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RF4CE REVOLUTIONIZES THE REMOTE CONTROL

ZigBee's new technology integrates radio-frequency functionality into the ubiquitous channel changer.

Throw away (or recycle) all of those remote controls scattered across your living room—or risk falling behind the digital age. The latest remote-control technology, dubbed "Radio Frequency for Consumer Electronics" or better known as RF4CE, will be coming soon to a store near you. Courtesy of ZigBee, it's now undergoing certification tests.

The RF4CE remote control isn't the typical infrared device found in the home. Instead, it's an RF-based product designed to conform to ZigBee specifications as part of a wireless network. The ZigBee wireless network managing the RF4CE device is designated to be active on three ZigBee predefined channels—15, 20, and 25—from the ZigBee spectrum extending from channel 11 to channel 26 *(see the figure)*.

Radio-frequency remote controls offer more freedom to operate devices regardless of distance or line-of-sight (LOS) barriers. This reliable form of two-way wireless communication (remote-to-target and target-to-target) brings consumers enhanced user interfaces and better interaction, as well as new control techniques. Unlike current remote technology, RF can control devices from greater distances, no matter what object lies in its path.

Most people have used some form of Wi-Fi, often in their home networks. Those familiar with Wi-Fi operation shouldn't be confused between the channels designated to Wi-Fi and those designated to ZigBee in the 2.4-GHz band.

The figure shows the channels designated for each. It also shows areas of overlap, such as ZigBee channels 17, 18, and 19 overlapping with Wi-Fi channel 7. This overlap could affect operational smoothness. Also, stability issues may arise when both Wi-Fi and ZigBee are widely used in the same space.

How RF4CE Works

ZigBee devices that operate with RF4CE remote controls include TV sets, DVD players, and set-top boxes, plus others that may be added in the near future. In the RF4CE world, the remote control is the focal device. Others, such as the DVD player, are "targets."

The remote control, as well as any target, can initiate a ZigBee RF4CE network by announcing its capabilities. Additional devices can join the network after searching for existing (prejoined) devices and pairing with them. The term *pairing* identifies an existing channel connection between any two RF4CE devices that can exchange bidirectional wireless data. As in any conventional wired or wireless network, bidirectional wireless data carries different commands (to operate the devices) or data for all types of voice, video, files, etc.

The average RF4CE user needn't know the fundamentals of networking to benefit from most of the available features. However, to complete an easy task, it might be advantageous to know what happens on the ZigBee network. For instance, say a viewer is watching a program on TV while recording another on a DVD player. From an RF4CE perspective, a few things should occur on the ZigBee network to accomplish this feat.

First, a "pairing" connection must occur between the TV and the remote control. Then another one must happen between the TV and the DVD on the available (mostly unused) channels from the designated channel 3 (15, 20, and 25). Subsequently, the viewer must command the remote control to choose the recording channel, set the DVD in recording mode, start the recording at the desired time, and choose the channel to watch.

All of these activities can be completed with the RF4CE remote control without pointing to either the TV or the DVD. Additionally, these functions might be completed from a tablet (notebook or laptop) that

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has access to the ZigBee network. The tablet would then command the remote control.

ZigBee RF4CE specifications require frequency agility. In other words, if a channel becomes noisy enough to interfere with a smooth operation as well as the existing pairing relationship between a remote control and a target, the remote control (or in some cases, the target) has to change its operations from the existing channel to another one. For this to happen without disturbing the current viewing, recording, or streaming activities, the initiator of the channel change must notify the other paired unit to also switch to that new channel.

Also known as Wi-Fi, the mechanism is required for access points working in the higher frequency band of 5 MHz, with channels higher than channel 13. This frequency band is high enough to detect a radar signal from a nearby airport or a moving vehicle that uses radar (such as police cars). Therefore, some ability to sense the interference and initiate a frequency change becomes necessary.

Compliance Testing

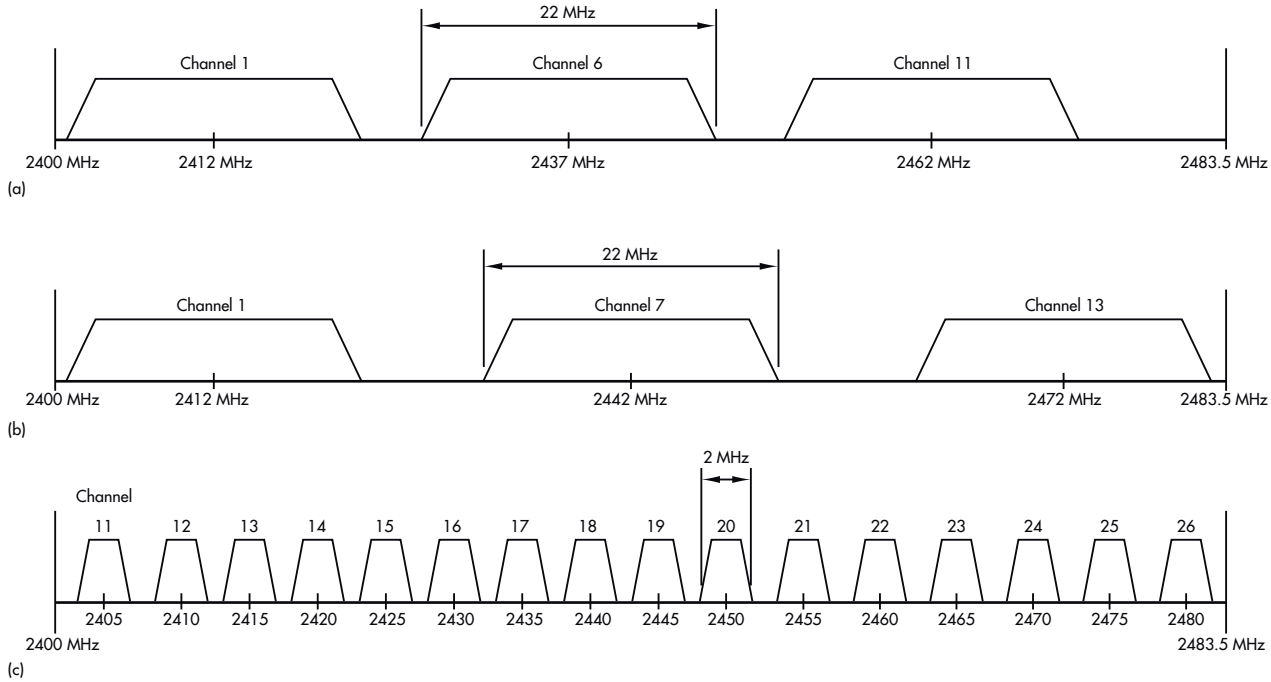
Compliance testing is an essential part of all new communications technologies. The goal is to ensure that all products match the standards and interoperate with one another (e.g., Wi-Fi). In this case, the ZigBee Alliance is sponsoring certification testing that will be performed by TÜV Rheinland.

The ZigBee RF4CE testing platform is based on IEEE 802.15.4, the media access controller/physical layer (MAC/PHY) radio technology in the 2.4-GHz unlicensed frequency band. The test program verifies functionality and interoperability across multiple vendors. Compliance allows manufacturers to quickly and easily develop products that operate worldwide, require low-power consumption, and provide instantaneous response time.

TÜV Rheinland has established ZigBee RF4CE test beds in Pleasanton, Calif., and Tokyo, Japan, for the certification of RF4CE products. The official certification leading up to the launch of these products to consumer outlets will happen in two phases.

First will be the certification of the "Profiles," which are designed and established by the chipmakers. These profiles will be the core that operates the RF4CE devices according to the ZigBee network specifications. The second phase will be the certification of the actual RF4CE products, i.e., the remote controls, TVs, DVD players, and other devices. The products to be tested for certification must be built on previously certified RF4CE platforms.

In the U.S., TÜV Rheinland participated in the official certification of the first two platforms, offered by Texas Instruments and Freescale Semiconductor, known now as the "Golden Units Platforms." TÜV Rheinland also successfully tested a future product that passed all platform testing requirements for certification in Japan. In the near future, the company expects RF remote controls to replace infrared as consumers' remote of choice. 3d



The operational channels for 802.11 Wi-Fi and 802.15.4 ZigBee overlap, which could cause interference problems. However, the RF4CE standard includes frequency agility in the remote control and its targets to mitigate this problem. Shown are the channel selections for IEEE 802.11b North America, non-overlapping (a), IEEE 802.11b European, non-overlapping (b), and IEEE 802.15.4, 2400-MHz PHY (c). *(source: IEEE 802.15.4-2003 Specification)*