

# Solving the challenges of RF design with certified wireless modules



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# Overview

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In all respects, the Internet of Things (IoT) is no longer just a concept, but a rapidly growing set of technologies that are forcing suppliers to move faster than ever before.

In 2016, industry research firm MarketsAndMarkets estimated that the IoT technology market in 2015 was valued at \$130 billion. [The study also predicts](#) a compounded annual growth rate of 32.4 percent between 2016 and 2022 that will increase the market to an estimated \$883.55 billion. And yet another [study from Gartner](#) predicted 5.5 million new IoT devices would come online each day in 2016, reaching 20.8 billion by 2020.

This growth is due to the tremendous value connectivity adds to so many types of applications and verticals; such as building automation, smart grid, factory automation, automotive, wearable devices and home electronics. And, naturally, wireless connectivity protocols like Wi-Fi<sup>®</sup>, Bluetooth<sup>®</sup>, Sub-1 GHz and ZigBee<sup>®</sup> are more desirable than wired networking solutions because of their flexibility and easy cloud integration.

The challenge system developers now face is efficiently connecting their applications to the Internet while maximizing revenue and reducing investment risks. This white paper works to detail how wireless connectivity modules—small plug-in PCBs that feature all of the componentry and software protocols needed to provide a turnkey RF communications front-end or back-end—are helping developers bring products to market quickly while lowering costs and simplifying design challenges.

## Introduction

No matter the industry or application, one of the most important considerations for system developers is incorporating features that will differentiate a product in the marketplace. However, many companies today do not always have adequate radio frequency (RF) expertise on staff to help implement these features into new systems; making it difficult to rapidly design products that involve both analog and digital circuitry.

To counter this obstacle, many technology suppliers are now utilizing certified wireless modules to overcome many of the challenges inherent in complex RF design projects.

## The challenges of RF design

*Which oscillator do we need? Where should the antenna be routed to reduce electromagnetic interference (EMI)? Which passives, filters, capacitors, etc. are most economical and still get*

*the job done? Which wireless connectivity chip is best for this design?*

The countless questions facing today's RF designers are complex and vary by industry. Even when an experienced engineer believes they have followed best practices, RF designs can still encounter issues like high EMI, reduced antenna efficiency, failed government certifications or excessive power consumption. When any of these problems occur (or others), more time is added to the already tight development schedule, requiring additional design spins, prototypes and testing before the product eventually makes it to market.

A critical aspect of regulatory certification is EMI emission testing. Throughout the design process it is imperative that a system meets these requirements to receive approval from regulatory agencies such as the Federal Communications Commission (FCC) in the U.S., the European Union's CE or Japan's TELEC. Unfortunately, this can be difficult to achieve as expensive testing equipment costs more than \$100,000 and outsourcing can range between \$1,000 to \$2,000 per hour.

Once designers are confident that an RF design will pass certification testing, it must be submitted to a government-approved lab—where additional fees are incurred. The total cost of certification varies by application, but typical estimates range from \$30,000 to \$50,000 and requires approximately six months.

Another problem that often arises during RF development is design failure. The cause might be insufficient wireless connectivity range, impaired throughput or any other metric that didn't meet system specifications. Whenever a performance problem is discovered, extensive testing and debugging must then be done to determine the root cause, again adding more costs and delaying time to market.

Of course, RF design can be expedited by adopting reference designs from a wireless technology provider, but these are not one-size-fits-all solutions. Any deviation in terms of form factor, component selection or PCB layout could jeopardize the performance. And while reference designs provide a great initial framework, it is up to the developer to implement it in a unique way that creates a competitive advantage.

The final step of wireless design before production (and ultimately its introduction into the marketplace) is interoperability testing. This process determines if the product will effectively communicate with wireless devices from other suppliers and must work seamlessly before finalizing a design. For example, a Wi-Fi-enabled sensor must be tested to verify it will operate with a wide range of new and existing Wi-Fi access points.

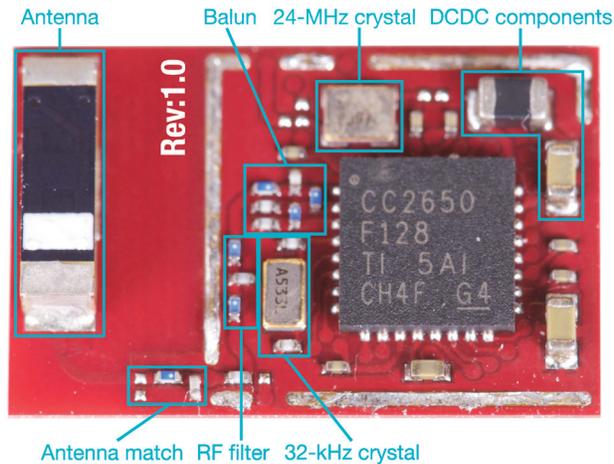
The bottom line—RF design projects are subject to a wide range of risks that could slow or halt the production process, but advancements in semiconductor technology can help provide a solution.

### **The solution: Certified wireless connectivity modules**

To combat the aforementioned challenges, semiconductor providers began developing small plug-in PCBs that feature all the components and software needed to provide a turnkey RF communications front-end or back-end—referred to as wireless connectivity modules.

Essentially, these modules serve as “black box” wireless connectivity solutions that support a broad range of communications standards, wireless interface chips, form factors and performance levels. And some even include an integrated microcontroller (MCU) to run application software. When developing a motherboard design, engineers simply need to follow a set of guidelines to

ensure the chosen module can be plugged in during production.



**Figure 1.** SimpleLink™ Bluetooth low energy CC2650MODA module layout

To further expedite the design process, some vendors are able to deliver these modules fully certified by appropriate government agencies and tested for EMI. Additionally, vendors will also test throughput performance and module interoperability or will even include a high-level application programming interface (API) to ease integration of the wireless protocol stack with the system's operating and application software. This certification and testing can save thousands of dollars and reduce time to market by as much as six months.

It's easy to see that wireless modules empower companies to quickly expand their IoT product offerings and relieve much of the burden typically associated with wireless designs. RF expertise is not an asset that many firms hold, especially when developing unique application features and products are the top priority.

By choosing to work with Texas Instruments (TI), developers are offered a wide range of wireless connectivity modules (made both by TI and third-party partners), including [Bluetooth low energy](#), [dual-mode Bluetooth](#), [Wi-Fi](#) or a [Wi-Fi and](#)

[Bluetooth](#) combination, [Sub-1 GHz](#) and 6LoWPAN/ZigBee® wireless technologies.

## Certified modules from Texas Instruments: A high-quality option for many technologies

For many years, TI has developed low-power, high-performing wireless connectivity modules that come fully tested and certified by the most critical governmental agencies, including the FCC, CE and TELEC. As the only module supplier to support such a broad range of wireless technologies and protocols, customers can be confident that TI's modules will simplify the development process (engineers should also check each module for specific details, as well as other pertinent industry standard bodies such as the Wi-Fi Alliance and Bluetooth SIG).

One of the company's most recent releases is a Bluetooth low energy module featuring an integrated antenna that interfaces with the MSP432™ MCU or any other corresponding microcontroller. The SimpleLink™ [CC2650MODA](#) module, which features an integrated antenna, provides the longest



**Figure 2.** SimpleLink Bluetooth low energy CC2650MODA module

range (twice that of comparable units) for the lowest power in the industry; and, like other TI modules, is easy to integrate because of extensive software tools, support, APIs and development kits.

Additionally, TI offers a dual-mode Bluetooth solution (Bluetooth Classic and Bluetooth low energy on one chip), the [CC2564MODA](#) device,



**Figure 3.** Dual-mode Bluetooth CC2564MODA

which also includes an integrated antenna and easily interfaces with a wide range of MCUs. The TI-certified Bluetooth stack maturity makes it the most robust and stable Bluetooth solution in the market offering classic Bluetooth performance over a longer range (100 m).

For embedded Wi-Fi connectivity, the SimpleLink Wi-Fi [CC3100MOD](#) and [CC3200MOD](#) modules are similar to their Bluetooth counterparts as one offers a wireless microcontroller (CC3200) and the other (CC3100) is a network processor that can be easily connected to any MCU. Both are the lowest-power Wi-Fi modules available in the industry and are FCC, IC and CE certified. Extensive testing in TI's research and development lab has also verified interoperability with more than 200 Wi-Fi access points. Finally, the CC3100 and CC3200 modules are pin-for-pin compatible with each other and both connect to an external antenna.



**Figure 4.** SimpleLink Wi-Fi CC3200 wireless MCU module

If a customer is looking for both high-performance Wi-Fi and dual-mode Bluetooth connectivity on a single chip, the [WiLink™ 8](#) technology is a great place to start. Like SimpleLink, the WL18xx modules are also all pin-for-pin compatible with each other, FCC, IC, CE and MIC certified. The WL18xx modules feature industrial temperature

range of  $-40^{\circ}$  to  $85^{\circ}$  Celsius both for 2.4 GHz and 5 GHz, with differentiated features such as [Wi-Fi mesh capability](#) and the coexistence mechanism with ZigBee technology which makes it a great fit for gateways for instance.



**Figure 5.** WiLink 8 combo connectivity modules for Wi-Fi and Bluetooth/Bluetooth low energy connectivity

## Faster development time: Software, kits and more

One thing TI demands from its wireless connectivity modules is each must be easy for manufacturers to integrate. For this reason, the company offers a wide variety of tools, software, documentation, reference designs and online support to help ease the design process.

To accompany its modules, TI also offers certified, royalty-free wireless protocol stacks and software development kits with simple APIs, along with the option to include integrated antennas for easier and faster certification. Not to mention, the LaunchPad™ ecosystem development kits, including BoosterPack™ plug-in modules, free Real-Time Operating System, cloud-based Integrated Development Environment provides another avenue to jump start the design process.

For additional resources, users will find a large range of technical documents (such as application notes and white papers) on [www.ti.com](http://www.ti.com), along with 24/7 support through TI's [E2E™ community](#). And those interested in self-guided support can visit the [TI training portal](#) for interactive, hands-on experiences

with TI's wireless devices such as the [SimpleLink Academy tutorial](#).

## **A dependable supplier and worldwide supply chain**

With a solid track record of shipping millions of wireless modules, TI offers high-quality manufacturing processes for its wireless connectivity modules. Equipment manufacturers have come to rely on TI's manufacturing capabilities as if they were an extension of their own. Continuity of supply and worldwide availability provide manufacturers peace of mind during their design and production phases. Another key advantage of working with TI-certified modules is the easy migration path from module to chip-on-board design for future additional system cost reduction.

## **Special requirements? Third-party modules might be the answer**

To offer a broader ecosystem of modules, TI works with [third-party partners](#) that expand its offerings. These third-party modules feature TI's wireless devices and related technologies, but include additional features that augment TI's off-the-shelf solutions (additional package options, antenna design, middle-ware software options, etc.). While third-party modules are not entirely TI components, TI still supports these products with its portfolio of development tools.

### **For more information**

For the latest information on TI's wireless connectivity module offerings, please visit [www.ti.com/wirelessmodules](http://www.ti.com/wirelessmodules)

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