Bluetooth Low Energy Creates New Testing Requirements

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By eliminating wires and simplifying connections between devices, Bluetooth wireless technology influences people's lives in many ways. Mobile phones, PCs, motor vehicles and portable music players now have the ability to be connected quickly and easily whenever we want. The broad range of applications that Bluetooth supports has resulted in the technology becoming ubiquitous and shipping over 1.5 billion chips a year.

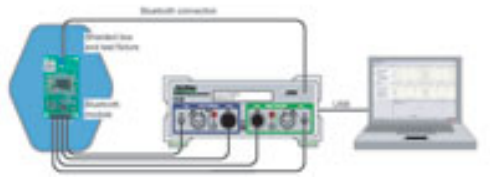
Bluetooth technology is now poised for a second burst of growth through the adoption of the latest version of the Bluetooth Special Interest Group (SIG) specification, V4.0. The new specification introduces a new low energy standard which lessens power requirements and increases the products in which Bluetooth technology can be designed into. Devices ideally suited to Bluetooth low energy include health care equipment, such as wireless blood sugar monitors, fitness performance equipment, including heart rate monitors and remote displays, such as those found on wrist watches.

Bluetooth low energy was developed to work in conjunction with existing Bluetooth devices. However, since it is going to be designed into a wider range of products, the technology brings with it something new to many engineers in these markets- the need for RF testing at a frequency of 2.4 GHz. Testing RF at such a frequency, coupled with the fact that Bluetooth low energy offers data rates of up to 1 Mbit/sec over a range of 10+ meters, creates design and testing challenges.

Design Challenges

If Bluetooth low energy devices are going to be successful, it must be simple to integrate the technology into new products. Typically the target products are small in form factor and may already contain sensitive electronic circuits. Integrating Bluetooth technology alongside existing high speed digital circuits, high speed clocks and power supplies can cause the performance of the Bluetooth radio module to degrade. The casing of the host product can also impact the radios range, especially if it is metallic. Even when using pre-qualified Bluetooth modules, there is a need to re-validate the performance of the radio after it has been integrated into the host product.

Two types of Bluetooth low energy devices are used. Dual Mode devices integrate Basic Rate, EDR, and low energy functionality into a single chip. Single Mode devices support only the low energy standard. Mobile phones and PCs will most likely support the Dual Mode devices, and sensors and peripherals may only support the low energy standard.



Unlike Basic Rate and EDR testing, the low energy specification does not define a signaling-based test mode connection to the device under test (DUT). For accurate and effective testing, the DUT must be controlled using defined test control commands that are sent through the DUT Host Control Interface (HCI interface). If the DUT does not support an HCI interface, a simple two-wire control interface has also been defined.

Test Solutions Fit the Need

Given these design scenarios, Bluetooth test solutions need to conduct traditional Basic Rate and EDR tests, as well as measure low energy performance, to reduce the cost of test, and improve test times. Automated testing is also advantageous. Test solutions (Figure 1) that can send test controls to the DUT can create a fully automated testing environment that will reduce test costs and time.

Simplicity is critical in Bluetooth testing, however instruments should be powerful enough to display results quickly and accurately. Some solutions offer a “Quick Test” function with simple one-touch operation. These test scripts need to operate in seconds and measure power, frequency, modulation and receiver sensitivity (BER).

Test instrumentation should also be validated by the Bluetooth SIG. Validation confirms that the SIG has approved all supported measurements of the instrument,

and that it fully meets the requirements of the Bluetooth System Specification. Validated Test Systems can be used for the qualification of other Bluetooth products.

Measuring Bluetooth Modules

Because Bluetooth is being integrated into so many designs, there are subtle differences in testing requirements, depending on the device. For example, test solutions for Bluetooth modules that include BR/EDR radios must be able to establish a link with the module under test and perform a comprehensive set of transceiver measurements in less than five seconds, to meet the need for high product throughput. A radio link can only be established between tester and module once the module's Bluetooth address is known. If the module address is unknown, a testing unit can read it through the module Host Control Interface (HCI) or perform an Inquiry using standard radio layer signaling. Prior to testing, an integrated CW frequency counter may be required for crystal trimming, as part of a simple calibration process. Figure 2 provides an example of a module test set up.

Module testing requires a test fixture to interface the Bluetooth module to the test instrument. The test fixture should provide a direct RF connection plus a connection to the module's HCI interface, if required. Typically the test fixture is housed in a shielded enclosure to isolate it from any interfering radio signals such as WLAN access points, or even other Bluetooth devices.

Mobile Phone Testing

Mobile phone manufacturers need to prove the performance of both the Bluetooth and mobile phone radios. Test can be a bottleneck in any mobile phone production line, so testing the Bluetooth interface must be done without increasing total test time. It is also vital to confirm that both radios can be active simultaneously without any interference between them.

These demands result in the need for parallel testing of the Bluetooth and mobile phone radios. For mobile phones without an RF test connector, it is important to be able to make all measurements over the air interface. Simply use a test fixture to position the DUT accurately with respect to the test antenna. The test system can then be built up using a mobile phone test set alongside a Bluetooth test set and running the two testers in parallel to minimize test time.

Consumer Products

Bluetooth interfaces are now common in mobile phones, all formats of PC, motor vehicles, music players, mono and stereo headsets and game controllers. With the introduction of Bluetooth low energy for many manufacturers, it is the first time that RF measurements have been made in their production facilities. Because of this, Bluetooth low energy test equipment used in this environment should have pre-programmed test scripts. This reduces any learning curves while assuring accurate

test results, which in turn, ensures product quality.

Audio Measurements

Consumer products - such as headsets, audio gateways and in-car consoles - that offer voice over Bluetooth require audio measurements as well as radio layer measurements. Important features to look for in test solutions used in this application include support for both mono (Hands-free profile) and stereo (Advanced Audio Distribution Profile) A2DP profile. The latest generation of audio testers also allows for the direct connection of test microphones and speakers so that fully assembled headsets can be tested.

Conclusion

Bluetooth low energy was developed for designs in which classic Bluetooth draws too much power. Its ability to operate at significantly lower power levels creates a number of new applications in which Bluetooth technology can be used. To help ensure the successful implementation of Bluetooth low energy in these new, low-power designs, test solutions must be able to conduct the necessary tests based upon the Bluetooth standards, quickly and cost efficiently.

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