Innovative RF Solutions for Wireless Access Points and Routers within the Connected Home

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They say that creativity thrives on constraints and not many design situations are more constrained than wireless devices. The notion of "always on" connectivity comes with significant analog and RF complexity; solutions must have ever-increasing data rates, ensure that connectivity technologies work seamlessly, occupy minimal space and address signal transmission and conditioning issues as well as filtering, tuning, power management, voltage regulation and, for portable devices, battery use and charging limitations. And that's just at the system level. Front-end components such as power amplifiers (PAs) and transmit/receive switches present their own design challenges. The power amplifier, for instance, is a critical component within a WLAN transmitter circuit because PA performance affects the wireless coverage area, data rate capacity, and battery life. Mobile devices and wireless access points typically transmit between 100 mW (+20 dBm) and 1 W (+30 dBm) of RF output power, and the PA must be able to generate sufficient power with minimal nonlinear distortion. What's more, PAs are being designed into modules that also may perform such functions as switching, filtering and power detection — all in a package that is only a fraction as large as it was only a few years ago.

As this article will discuss shortly, these requirements, while formidable, play directly to Skyworks' strengths given its broad selection of high performance front-end modules, PAs, low noise amplifiers (LNAs) and switches. But before we delve into why, a bit of background is in order.

The Connected Home

As the connectivity explosion continues to move beyond mobile to the Internet of Things (IoT) — the connected home and car, wearables, medical, machine-to-machine and industrial — as everyday objects become wirelessly linked to each other, consumers are demanding that their home Wi-Fi networks deliver increasing data throughput to support a growing range of applications like streaming media and gaming. ABI Research forecasts that IoT shipments will reach one billion units over the next five years, with set-top boxes (STBs) and gateways becoming the hub of the connected home.

Since much mobile data activity also takes place within users' homes, for consumers with fixed broadband and Wi-Fi access points at home — and that's almost everyone — a sizable proportion of traffic generated by portable devices will be offloaded from the mobile network onto the fixed network. According to Cisco's 2015 Visual Networking Index (VNI) forecast of Global Mobile Data Traffic (updated Feb. 2016), more than half of all traffic from smartphones and tablets were offloaded to fixed network via Wi-Fi in 2015. In total, 3.9 exabytes of mobile data traffic were offloaded onto the fixed network each month.

In this scenario high performance routers become vitally important. A router is connected to a minimum of two networks. It basically decides which way to send each information packet so you can think of it as a sort of traffic cop, directing traffic between different clients connected to your network.

Routers are used to generate Wi-Fi, and the Wi-Fi standard is periodically updated to allow faster speeds and better security. The benefits of the latest iteration, the 802.11ac router, include higher 1 Gbps throughput (vs. 600 Mbps limit using 802.11n) and the ability to broadcast Wi-Fi over a longer distance on the 5.0 GHz wavelength. Each spatial steam of

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the 802.11ac standard is about four times faster than that of the 802.11n standard. The 802.11ac standard also creates new technical challenges to the Wi-Fi front-end module (FEM) and power amplifier design as the dual-band WLAN radios support concurrent operation of the low- and high-band radios, which results in significantly increased data throughput.

Overall, while network box sales are flat or even down slightly, there is increasing content opportunity in each box with more input/outputs. Data router stream count is increasing, too. Skyworks' suite of solutions is enabling devices that support these higher data rate speeds. Its components can be found in almost all of today's top rated routers. Here are just three instances: The D-Link DIR-895L/R AC5300 ("the first router on the market can deliver the full Wi-Fi bandwidth of 5,300 Mbps" CNET); Asus' RT-AC88U ("Best Routers of 2016" PC Magazine), and TP-Link's Archer AC5400 (Best Buy 5-star rated).

All of these best-selling routers have one thing in common: Skyworks components. All three include Skyworks SE2623L 2.4 GHz power amplifiers. The D-Link model also has Skyworks' SKY85405-11 5 GHz power amplifier (x4, the 802.11ac standard supports MIMO configuration which needs multiple power amplifiers in one system) in its two 5 GHz radios. Skyworks is the exclusive provider of RF content powering D-Links' next-generation 802.11ac Wave 2 devices, such as the AC5300. The ASUS unit also has a Skyworks SKY85201-11 2.4 GHz SPDT switch with LNA (x4) and a SKY85605-11 5 GHz SPDT switch with LNA (x4). The TP-Link Archer AC5400 router includes 100 percent Skyworks content including SKY85201-11 2.4 GHz SPDT switch with LNA and SE2623L-R LAN power amplifier(x4) and SKY85605-11 5 GHz SPDT switch with LNA and SKY 85405-11 WLAN power amplifier (x8).

Preparing for the Future

As recent as 802.11ac is, it's hard to believe that an IEEE working group is developing other 802.11 revisions. One of the most promising and broadly appealing standards is IEEE 802.11ax. In a word, 802.11ax is going to be fast. While the typical consumer may have a hard time getting more than 400 Mbps from his/her smartphone via 802.11ac, 802.11ax should deliver real-world speeds above 2 Gbps. 802.11ax developers are aiming not just to increase speed, but also for the ability of connections to stay active even when interfered with heavily. Ballots for voting on the final 802.11ax standard are not due until September 2018; with version 1.0 due in September

2016 and version 2.0 slated for September 2017.

While 802.11ac allows for up to four different spatial streams using multiple-input and multiple-output (MIMO), 802.11ax massively increases the spectral efficiency (and thus maximum throughput) of each stream. Like its predecessor 802.11ac, 802.11ax will operate in the 5 GHz band.

Fig 1. TP Link's Archer AC5400 Wireless Tri-Band MU-MIMO Gigabit Router boosts Wi-Fi speeds on all bands by 25% achieving combined Wi-Fi speeds of up to 5334 Mbps and 4X efficiency by communicating with up to four devices at once.

As it did in 802.11ac, Skyworks can be expected to empower the next wireless networking revolution, 802.11ax. Indeed, the company's expertise in integrating all the RF and analog content between the transceiver and antenna also is applicable to other demanding next-generation platforms such as 5G. Skyworks is directly addressing the transition to 5G and the proliferation of small cell systems with a suite of high performance amplifiers for the small cell infrastructure market. The new SKY66184-11, SKY66185-11 and SKY66186-11 are compact devices designed for FDD/TDD small cell base stations and cover major LTE bands.

You'll find Skyworks' Wi-Fi (IEEE 802.11), ZigBee® (802.15.4) and Bluetooth® products widely used in such diverse applications as wireless infrastructure, WLAN, automotive, wearables, medical, industrial, energy management and, of course, cellular/handset applications. In the past, the company has demonstrated it can respond to customer interest in new designs very quickly. Following discussions, the first samples can be released in six months, compliancy with specifications met within 10 months, and a production ramp within just 12–14 months or possibly sooner. As a result, the company's components are part of an equally-impressive end product list that includes smart thermostats, security systems, sensors, light switches, smoke and CO alarms, appliances and door locks, as well as routers, high definition televisions, gaming consoles and much more.