Logging of RF Power Measurements

By Orwill Hawkins

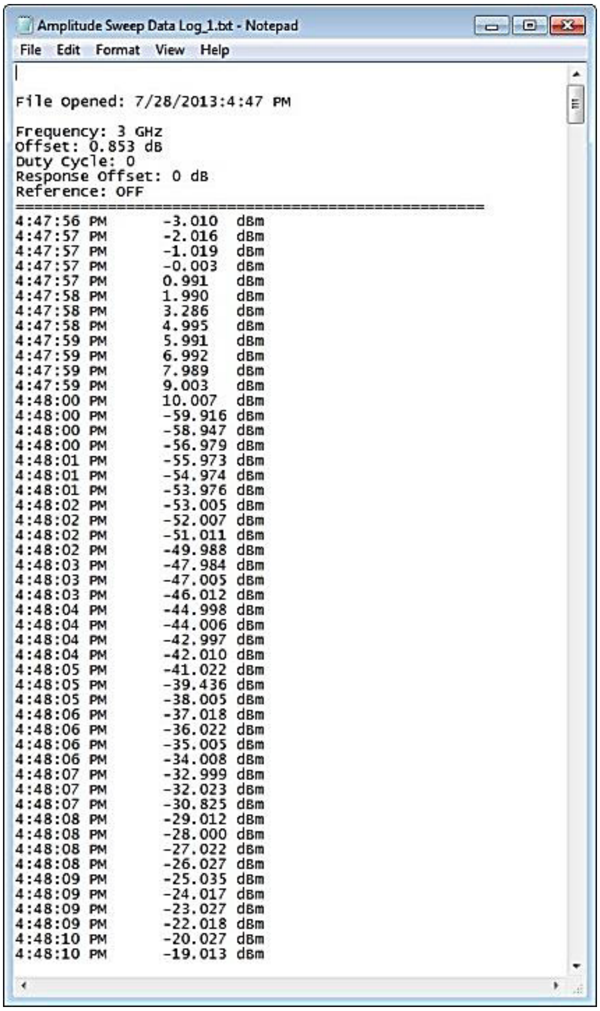
Exploring the use of RF power data logging with a USB power sensor.

Logging of measurement data is critical for effective trend, drift and event analysis of various processes. For RF power measurements, logging is used in a number of applications including during environmental test, characterizing transmit power versus battery drain or temperature, analyzing RF interference, and monitoring signals in the field. These applications have different requirements for the speed at which the data needs to be recorded. For instance, measuring the RF power of a transceiver module during thermal cycling may only require measurements every few seconds or more; but when trying to catch an intermittent spurious signal at a particular frequency, higher speed logging on the order of milliseconds or less will be required. Figure 1 shows an example text file for a logging process recording data at about every 250 ms.

We will explore the use of RF power data logging with a USB power sensor. Together with a computer and data logging software, this solution provides a cost-effective method for addressing these wide-ranging applications. In addition, we will review ways to optimize the logging measurements to conserve memory, making data reduction and analysis easier.

Finding Root Causes

When performing environmental stress testing such as burn-in or thermal cycling, it is important to know how far into the test a failure occurred and whether it was gradual or immediate. This information will be critical in determining the root cause of the failure of a RF transmitter module or a RF amplifier. Additionally, logging RF power data through thermal cycles provides not only information about failures and failure rates but can also be useful in characterizing the behavior of the RF device and how it might change over time and number of cycles. As this type of testing may


Amplitude Sweep Data Log_1.txt - Notepad
File Edit Format View Help

File Opened: 7/28/2013:4:47 PM

Frequency: 3 GHz
Offset: 0.853 dB
Duty Cycle: 0
Response Offset: 0 dB
Reference: OFF
==

4:47:56 PM	-3.010	dBm
4:47:57 PM	-2.016	dBm
4:47:57 PM	-1.019	dBm
4:47:57 PM	-0.003	dBm
4:47:57 PM	0.991	dBm
4:47:58 PM	1.990	dBm
4:47:58 PM	3.286	dBm
4:47:58 PM	4.995	dBm
4:47:59 PM	5.991	dBm
4:47:59 PM	6.992	dBm
4:47:59 PM	7.989	dBm
4:47:59 PM	9.003	dBm
4:48:00 PM	10.007	dBm
4:48:00 PM	-59.916	dBm
4:48:00 PM	-58.947	dBm
4:48:00 PM	-56.979	dBm
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4:48:02 PM	-49.988	dBm
4:48:03 PM	-47.984	dBm
4:48:03 PM	-47.005	dBm
4:48:03 PM	-46.012	dBm
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4:48:05 PM	-39.436	dBm
4:48:05 PM	-38.005	dBm
4:48:06 PM	-37.018	dBm
4:48:06 PM	-36.022	dBm
4:48:06 PM	-35.005	dBm
4:48:06 PM	-34.008	dBm
4:48:07 PM	-32.999	dBm
4:48:07 PM	-32.023	dBm
4:48:07 PM	-30.825	dBm
4:48:08 PM	-29.012	dBm
4:48:08 PM	-28.000	dBm
4:48:08 PM	-27.022	dBm
4:48:08 PM	-26.027	dBm
4:48:09 PM	-25.035	dBm
4:48:09 PM	-24.017	dBm
4:48:09 PM	-23.027	dBm
4:48:09 PM	-22.018	dBm
4:48:10 PM	-20.027	dBm
4:48:10 PM	-19.013	dBm

Figure 1 • Text file with the table of logging results.

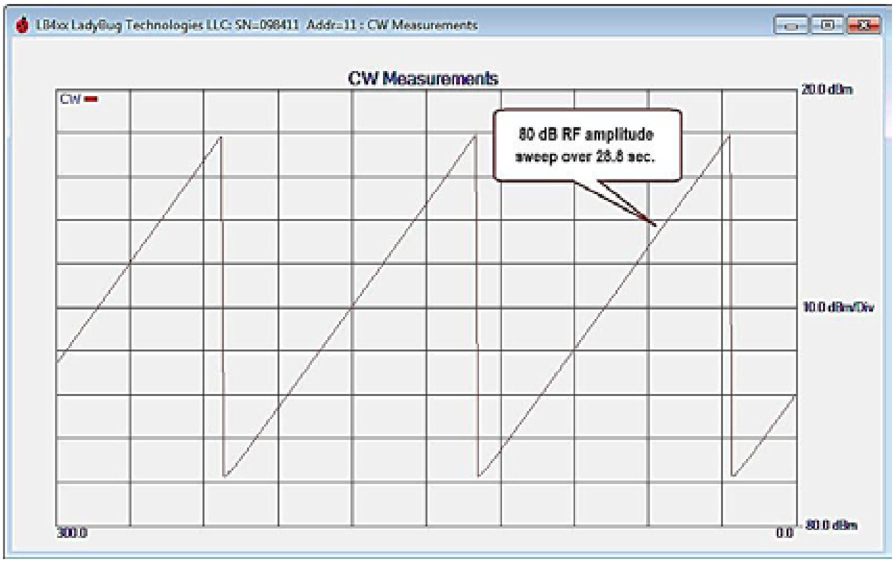

Figure 2 • Slow speed logging of an RF amplitude ramp using a LadyBug USB power sensor. In addition to the graphical display the data can be written to a file for recording data points over a long time period.

take place over days or even weeks using multiple sensors, the amount of data captured could be significant. How often data points are recorded depends on the anticipated failure rate and how much accuracy with respect to time is needed.

Figure 2 shows an RF power ramp over a period of a little less than 30 seconds. The wide dynamic range of the LadyBug sensor allows measurements from - 60 to + 20 dBm. Logged data can be written to a file or shown in a graphical dis-

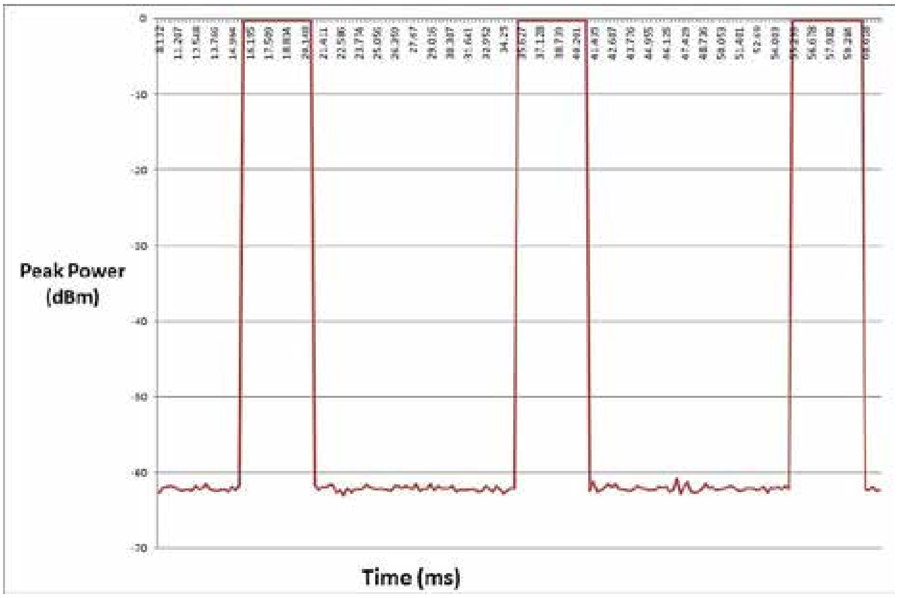

Figure 3 • High speed logger can be used to track signal amplitude changes like this pulsed signal (20 ms period and 5 ms width). The LadyBug High Speed Logger application software enables fast capture of data that can be exported to tools like Excel™ or MATLAB™ for analysis and visualization.

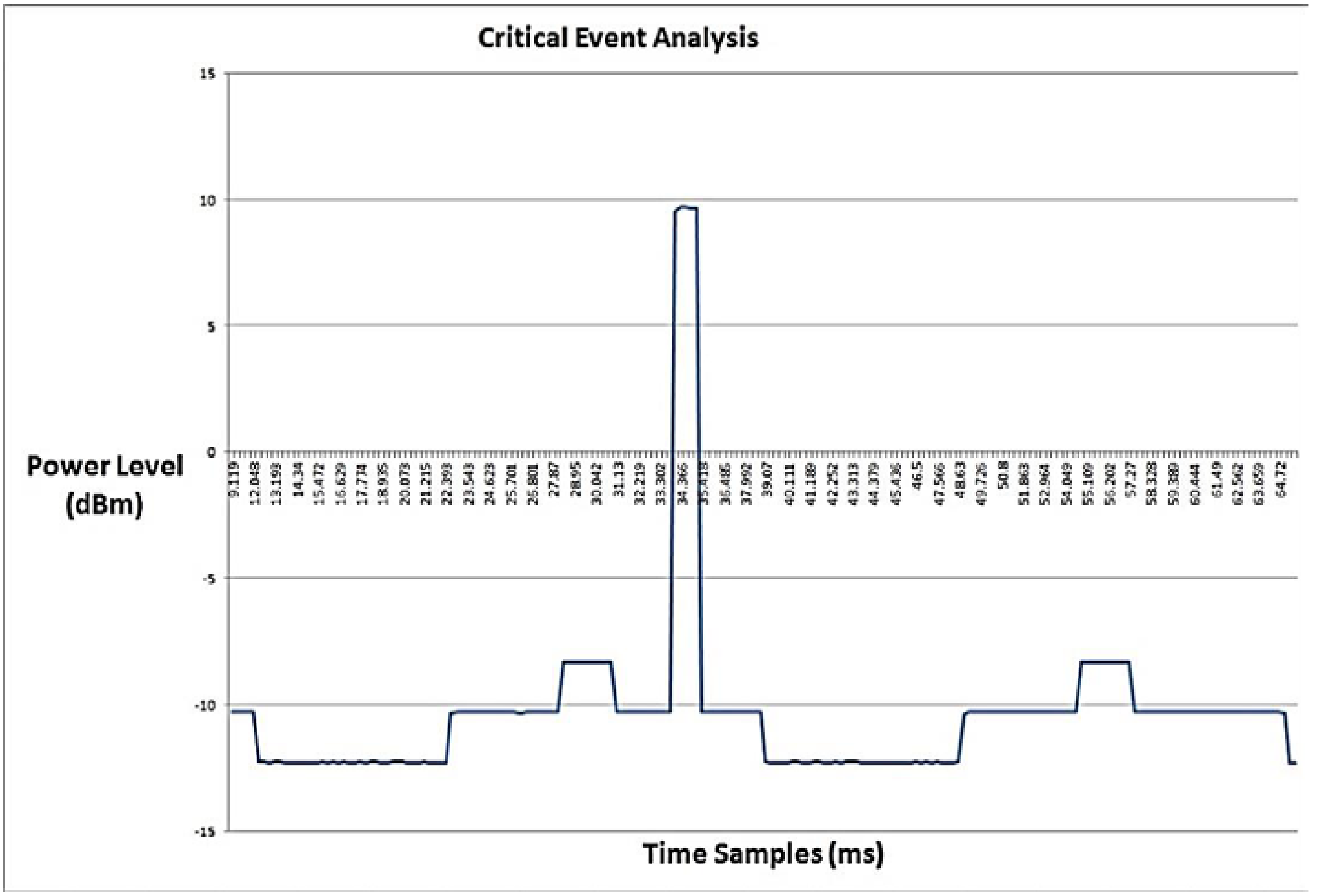

Figure 4 • Logging data with a LadyBug USB Power Sensor provides an inexpensive method for finding and analyzing intermittent and critical events or faults during system operation.

play. When writing data to a file, about 50 bytes of memory are required for each data point. Depending on the number of different parameters taken and the logging rate, a 10 day log would be about 4 MB in size.

High Speed Logging

Many data logging applications require a much higher rate of data recording. This is especially true when the need is to record RF signal samples in a constantly changing environment. Modern radio communication systems, whether they are mobile phones or wireless data networks, usually involve waveforms that are changing power levels or "bursting" on and off depending on the operating mode. Additionally, in order to conserve power and make the most efficient use of spectrum resources, RF signals are transmitted only when there is information to send or when channel resources are available. If precise power readings can be made across the duration of the signal they can then be analyzed to isolate problems with individual parts.

Envelope tracking is a method of modulating the power supply voltage of an RF amplifier so that it operates as efficiently as possible. The supply voltage is varied with the power envelope of the RF signal so that the amplifier always operates near compression. High speed logging is one cost-effective way to evaluate how well the tracking works, showing latencies and the effects of wide and fast signal variations. With logging at higher speeds, the envelope of a waveform can be traced, as shown in Figure 3. When using high speed logging with a LadyBug power sensor, the maximum sample rate is about 250 to 300 µs. This time will vary depending on the computer being used with the sensor.

Characterizing the power emanating from the base station for each LTE slot to ensure flatness for each channel over time is another application of high speed logging. The basic type 1 LTE frame (frequency division duplex, or FDD) has an overall length of 10 ms and is further subdivided into 20 individual slots. High speed logging allows measurement of all slots within a single frame.

Another use case for high speed data logging involves critical event failure analysis (see Figure 4). In this case we wish to find a signal anomaly that either indicates a failure in the system or an intermittent event that we want to track and analyze further.

For this type of analysis measurement triggering capabilities are important to success. The logging software needs the flexibility to match the proper triggering with the expected waveform. With High Speed Logging application software from LadyBug Technologies, multiple triggering options are available. Figure 5 shows the user interface for starting the logging process.

The first option is to simply begin logging when the user clicks the “start” button. The second is to begin logging when the RF power level reaches a preset threshold, such as when looking for an intermittent event within the signal. The third involves supplying the classical external trigger signal coupling the start of measurements to another event detected by a separate instrument. Our fourth and last option allows the user to select a specific time of day to initiate logging. In any case the start of logging can be delayed to better position the acquisition around the data of interest.

There are different aspects to be considered when recording large amounts of data over a period of time. The first would be memory usage. The rate at which data is to be recorded and the number of different parameters included in the recording affect the amount of memory needed. As mentioned earlier, when writing data to a file, about 50 bytes of memory are required for each data point. The amount of RAM available within the computer needs to be sufficient for the length of the log, but the more critical issue is the capability of the software being used to view and analyze the data. Different programs vary in their ability to handle large data sets. Notepad is the default text file editor used by the LadyBug high speed logging application. If the file is created with the data tab delimited it can easily be viewed and analyzed using Excel™.

Through the use of data logging software provided by LadyBug Technologies, the USB power sensor provides a cost-effective method for monitoring various processes that involve RF waveforms. Additionally, LadyBug Technologies makes the source code for the High Speed Logging application available for modification and adaptation by the user.

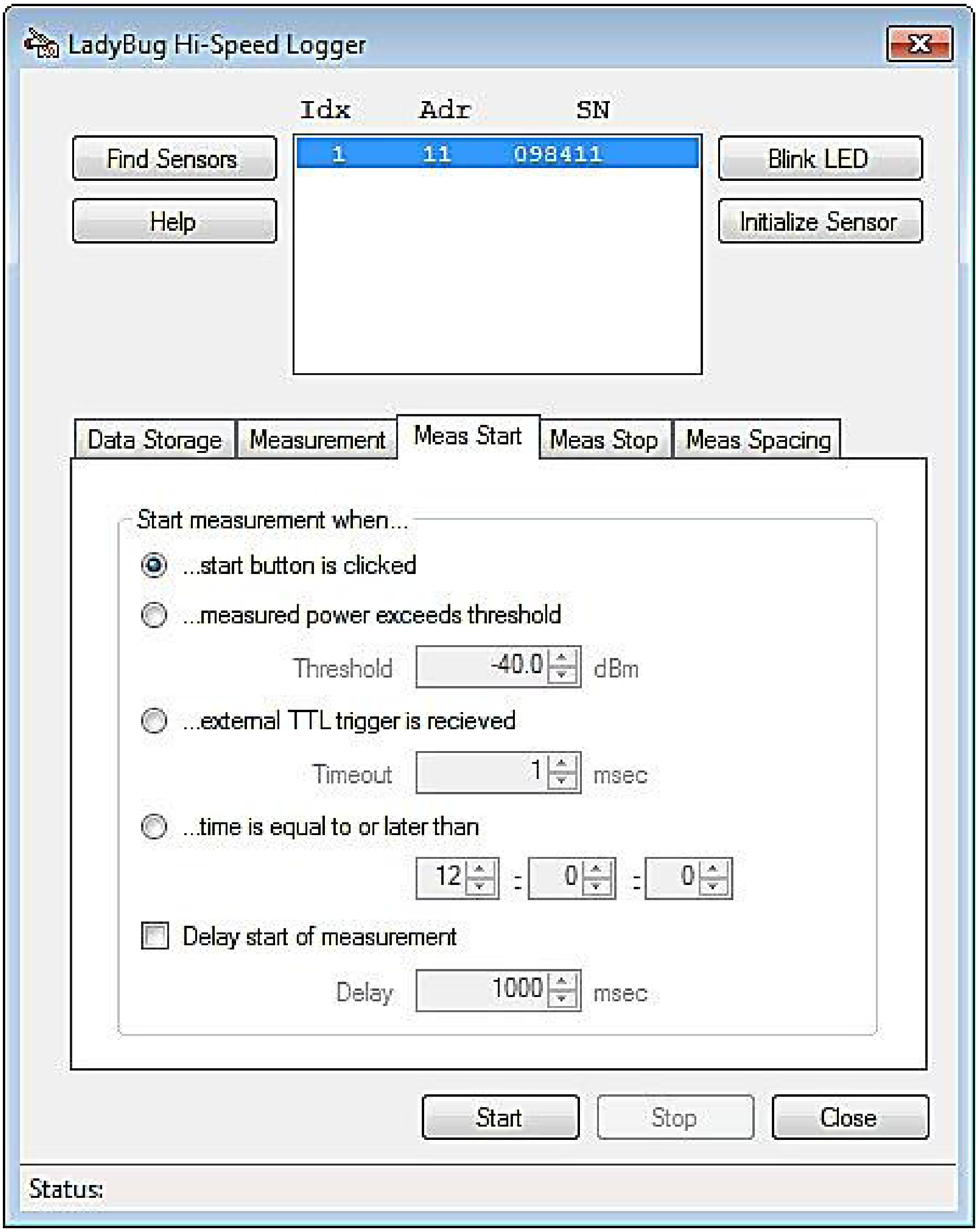

Figure 5 • Triggering alternatives to start the logging process with the LadyBug High Speed Logger application.

About the Author:

Orwill Hawkins serves as Vice-President of Marketing at LadyBug Technologies, Santa Rosa, Calif. He has over three decades of management, marketing, engineering and manufacturing experience, and extensive hands-on design and manufacturing experience in the RF, analog, and digital fields. Among the many products he has designed and marketed are a self-contained RF field disturbance burglar alarm system, a sailboat speedometer, and various robotic servo systems. Additional inventions include a prototype oscilloscope, a CNC cutting system, and various other analog, digital and RF projects.