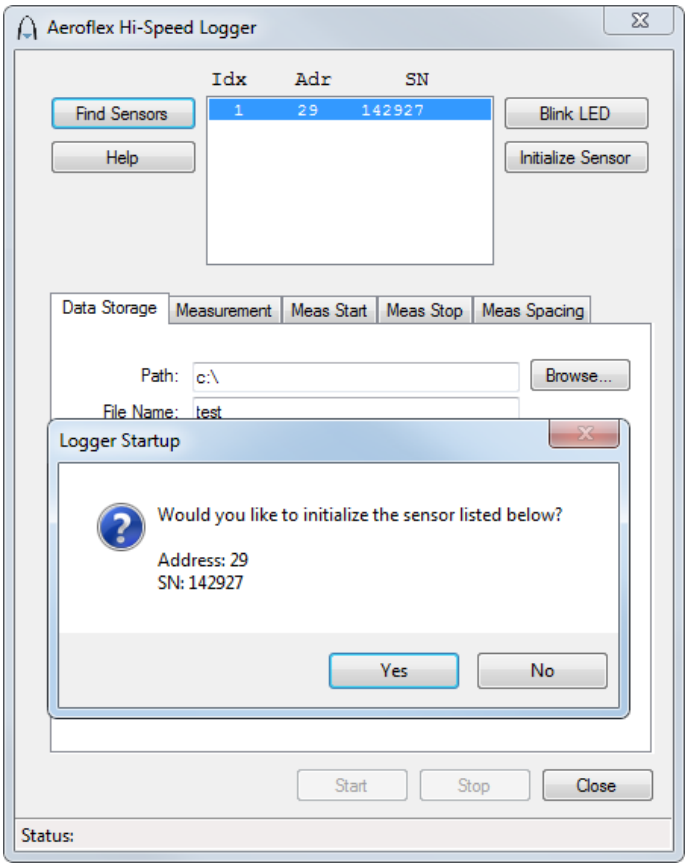

Fig. 1 Logger startup window

By clicking **Yes**, the sensor is initialized and you are ready to start making measurements. The window you see next is:

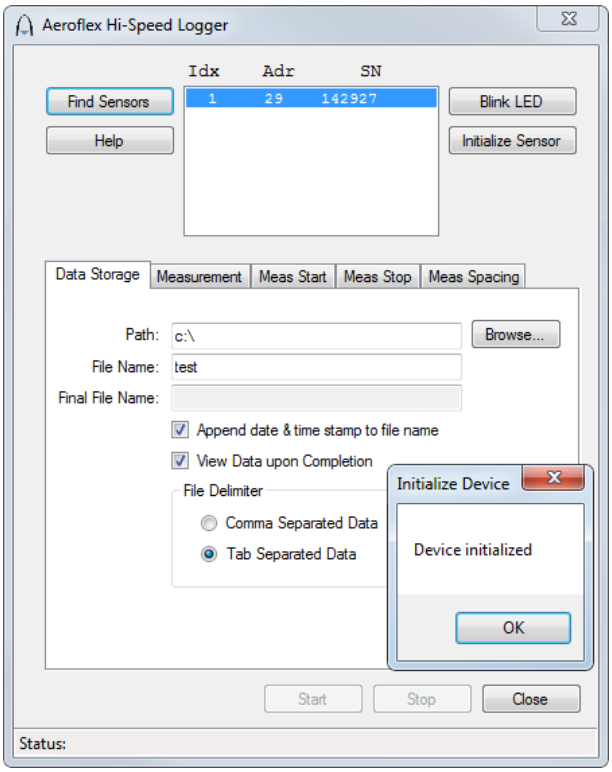

Fig. 2 Device initialize window

Note that the selected sensor is highlighted. If there are multiple sensors, you need to select a sensor and click **Initialize Sensor**. You may initialize several sensors. The selected and initialized sensor is the sensor used to make the measurements.

Data storage tab

The device initialize window shown in Fig. 2 has five tabs. The first tab is Data Storage:

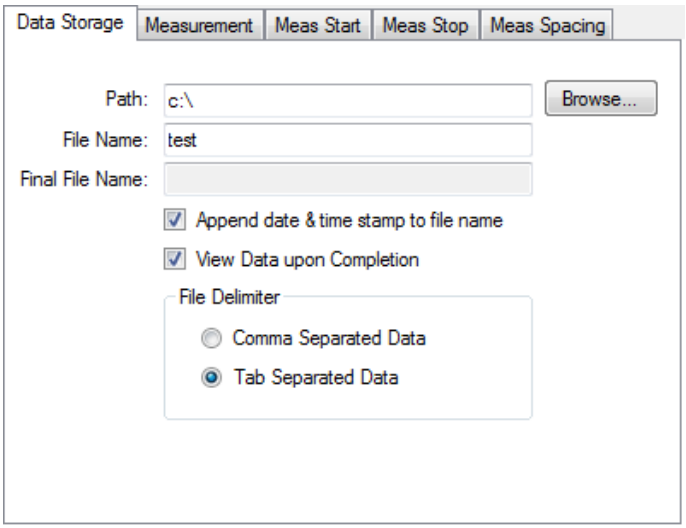

Fig. 3 Data Storage window

Data Storage specifies:

- Where files are 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 & time stamp to file name’, the date and time is appended to the specified file name and 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.
- How the data is displayed. Checking ‘View Data upon Completion’ causes the data to be displayed in Notepad (by default) when the measurements are complete.
- The format of the files (tab- or comma-delimited). Tab-delimited works well with spreadsheet applications like Microsoft Excel.

Measurement tab

The second tab is Measurement:

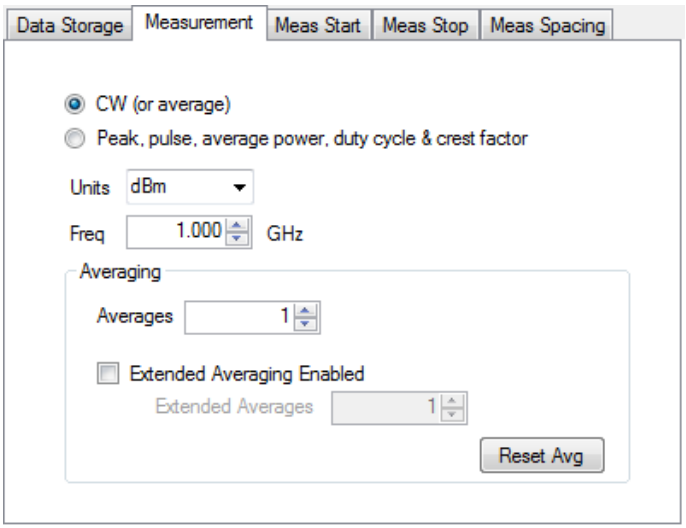

Fig. 4 Measurement window

Use the Measurement tab to select the type of measurement, the units and the frequency. You must set the frequency to get accurate measurements. If CW is selected, only the average or CW power is recorded. If 'Peak, pulse, average power, duty cycle & crest factor' is selected, all of these parameters are recorded. The following text is from CW measurements. The data is 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 column is the relative elapsed time. The remaining data is measurement results.

Meas Start and Meas Stop tabs

The next two tabs, Meas Start and Meas Stop, let you specify the starting and stopping criteria:

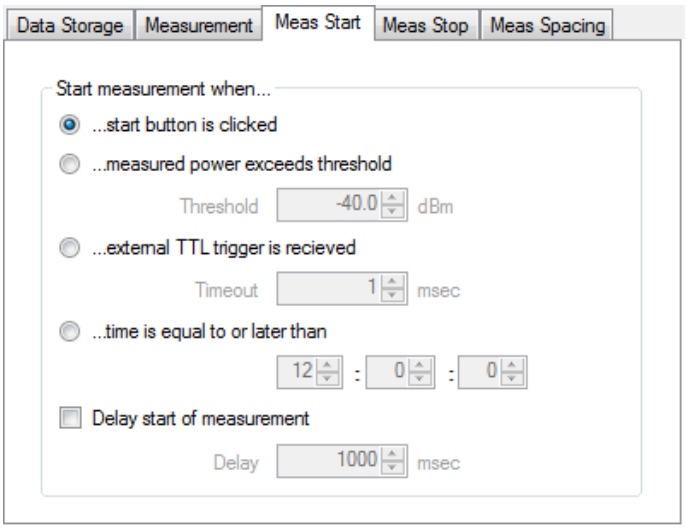

Fig. 5 Meas Start window

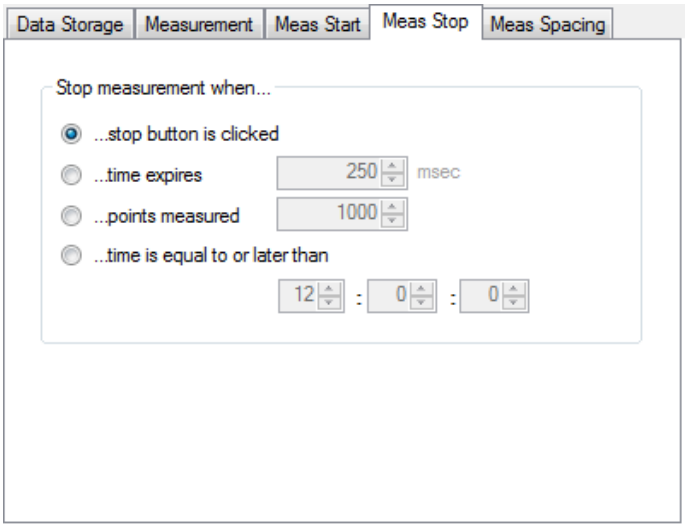

Fig. 6 Meas Stop window

The Meas Start tab is used for starting the measurement process. The Meas Stop tab is used for 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.

Start criteria

There are four types of start criteria:

- The **Start** button — clicking **Start** 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 *(not currently supported)* — 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 begins, no measurements are 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 potential file size, some consideration should be taken with regard to measurement spacing.
    - This 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 start at 2:05 p.m. and continue for five minutes until 2:10 p.m.:
        - **Start** button is clicked: 14:00:00 (or 2 p.m.)
        - Start time: 14:05:00 (or 2:05 p.m.)
        - Stop time: 14:10:00 (or 2:10 p.m.)
    - 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 start at 2:05 p.m. and continue for 23 hours and 59 minutes until 2:04 p.m. the following day:
        - **Start** button is clicked: 14:00:00 (or 2 p.m.)
        - Start time: 14:05:00 (or 2:05 p.m.)
        - Stop time: 14:04:00 (or 2:04 p.m.)
    - 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 starts and runs almost a full day until it becomes 1:05 p.m. the following day. At this time, it begins measurements. Measurements continue for five minutes and then stop.
        - **Start** button is clicked: 14:00:00 (or 2 p.m.)
        - Start time: 13:05:00 (or 1:05 p.m.)
        - Stop time: 13:10:00 (or 1:10 p.m.)
    - 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 starts and runs almost a full day until it becomes 1:05 p.m. the following day. At this time, measurements begin. Measurements then continue for 23 hours and 59 minutes, stopping the day after tomorrow.
        - **Start** button is clicked: 14:00:00 (or 2 p.m.)
        - Start time: 13:05:00 (or 1:05 p.m.)
        - Stop time: 13:04:00 (or 1:04 p.m.)

Delay criteria

Now that the start criteria are satisfied, a delay (milliseconds) can be set. The delay begins immediately after the start criteria have been met and precedes the onset of measurements.

Stop criteria

The final item is the stop criteria. As well as setting the stop time as shown above, there are three additional 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 has been made.

Meas Spacing tab

The final tab, Meas Spacing, is shown below:

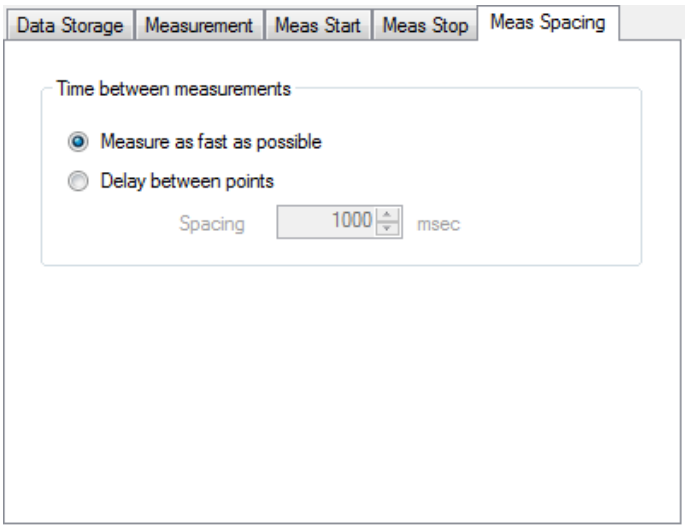

Fig. 7 Meas Spacing window

This tab has two options: ‘Measure as fast as possible’ and ‘Delay between points’.

Measure as fast as possible

This option makes a measurement at the rate of approximately 350 µsec per point on most computers, although some computers may be faster, some slower. Many factors may affect this rate. Virtually any loading on the computer may slow the rate of measurement. The magnitude of the effect is a function of the power of the computer and the demands of the competing applications. In most cases these effects are modest, but they should not be ignored.

Delay between points

This value (in milliseconds) is negatively impacted by many of the same factors. Again, these effects tend to be modest in most cases and pose little concern. The resolution and accuracy of the computer clock has 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 results in the following:

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

In the second set, the data is taken with a 20 ms 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 shows the following:

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

While there is some variation in timing, it is better than 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 unconstrained, this application consumes memory and disk space very rapidly. As a result, memory faults can occur. Since this application has a dual purpose, error checking has been minimized: in fact, only the absolute minimum error trapping is included. Errors typically occur in one area but for two different but related reasons. The first reason is that you cannot view the text file. This is probably because the text file written during measurements is too large for the application trying to display the file (for example, Notepad). The second reason that errors may occur is because of insufficient memory (RAM). Each measured point requires approximately 54 bytes. If there is insufficient memory and no attempt is made to reduce memory usage, it is possible to simply run out of RAM.

The primary means of minimizing the usage of memory is to use the Meas Spacing tab. Measuring as fast as possible consumes about 150–220 bytes per millisecond, or about 150–220 kB/s. This translates to about 13 MB per minute or 790 MB per hour. However, reducing the duration of measurements down to 10 ms consumes 20 MB of RAM per hour.

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

However, text file usage is more problematic because text is less efficient. You can assume about 100 kB/s for CW and 250 kB/s for pulse (based on three or four measurements per millisecond). Files can become 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.

Spreadsheets also have limitations (number of rows and columns). In each case, you 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 that you have installed the applications.

Simplest measurement: Start/Stop buttons

1 Open or start the HSL (High Speed Logger).

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 the **Browse** button and select Desktop (your desktop) — click **OK**.

6 Enter 'TestFile' into the File Name textbox.

7 Ensure 'Append date & time stamp to file name' is checked.

8 Ensure 'View Data upon Completion' is checked.

9 Select the 'Tab Separated Data' radio button.

10 Click the Measurement tab.

11 Select the 'CW (or average)' radio button.

12 Set Units = dBm.

13 Set Freq = 1.000 GHz.

14 Click the Meas Start tab.

15 Select the '…start button is clicked' radio button.

16 Click the Meas Stop tab.

17 Select the '…stop button is clicked' radio button.

18 Click the Meas Spacing tab

19 Select the 'Measure as fast as possible' radio button.

20 Now click **Start**. Wait one or two seconds and click **Stop**.

21 Upon clicking **Stop** a Notepad or text file should appear, with data similar to that shown below. Depending on the time between clicking Start and Stop, you may have 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 and 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. Set up 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 "…measured power exceeds threshold' radio button.
- Set the threshold to −10 dBm.
- Check 'Delay start of measurement'. Set the delay to 5000 ms.

Select the Meas Stop tab.

- Select the '…time expires' radio button. Set the time to 400 ms.

Get ready to observe the following:

- After clicking **Start**, no measurements are made (Status at the bottom of the window indicates that it is waiting for the threshold value).
- When you set the RF on/off button to On, there is a 5 s delay before measurements are made (Status at the bottom of the window indicates a pre-measurement delay).
- Then you see measurements made and the results displayed. You should see a brief message indicating the measurements are being made.

Examine the data and notice that the second column, last line indicates a time of about 400 ms. On a typical computer, there may be approximately 1500 measurements in that period.

Start and stop using time of day and 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 the '…time is equal to or later than' radio button. Set the start time for 10 minutes from now.
- Uncheck 'Delay start of measurement'.

Then select the Meas Stop tab.

- Select the '…time is equal to or later than' radio button. Set the stop time for 11 minutes from now.

Select the Meas Spacing tab.

- Select the 'Delay between points' radio button. Set the delay between points to 20 ms.

Get ready to observe the following:

- After clicking **Start**, no measurements are made until about 10 minutes have elapsed.
- The measurements then continue for about 1 minute.
- The measurements made, and the associated results, are displayed. There should be approximately 2900–3100 measurements (50 per second for 60 seconds). Each measurement is separated from the next by about 20 ms.

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