ZigBee RF4CE and RemoTI FAQ

1 ZigBee RF4CE and ZigBee Alliance FAQ's

1.1 What is the difference between ZigBee, ZigBee PRO, and ZigBee RF4CE?

1.1.1 When referring to ZigBee or the ZigBee feature set, one is referring to the core ZigBee mesh networking protocol first finalized in 2006 and later updated with optional features including frequency agility and fragmentation.

1.1.2 The ZigBee PRO feature set is an enhanced mesh networking protocol that utilizes additional and/or alternative features including alternate addressing, many-to-one routing, high security, and much more. Please see FAQ#7 on the ZigBee website for more information. (http://www.zigbee.org/About/FAQ/tabid/192/Default.aspx).

1.1.3 Devices adhering to the ZigBee and ZigBee PRO feature sets can co-exist on the same network under the conditions that a ZigBee device only joins a ZigBee PRO network as an End Device (not as a Router or Coordinator), or vice-versa. A ZigBee router cannot be a router on a ZigBee PRO network and a ZigBee PRO router cannot be a router on a ZigBee network.

1.1.4 ZigBee RF4CE differs from ZigBee or ZigBee PRO in that it supports a simpler networking protocol focused on one-to-one and one-to-many communication. ZigBee RF4CE defines the network and application profile space, and is not meant to be interoperable with ZigBee or ZigBee PRO devices. A ZigBee RF4CE compliant device therefore cannot join a ZigBee or ZigBee PRO network under any conditions, and vice versa.

1.2 When will the ZigBee RF4CE specification be available?

1.2.1 The ZigBee RF4CE specification, originally ratified and approved by the RF4CE consortium, has been converted to a formal ZigBee document and is available today for ZigBee Alliance Members on the ZigBee Alliance website (www.zigbee.org). The Remote Control profile, ZigBee RF4CE's single public profile to date, is also available as part of the ZigBee RF4CE specification. Presently the RF4CE specification is only available to members of the ZigBee Alliance, but should be made available to non-members at some time in the not too distant future.

1.3 If I would like my device to be truly interoperable, what public profiles are available for specific markets?

1.3.1 RF4CE: If you would like to build a product to support RF4CE and the RF-based remote controls consumer electronics market, RemoTI, our ZigBee RF4CE compliant protocol stack supports the Remote Control (formerly CERC - Consumer Electronics Remote Control) profile which ensures interoperability for basic discovery, pairing, and control commands.

1.3.2 Home Automation: If you would like to build a product to support a ZigBee Home Automation device you can utilize TI's ZigBee compliant Z-Stack, coupled with the interoperable Home Automation Profile, to ensure interoperability of your HA device. Z-Stack and HA work on our MSP430+CC2520 dual-chip, and CC2530 System-on-Chip devices.

1.3.3 Smart Energy: If you are interested in building a fully compliant, fully interoperable Smart Energy solution TI offers Z-Stack and our Smart Energy profile w/ sample code as a quick and easy solution to getting a Smart Energy product to market fast. Z-Stack w/ ZigBee PRO and Smart Energy profile is supported on our MSP430+CC2520 and CC2530 platforms.

1.4 Will RF4CE compete with ZigBee Home Automation?

1.4.1 ZigBee Home Automation and ZigBee RF4CE w/ the Remote Control profile should not be thought of as competing technologies. ZigBee RF4CE will initially focus on the consumer electronics market, and provides a simple, robust, standardized communication protocol for remote controls and the devices they control. ZigBee Home Automation, on the other hand, provides a more feature rich, multi-hop communication protocol that is designed to scale to support a more diverse application space. Applications that come to mind include lighting control and security. ZigBee Home Automation and ZigBee RF4CE are also complementary in the sense that a ZigBee HA device could communicate across a bridge or through a gateway to a ZigBee

RF4CE device, and vice versa. I believe only time will further clarify the exact relationship between these two solutions.

1.5 What is the Remote Control profile?

1.5.1 The Remote Control profile is built on top of ZigBee RF4CE to support specific methods of device discovery and push button pairing, and provides a common command set for basic consumer electronics devices including the HDMI CEC commands. Remote Control has been kept simple to ensure code size and complexity is kept to a minimum.

1.6 How do I obtain IEEE addresses for my product

1.6.1 A range of IEEE addresses can be purchased from the IEEE organization (www.ieee.org). You can obtain 2^40 addresses for a relatively nominal fee. Additionally the CC2530 comes pre-programmed with a unique IEEE address, taken from the pool of Texas Instrument's allocated addresses, which can be used in your product.

1.7 What is the certification process for RF4CE?

1.7.1 Certification for ZigBee RF4CE Remote Control, ZigBee Smart Energy, ZigBee Home Automation, or any ZigBee product follows the same rules, procedure, and costs. Please review the certification process on the ZigBee Alliance website (http://www.zigbee.org/Products/CertificationProcess/tabid/235/Default.aspx)

1.8 Where can I get more information on ZigBee RF4CE

1.8.1 Please visit www.zigbee.org/rf4ce and www.ti.com/remoTI for more information on RF4CE and TI's RemoTI solution.

1.9 Does RF4CE have built in support for interference avoidance

1.9.1 ZigBee RF4CE employs a frequency agility mechanism supported by all nodes in the network. Should the channel become compromised due to some external source of interference, the target device will switch channels and begin communication on an alternate clear channel. The controllers, being aware of the frequency agility feature, either already send on the alternate channel if they are configured for multi-channel communication or will recognize that the frequency agility mechanism has been triggered and will re-configure to operate on the newly selected channel.

1.10 What topologies does RF4CE support?

1.10.1 One to one, many to one, and many to many pairing is possible

1.10.2 Multiple PAN's can co-exist and interact (allowing target to target communication)

1.11 What device types exist in RF4CE?

1.11.1 An RF4CE network is a fully peer-to-peer system with direct communication between devices. There are two logical device types in RF4CE, a Target and a Controller. A target device is usually the recipient of commands and is intended to be used in application like a TV or Set Top Box. A controller device is usually the issuer of commands and is intended for use as a remote control device.

1.11.2 It should be noted that although ZigBee RF4CE was designed with the consumer electronics market in mind, there is no reason that the networking protocol should not be used for other products in different markets where a low-cost, low-power, light-weight star or peer-to-peer networking protocol is required. One can think of ZigBee RF4CE as the 802.15.4 MAC protocol with additional support in the higher layers for advanced functionality that may be of interest across a diverse application space.

1.12 What is pairing and how is it used?

1.12.1 A pairing is a logical link between two nodes at the application layer. It is mandatory to create a pairing link before two devices can exchange application level packets. Typically a pairing is created between a Target and a Controller, however it is also possible to pair two Target devices.

1.13 What channels does RF4CE operate on

1.13.1 ZigBee RF4CE uses channels 15, 20, and 25 from the standard IEEE 802.15.4 channels, chosen to avoid the most interference from existing 2.4GHz devices such as 802.11b/g/n. Please see the developer's guide and application notes on the RemoTI product folder page for additional information.

1.14 What data transmission options are available when using RF4CE?

1.14.1 The RF4CE protocol supports several transmission options that are available to the application when requesting a packet transmission. These include ACK / No Ack, Unicast / Broadcast, and Multi Channel or Single Channel. These can be used in various combinations dependent on desired system wide behavior. Please see the RemoTI Developer's Guide for more information.

1.15 Does RF4CE support power savings

1.15.1 RF4CE supports power savings on both the target and controller devices. To simplify application development, RemoTI additionally has automatic power savings features on both the Target and Controller devices. On a controller the device is normally the initiator of communication and therefore under normal operating conditions will remain in a low-power standby state until a button press or other stimulus triggers communication or configuration into a receive mode. On a target, the usual recipient of packets, the radio receiver is normally turned on but can optionally be put into a low power state where the receiver is duty cycled between stand-by and receive mode, adding to the latency of communication but reducing power consumption significantly.

1.15.2 Controllers simply turn off when no buttons are being pressed

1.15.3 Targets must use power save when in standby, but must periodically wake up (duty-cycle) to ensure an appropriate response time

1.16 Does RF4CE support security and/or secure communication

1.16.1 The RF4CE protocol stack provides built in security at the network layer which is utilized for communication between paired devices. This security mechanism provides privacy in the way of encrypting application layer payloads, message integrity which provides a message integrity check to prevent modification of the contents of a message, as well as replay protection to prevent the same packet from being recorded and retransmitted at a later time. The CC2530 supports hardware AES and CCM engines as well as a hardware random number generator used to implement these RF4CE security features.

1.17 Does RemoTI have to be used for remote control and consumer electronics?

1.17.1 ZigBee RF4CE and therefore RemoTI is by no means limited for use in the remote control / consumer electronics space. Although ZigBee RF4CE was designed with the consumer electronics market in mind, there is no reason that the networking protocol should not be used for other products in different markets where a low-cost, low-power, light-weight star or peer-to-peer networking protocol is required. One can think of ZigBee RF4CE as the 802.15.4 MAC protocol with additional support in the higher layers for a clean and easy to use interface along with advanced functionality that is of use across a diverse application space.

1.17.2 Additionally although the single profile, Remote Control, is even more specific to consumer electronics and remote controls, there is no reason that this profile could not be used – potentially with modifications – for other applications as well. However it should be noted that any

modifications to this profile would render the product non-certifiable as an RF4CE logo compliant product.

1.18 How can I learn more about ZigBee RF4CE

1.18.1 RF4CE documents are available to ZigBee Alliance members (specification, Remote Control profile, Vendor ID list, Device Type List, Profile ID list, Technical and Compliance Overview) through the ZigBee Alliance website.

1.19 Are there any competing RF remote standards out there?

1.19.1 There are no mature competing standards to date, but multiple proprietary solutions exist. RF4CE solves this problem by standardizing for this market.

1.19.2 The existing Bluetooth standard could be thought of as competition to RF4CE, although from the standpoint of power consumption and number of devices supported Bluetooth is not a very good solution for consumer electronics and remote controls.

2 RemoTI SW and Tools

2.1 What is RemoTI?

2.1.1 RemoTI is TI's industry leading RF4CE-compliant software architecture. RemoTI is built on TI's well proven IEEE 802.15.4 compliant TIMAC, and offers a simple, easy-to-use, intuitive software architectural framework with all of the tools, documentation, and support needed to build an RF4CE compliant product. For more information on RemoTI and the ZigBee RF4CE protocol please visit www.ti.com/RemoTI.

2.2 When will RemoTI be available and what does it cost?

2.2.1 RemoTI has been officially released on April 30th, 2009, the same day as the CC2530 RTM. Please visit www.ti.com/RemoTI to learn more about RemoTI and the CC2530, download the stack, order your development kit, and get started building your RF4CE-compliant product. RemoTI is FREE of charge and available for download to everybody.

2.3 Is RemoTI RF4CE compliant?

2.3.1 RemoTI, TI's RF4CE-compliant protocol stack, is a golden unit for the ZigBee RF4CE protocol which means that TI provides the stack to which other stack vendors, wishing to certify their ZigBee RF4CE platforms, will have to test against and comply with.

2.4 What is the code size of the RemoTI stack?

2.4.1 RemoTI w/ peripheral support and a small remote control or consumer electronics application fits into the 64K FLASH version of our latest IEEE 802.15.4 compliant SoC, the CC2530. For more complex applications you can utilize the larger memory size versions of the CC2530 (128K or 256K), or take advantage of the RemoTI network processor that loads onto the CC2530 and is driven over SPI or UART by any host processor (e.g. MSP430) of your choosing.

2.5 What is a Network Processor and how can I use this in my design to make product development easy?

2.5.1 The RemoTI network processor encapsulates the RF4CE compliant stack and Remote Control profile into an easy-to-use black box. When being used as a network processor the CC2530 is loaded with the RemoTI Network Processor stack project exposing a simple, intuitive API over the SPI or UART interface provided on the CC2530. Product development then consists of implementing your application (e.g. TV or STB) on a host processor, utilizing the CC2530 and RemoTI network processor for networking and communication.

2.6 What is the RemoTI-CC2530DK and when will it be available on the market?

2.6.1 The RemoTI-CC2530DK is the RF4CE remote control form factor development kit providing everything necessary to get a ZigBee RF4CE compliant product to market fast. The RemoTI-CC2530DK kit is available today for $149. Please visit *www.ti.com/rf4ce* for more information.

2.7 With this REMOTI-CC2530DK, will I be able to develop a prototype product compliant to the RF4CE standard and at the same time add in some of my own software stack?

2.7.1 The RemoTI-CC2530DK provides the hardware needed (and pre-loaded sample demo code) for an RF4CE solution. With the kit in hand, you can then go to the RemoTI webpage (*www.ti.com/remoTI*) to connect to a website where you can download the RF4CE compliant stack. If you develop a product based on RemoTI, it will be RF4CE compliant at the network layer. We also will provide the Remote Control profile so that you can adhere to the RF4CE public application profile and ensure your device will pass certification and remain interoperable. In addition the Remote Control profile allows for manufacture specific extensions so you can add your own "special sauce" as desired, while still remaining compliant. The full details regarding the process to bring a compliant product to market are available on the ZigBee alliance website. If you are not already a ZigBee Alliance member please make sure to join as this will be required to release an RF4CE compliant product to market.

2.8 With the purchase of REMOTI-CC2530DK, will I have the full implementation of the RF4CE software stack source code or what I will get is only the API to develop a RF4CE standard application?

2.8.1 The RemoTI stack provides the core RF4CE stack in object form. Building on this network protocol, the RemoTI stack provides two layers of interfaces, RTI and RCN. The RCN API is the direct interface to the RemoTI RF4CE stack. RTI is the RemoTI API which provides an interface to an application framework to simplify application development. The RTI application framework is implemented using the RCN API, and removes some of the RCN layer complexity. The RTI application framework is restricted to supporting the (currently only) RF4CE profile, Remote Control, with regards to certain features such as discovery and pairing. The RCN API is optionally provided so that customers can build their own application on top of the RCN API directly to leverage full flexibility at the network layer interface such as to perform non Remote Control profile discovery and pairing.

2.9 Is there any power profile available stating the power consumption of a RF enabled remote control (in this case the 2.4Ghz RF) in comparison with the traditional IR remote control?

2.9.1 On the RemoTI product folder page an application note is available showing the power consumption calculation of RF4CE and RemoTI on the CC2530. The use-case has been selected based on a "typical" usage model, but all information is provided to allow a customized analysis. We do not compare directly to IR as we show that the RF portion of power consumption is minimal with respect to the power consumption of a typical remote control and therefore should not be a barrier toward adopting RF into your design.

2.10 What is the supported data rate from remote to receiver when using RemoTI and RF4CE?

2.10.1 RF4CE / RemoTI is designed for relatively low bandwidth applications and does not support the streaming of video or even audio. The raw data rate of the IEEE 802.15.4 PHY, the foundation for RF4CE, is 250kbps, but with overhead, contention on the medium, back off, and general fair play, application throughput for any two paired devices communicating should be on the order of sending smaller amounts of data less frequently. An application on utilizing RemoTI for higher data rate applications is provided on the RemoTI development kit product folder page.

2.11 Can I have a more detail datasheet or specification on REMOTI-CC2530DK?

2.11.1 All documentation is available on the RemoTI website. Please check *www.ti.com/rf4ce* periodically for the latest update.

2.12 Does TI provide a packet sniffer for RF4CE?

2.12.1 Our RemoTI solution includes a basic PC packet sniffer application that runs on our SmartRF05 + CC2530EM boards, as well as our CC2531EM dongle. The packet sniffer allows one to monitor communication across all three RF4CE channels, gathering crucial data for development and debugging. More information is available at *www.ti.com/rf4ce*.

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Mailing Address: Texas Instruments, Post Office Box 655303, Dallas, Texas 75265
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