Keysight Technologies
A Cost-Effective Solution to Test Zigbee-enabled Smart Home Devices

Application Note
A Cost-Effective Solution to Test Zigbee-enabled Smart Home Devices

In the rapidly growing Internet of Things (IoT), applications from industrial machines, sensors to personal electronics are getting wirelessly connected to the internet. Smart home, also known as home automation, is a growth initiative in the overall IoT market. Smart home may include centralized control of lighting, HVAC (heating, ventilation and air condition), shading, security, pet feeding, yard watering and home entertainment system. Besides the benefits of convenience, comfort and energy efficiency, smart home also provides increased quality of life for the elder and disabled.

Wireless connectivity is the foundation for a smart home. Numerous technologies are deployed, spreading over multiple frequency bands using different communication protocols.

Table 1. Frequently used wireless technologies in IoT devices

<table>
<thead>
<tr>
<th>Wireless connectivity</th>
<th>General RF</th>
<th>Z-wave</th>
<th>Bluetooth*</th>
<th>WiFi</th>
</tr>
</thead>
<tbody>
<tr>
<td>Typical application</td>
<td>Remote controllers, doorbells</td>
<td>M2M network, home automation, industrial control traffic, security</td>
<td>Home automation, consumer electronics</td>
<td>PC/handset, peripherals, medical electronics</td>
</tr>
<tr>
<td>Frequency range</td>
<td>ISM band</td>
<td>868/902 MHz</td>
<td>868 MHz (EU)</td>
<td>2.4 GHz</td>
</tr>
<tr>
<td>Modulation format</td>
<td>AM/FM, ASK/FSK, GFSK</td>
<td>BPSK, OQPSK</td>
<td>FSK, GFSK</td>
<td>GFSK, 8DPSK</td>
</tr>
<tr>
<td>Typical Tx power</td>
<td>+7 dBm (5 mW)</td>
<td>0 dBm (1 mW)</td>
<td>0 dBm (1 mW)</td>
<td>+4 dBm (2.5 mW)</td>
</tr>
<tr>
<td>Distance</td>
<td>50 ~100 m</td>
<td>5 ~ 100 m</td>
<td>5 ~ 100 m</td>
<td>10 m</td>
</tr>
<tr>
<td>Symbol rate (bps)</td>
<td>1.2 ~ 19.2 k</td>
<td>250 k</td>
<td>9.6 k</td>
<td>1 M</td>
</tr>
<tr>
<td>Protocol</td>
<td>VES-P</td>
<td>IEEE 802.15.4</td>
<td>Z-wave Alliance</td>
<td>Bluetooth Alliance</td>
</tr>
</tbody>
</table>

Zigbee is a low throughput, low-power and low-cost technology. It mainly operates in the 2.4 GHz ISM band and can deliver up to 250 kbps of data throughput, although it is usually used at much lower data rates. It also has the capability to maintain very long sleep intervals and low operation duty cycles powered by coin cell batteries for years. Zigbee can be used in multiple IoT applications, but it has gained the largest momentum in home automation and lighting control applications.
Introducing a Cost-Effective RF Test Solution to Test ZigBee Modules

Testing ZigBee modules or boards during the manufacturing line is essential for ensuring they will perform in the field as desired, and while some test solutions can be costly, this section explains the capabilities of a budget-friendly solution, which includes:

- The Keysight BSA Series spectrum analyzers to address center frequency and transmission power test
- The Keysight IQ bundle, which uses the N9310A RF signal generator and 33522B/33600A Series waveform generator to address receiver sensitivity test

Transmitter characterization

Keysight BSA Series spectrum analyzers provide one-button Power Suite to address the essential transmission test demands for output

Note: if more extensive signal analysis is required, the Keysight N9000A CXA signal analyzer and W9064A vector signal analysis application software are recommended. See Figure 5 for reference.
Receiver characterization

Usually, an RF signal source is required to verify the sensitivity of the device under test (DUT). In instances when using an integrated vector signal generator is not feasible, the Keysight IQ bundle solution is a cost-effective alternative for digital signal generation. The 33522B or 33600A Series waveform generator used with the N9310A RF signal generator can be used to build the digital modulation formats that are widely used in sub 1-GHz modules, such as ASK, FSK, GFSK, or even OQPSK.

When using the IQ bundle solution, Figure 4 illustrates the typical procedure for building signals.

![Figure 3. A typical system setup when measuring ZigBee receivers](image)

![Figure 4. Overview of low-cost solution for building test signals](image)

A detailed IQ bundle solution for generating an OQPSK signal is discussed in the application note A Flexible Test Solution for 2.4 GHz ZigBee Transmitters and Receivers, literature number 5992-0464EN.
BSA Spectrum Analyzers

The N9320B and N9322C BSA spectrum analyzers focus on general-purpose spectrum analysis to address primary frequency domain measurement needs. They are ideal for consumer electronics, R&D, manufacturing, bench repair, universities and polytechnic education, and general-purpose spectrum monitoring.

They cover frequencies up to 7 GHz, offer one-button power measurement, and provide analog/digital demodulation and SCPI command compatibility with the Keysight ESA Series spectrum analyzers. They both offer an optional tracking generator for low-cost stimulus response measurements.

Built to perform on the test bench and priced to compete in the market place, the BSAs provide reliable RF performance and robust feature sets at affordable prices.

<table>
<thead>
<tr>
<th>Key specification/function</th>
<th>N9320B</th>
<th>N9322C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>9 kHz to 3 GHz</td>
<td>9 kHz to 7 GHz</td>
</tr>
<tr>
<td>DANL at 1 GHz w/min. RBW and preamp</td>
<td>-145 dBm</td>
<td>-152 dBm</td>
</tr>
<tr>
<td>Phase noise at 1 GHz, 10 kHz offset</td>
<td>-90 dBc/Hz</td>
<td>-90 dBc/Hz</td>
</tr>
<tr>
<td>3rd Order Intercept (TOI) at 1 GHz</td>
<td>+13 dBm</td>
<td>+15 dBm</td>
</tr>
<tr>
<td>AM/FM modulation analysis</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>ASK/FSK modulation analysis</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Spectrogram</td>
<td>No</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Summary

Keysight’s ZigBee test solution offers an efficient way for small to medium size companies to easily address their essential RF test needs, and improve productivity. For more information about the solutions mentioned in this application note, please visit:

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