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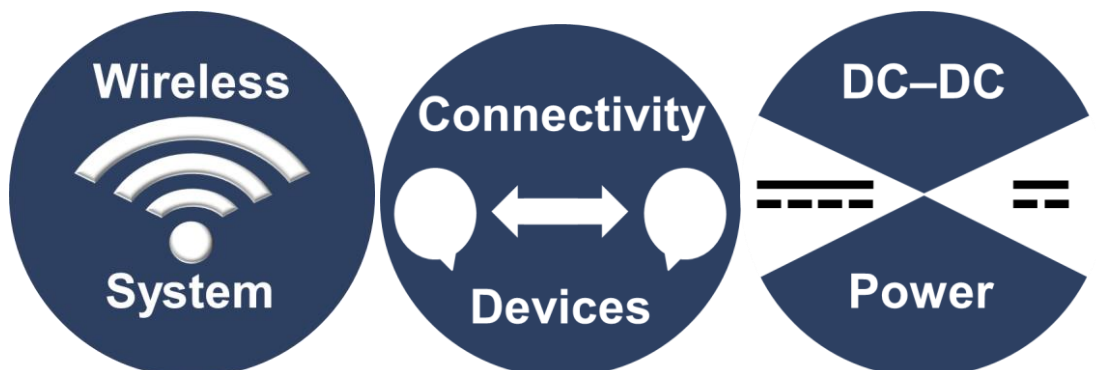
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Strata Enabled
Zigbee Green Power Energy Harvesting Kit
User Guide

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Introduction

The STR-NCS36510-ZB-EH-x-GEVK is a Strata-enabled kit that demonstrates the use of NCS36510 in a battery-free Zigbee Green Power application. The kit consists of one USB device, which is the Zigbee Coordinator (ZC) and interfaces with Strata, and two energy-harvesting nodes, which act as Zigbee Green Power Devices (ZGPD). By pressing the switch on each of these devices, energy is generated and used to power the NCS36510 module. Upon booting, the module sends out Zigbee Green Power frames to control the rendered smart home scene in the Strata PC application. One switch acts as a battery-free light switch, which controls the lighting in the scene when pressed. The other switch represents a door sensor, and when pressed will open and close the door in the scene.
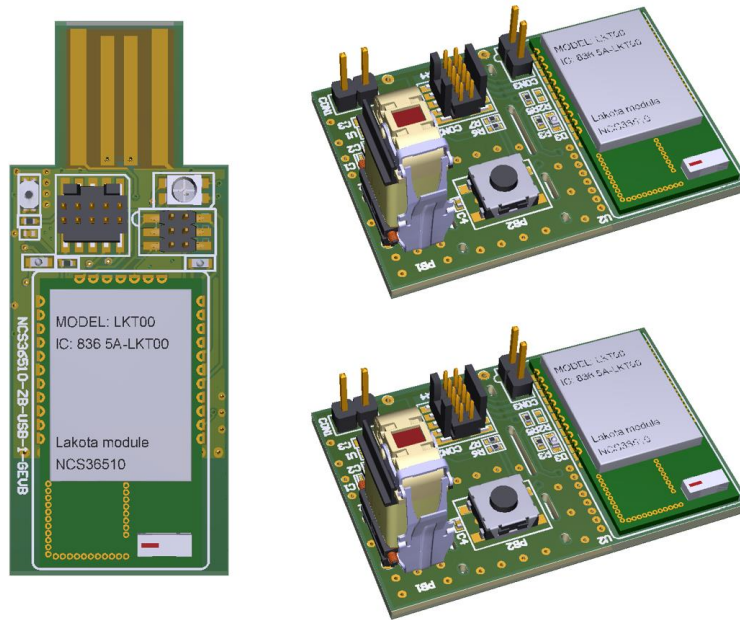
Figure 1: Zigbee Green Power Strata Kit Contents

Device Features

- 2.4 GHz IEEE 802.15.4 module Pre-Certified with FCC and Zigbee PRO R21
- Firmware based on the DSR ZBOSS Zigbee 3.0 & Zigbee Green Power Stacks
- 32-bit ARM Cortex−M3 Processor
- Ultra-Low Transmit Power Consumption (as low as 6.9 mW)
- Ultra-Low Receive Power Consumption (as low as 6.6 mW)
- Multiple Sleep Modes (Including 0.65 µA Coma Mode Sleep Current, 0.18 µA Coma Mode Leakage Current)
- Embedded Memory Configurations (640 kB FLASH and 48kB RAM)
- Exceptional Receiver Sensitivity of -99 dBm
- Programmable Output Power Up to ~8 dBm

Applications

- IEEE 802.15.4 Zigbee / 6LoWPAN / Thread Wireless Applications
- Smart home – Security, Automation, and Lighting
- Building and Industrial Automation

User Guide

This section provides an overview of the example application and how it functions, as well as instructions for setup and use.

System Overview

This kit consists of three boards: one USB dongle and two energy harvesting switches. The USB Dongle (NCS36510-ZB-USB-GEVB) is programmed with firmware that uses the DSR ZBOSS Zigbee 3.0 library, and is configured to be a Zigbee Coordinator (ZC). This device also interfaces with the Strata PC application via a JSON API, which is accessed via the FTDI USB-UART adapter. The Energy Harvesting Switch (NCS36510-ZB-EH-SWITCH-GEVB) is programmed with firmware to function as a Zigbee Green Power Device (ZGPD). It uses a ZF AFIG-0007 generator to provide power to the NCS36510 module via a rectifier and regulator. Each time the switch is pressed, a Zigbee Green Power "Toggle" command is sent from the ZGPD to the ZC. The Block diagram is shown below in Figure 2.

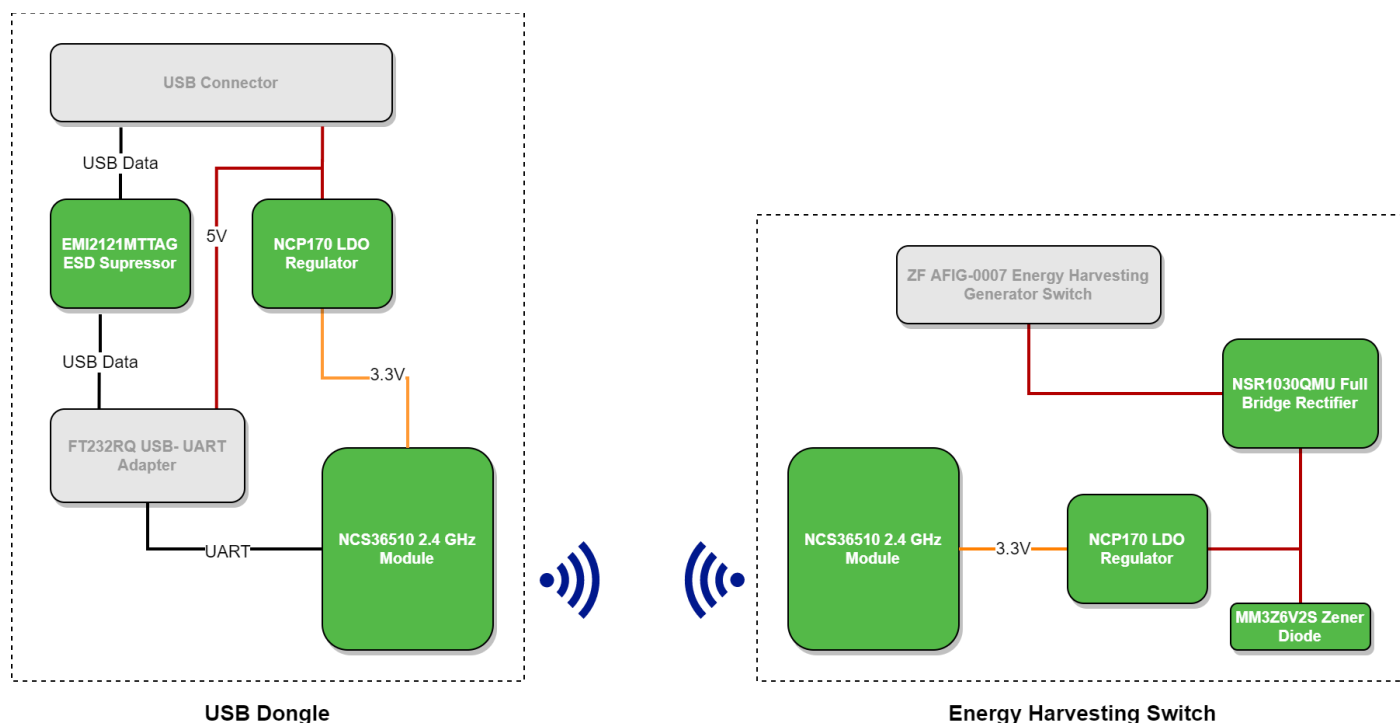**USB Dongle**   **Energy Harvesting Switch**

Figure 2: System Block Diagram

Figure 3 shows the correct method to press the ZF switch to activate the ZGPD device. Figure 4 illustrates the process by which the electrical current is generated. The negative voltage pulse generated by the "release" phase is rectified using the NRS1030QMU device.
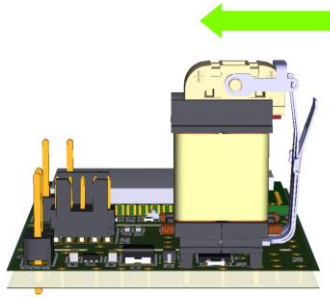
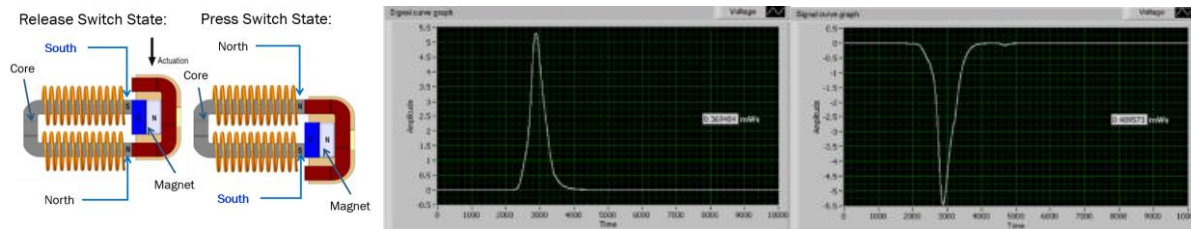**Figure 3: Operation of the ZF Energy Harvesting Switch**

Figure 4: Energy Harvesting Power Generation

These pulses charge a 33 uF capacitor, which feeds an NCP170 LDO, which provides a 3.3V supply to the NCS36510. As the charge is consumed, the voltage gradually decreases until the NCS36510 device powers down. This results in approximately 17 ms of available "run time" for the device. The startup of the device occurs in less than 5.6 ms, and a single ZGP frame is immediately transmitted. After transmission, the ZGPD switches to receive mode to listen for an 802.15.4 ACK from the ZC. Once received, the radio is powered down and an LED is illuminated until the available power is exhausted. If no ACK is received, the ZGPD will repeat the transmission / receive cycle as many times as possible. The DC current supply and consumption waveforms are shown below in figure 5.
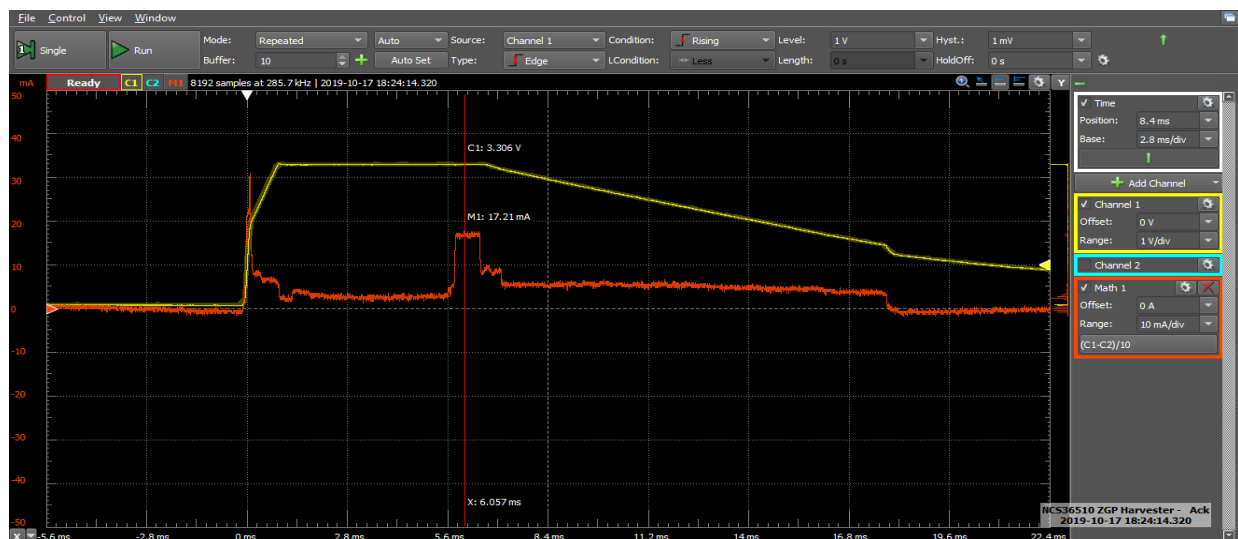

Figure 5: Waveforms of Regulated Supply (Yellow) and Device Current Consumption (Red)

Hardware Setup

This kit has been prepared so that each of the boards are programmed and the ZGPD nodes are commissioned with the ZC. To start this application, follow these steps:

1. Download the latest version of Strata from https://www.onsemi.com/support/strata-developer-studio
2. Open the Strata PC application and log in.
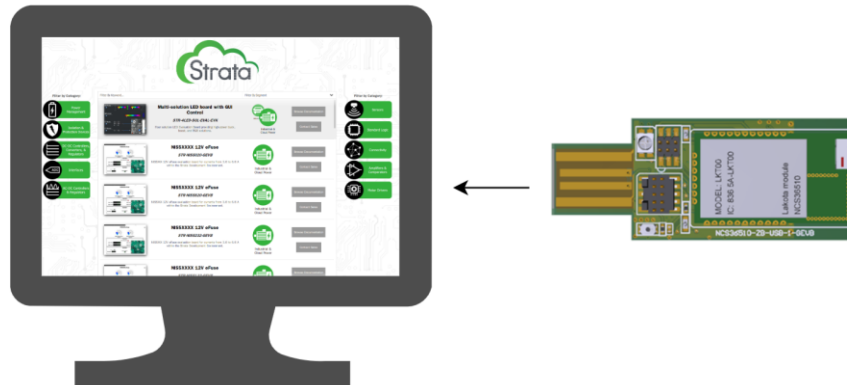3. Connect the USB dongle (ZC) to the computer as shown in figure 6.

Figure 6: Hardware Setup

User Interface

Once the ZC device is connected to the PC via USB, the NCS36510 Zigbee Smart Home UI displayed in Figure 7 will appear. This window contains a rendered scene of a modern smart home, and simulates both a Zigbee 3.0 lighting system and a security sensor on the door. Clicking one switch will toggle the lights on/off, and clicking the other will render the door open or closed.
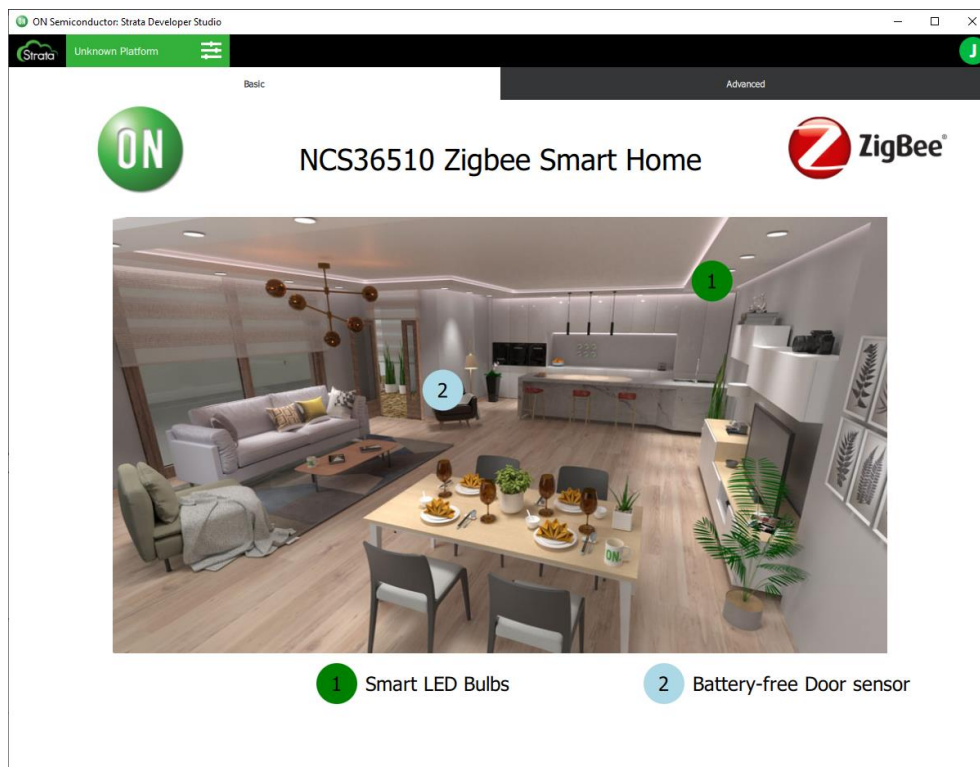
Figure 7: Main UI View

The Advanced tab displays a live feed of debug messages being sent from the Strata-enabled ZC device to Strata. This is shown in Figure 8.


Figure 8: Advanced UI View

Programming

While these devices come programmed with the firmware for the Strata application, they can be re-programmed and used as part of custom Zigbee 3.0 application development. Please refer to the NCS36510 Zigbee SDK User Manual for additional information on setup and use of the Zigbee SDK. This is available as part of the Zigbee SDK, downloadable from the NCS36510 product page. This section details how to use the included files from the Strata content tab to restore the Zigbee Strata application onto the kit hardware.

The following items are needed:

- Strata firmware, available in the Downloads section of the Platform Content tab of Strata
- J-Link debugger, with Jlink.exe installed and included in the system PATH variable
- 3.3V DC power supply

To flash the devices, follow the steps listed below:

Zigbee Coordinator:

1. Insert the board into a USB slot and connect to the J-Link as shown in Figure 9
2. Open Windows command prompt, and navigate to the STR-NCS36510-ZB-EH-GEVK_firmware_images directory
3. Execute the following command: "erase_nvram.bat"
4. Execute the following command: "load_custom_firmware.bat ./bin/light_zc_combo.bin"
5. Once flashing completes successfully, disconnect the board from the PC

Figure 9: J-Link connection to USB Board

Zigbee Green Power Harvesting Switch

1. Connect the J-Link to the board as shown in figure 10.
2. Power the board with a 3.3V DC supply, as shown in figure 10.
3. From the Windows Command prompt, at the same location as above, execute the following two command to update the bootloader for the ZGPD device: "load_bootloader.bat"
4. For one of the ZGPD boards, run the following command to load the firmware "load_custom_firmware.bat ./bin/zgpd_on_off_0x16.bin"
5. Repeat for the second ZGPD board, but with the other binary: "load_custom_firmware.bat ./bin/zgpd_on_off_0x16.bin"
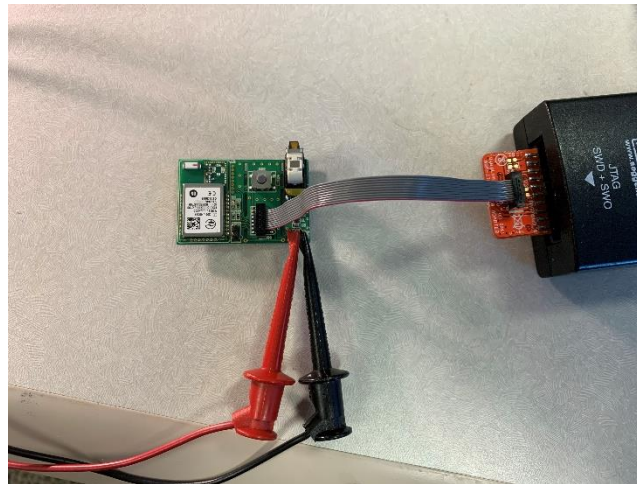
Figure 10: J-Link connection to USB Board

After programming, commission the switch nodes with the coordinator:

1. Plug in the coordinator
2. Wait 20 seconds for ZGPD commissioning to begin
3. Click one ZGPD switch. The LED on the ZC should toggle
4. Wait for the LED to change states again, indicating that the ZC is ready to add the second device
5. Click the other ZGPD switch. The LED on the ZC should toggle
6. The system is now ready for use with Strata

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