Applications and Advantages of USB RF Power Sensors

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Traditional RF power measurements involve the use of power meter and power sensor combinations. These instruments have served users well for many decades, but there are many limitations associated with this configuration. From the need to zero and calibrate periodically before making measurements to the sensor having to be so closely tethered to the meter, the meter/sensor combination causes major inconveniences we have just learned to live with.

With the introduction of USB power sensors there is now an alternative for accurate power measurements. USB sensors offer multiple advantages particularly where the application involves measurement at a point embedded in a test system, remote power sensing or use cases requiring mobility and portability. These compact measurement tools offer a true improvement in value with no only lower cost but higher performance than many traditional sensors.

When selecting a USB power sensor it is important to carefully review and compare the performance and features offered against the requirements of your application. The sensors currently available exhibit wide differences in capability. The line of USB sensors from LadyBug Technologies offers superior performance in terms of accuracy, measurement speed and dynamic range in addition to providing features such as triggering, pulse profiling and choice of connector type.

Applications

USB sensors can be used in nearly any power sensing application. They also enable new use cases that traditional sensors either can't support or at best are difficult to implement.

- *Remote power measurements*
  Making power measurements where the measurement point is needed at a distance from the test instrumentation is an ideal application for the USB sensor. Small and portable, a USB sensor can be placed very near the RF source reference point. The user is not limited by the 5 meter USB connection range as several alternatives are available for extending the range using Ethernet or optical fiber converters. Figure 1 shows the example of an antenna test range. The source antenna is normally located at the opposite end of the range from the rest of the test instruments on a tower or other supporting structure. The signal source is installed as near as possible the source antenna to minimize signal loss. But the measurement of the source power into the antenna is best made right at the antenna input to avoid having to calibrate for cable losses and the inaccuracies involved.

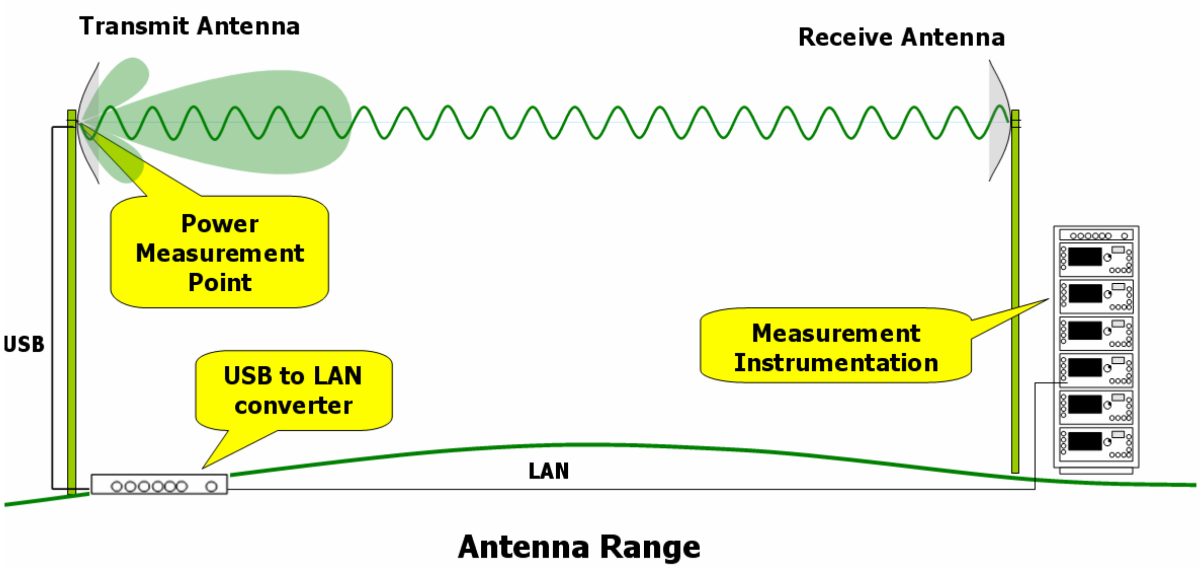

Figure 1 – Example of a Remote Sensing Application

- *Embedded power measurements*
  Often there is a need to measure power at a point where access is difficult due to space limitations or the point of interest being deep within a test system. For example, this point could reside in the back of an instrument rack, inside a switch matrix or on a test fixture.

  To try to use a traditional power sensor and meter in this application, first, space would have to be made in the rack for the meter. Second, the point of interest would have to be brought out via and extra cable to a port on the external bulkhead of the rack so that the sensor could be attached there (see Figure 2). The sensor will be disconnected and reconnected often for zeroing and pre-measurement calibration. Zeroing and reference calibration are never needed with USB sensors from LadyBug Technologies. Third, with the extra cable a switch, splitter, coupler or isolator will be needed and the additional loss will require calibration and make the measurement less accurate. Lastly, this added complexity will mean extra test software for control and calibration.

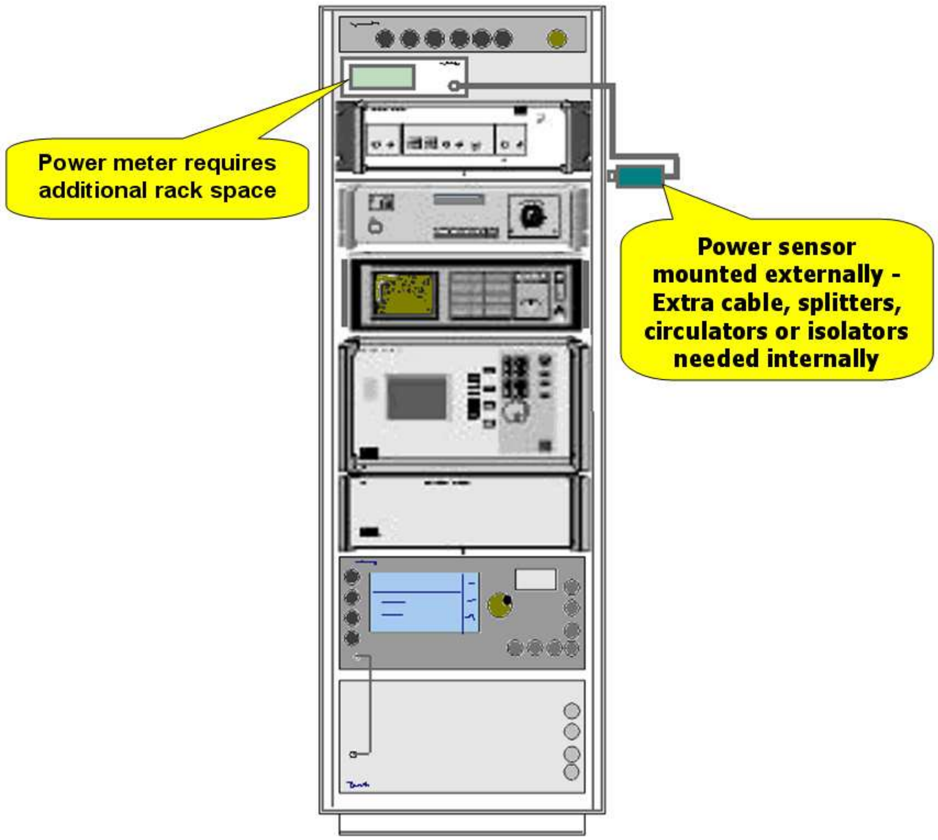

Figure 2 - Trying to use a traditional power sensor/meter in an embedded application

- *Portable measurement capability*
  When having to travel from site to site the less equipment you need to haul around to get your job done the better. USB sensors are small and light weight and only require a laptop computer to process, display and record measurements. And the computer can be located remotely from the point of measurement for applications in tight quarters.

Performance

Accuracy

Accuracy is of course the most critical of power sensor attributes. Many elements can contribute to the inaccuracy of a power measurement. Impedance mismatch between the sensor and the RF source to be measured contributes significantly to this error. Sensors with lower standing wave ratio (SWR) specifications will perform better. Minimizing the use of cables and adapters will help maintain a low SWR throughout the RF power measurement path. USB sensors from LadyBug are available with a flexible connector selection including SMA, Type-N and TNC. This way you can make the right connection for your application without adapters that can diminish accuracy.

An attribute that contributes to the inaccuracy of traditional power sensors and meters is the need to perform zeroing and reference calibrations prior to making a measurement. Inaccuracies in the reference signal and zero level of the meter adds directly to the inaccuracy of the measurement. This shortcoming of traditional sensors and meters can contribute as much as 2% error to the readings.

Zeroing and reference calibration

As discussed above traditional power sensors and meters require a periodic zeroing and reference calibration prior to making measurements. Some USB sensors now have an internal zeroing feature. These sensors are not required to be disconnected and reconnected for zeroing and calibration, but this approach has serious limitations. Sensors that perform an internal zeroing are subject to errors due to the isolation and subsequent leakage of the switch. This leakage produces an offset error during zeroing. The error becomes more prominent as input power increases and the measurement levels decrease. At input power levels of roughly 0 dBm or more the errors can become significant.

The line of USB sensors from LadyBug Technologies have eliminated the internal zero & calibration processes by design, providing highly accurate measurements without the need for and the error of zero & cal. Ladybug sensors also undergo the most rigorous factory calibration in the industry that includes calibration across the full operational temperature, frequency and power ranges.

Settling time

Measurement speed is critical to not only improve test throughput but to enable swept scalar measurements and pulse profiling within a reasonable test time. Lady Bug sensors have a best in class settling time with the ability to make a settled measurement at -60dBm in roughly a single millisecond. The typical settling time for a traditional sensor are generally greater than one second and could be up to three to four seconds.

Temperature Sensitivity

Changes in temperature can cause large errors in power measurements, particularly for very wide temperature variations. Figure 3 (note right hand scale) indicates that as the temperature of the sensor moves from 23^{o}C to the high or low temperature extremes, the power measurements of a typical sensor will vary by up to two dB or become non-operational depending of the power level to be measured. Two dB represents a measurement error of nearly 60%. Thermally compensated sensors like those from LadyBug show no variation from a measurement made at room temperature to measurements when the sensor is cooled to 0^{o} C or heated to 55^{o} C including the measurement of power levels as low as -60 dBm.

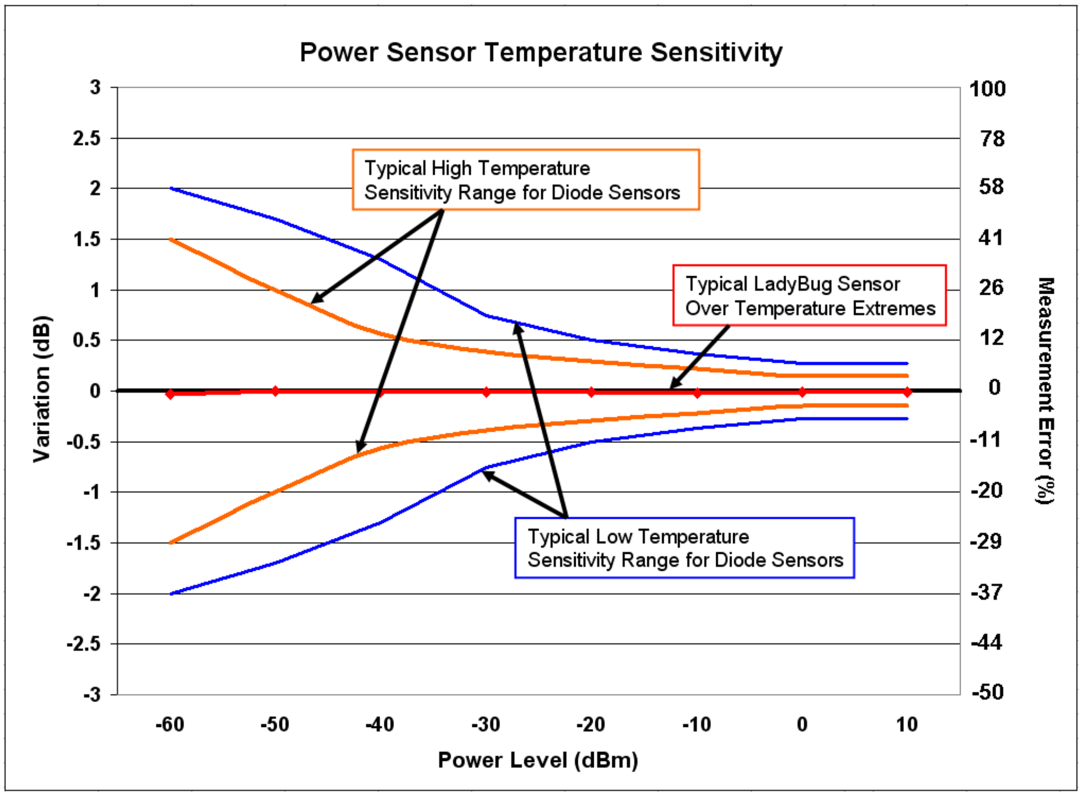

Figure 3 - Average measurement error of traditional sensors versus the LadyBug USB sensor

Value and Price

The value of USB sensors is apparent in a variety of ways. You now have the ability to place the sensor nearly anywhere within a system without the need for extra hardware. Depending on the frequency range needed this will save hundreds up to thousands of dollars in parts costs. You save not only the cost of the hardware but the integration labor including design, assembly and validation are significantly reduced. Also rack space always seems to be at a premium, but with a USB sensor you save at least two rack units and perhaps more if there are multiple sensors within your test system.

The need for test software development is significantly reduced when implementing a system with USB sensors. The fact that zero & cal is not needed eliminates the requirements for control of switches, additional calibration tables for the cables needed to route the sensors and to interrupt the test for periodic re-zeroing. Overall test throughput is increased as a result.

For a traditional power sensor and meter combination, prices roughly run between $5k and $8k for the meter alone and an additional $2k to $5k for the sensor. A USB sensor (not including a PC) ranges from about $2k to $5k. USB sensors can be very economical particularly if a PC already exists and note that a single PC can be used for multiple sensors. Using USB hubs, one PC can support up to eight LadyBug sensors enabling a variety of scalar measurements including multiport network analysis, mixer testing and simple ratio measurements. This provides tremendous value over traditional power sensors with a meter needed for at least every two sensors.

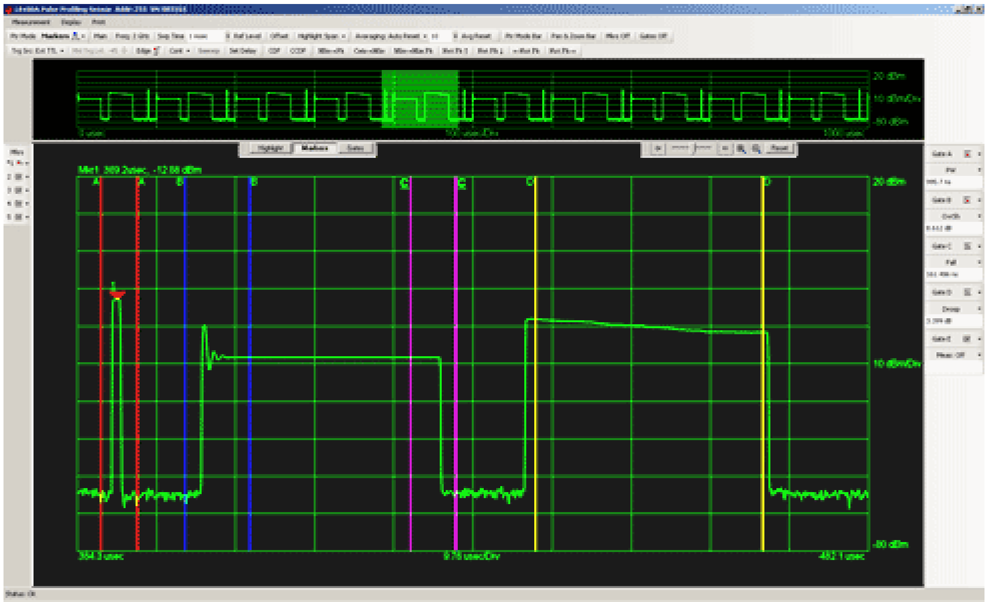

Figure 4 - Pulse profiling software showing measurement of a complex signal with pulse width, overshoot, rise & fall time, and droop.

Conclusion

USB sensors have many significant advantages over traditional sensors and meters. In performance and value comparisons, the older technology can no longer compete in most applications. Of the various USB sensors now available, the PowerSensor+ ^{TM} product line from LadyBug Technologies stands out. These compact and ruggedized sensors deliver high performance in terms of accuracy, settling time and stability over temperature at the lowest price in class. Features available from LadyBug include triggering, recorder output, and pulse profiling (see Figure 4). Visit the LadyBug Technologies website at http://www.ladybug-tech.com/