TI Designs
CC2540 Bluetooth Low Energy USB Dongle

TEXAS INSTRUMENTS

TI Designs

TI Designs provide the foundation that you need including methodology, testing and design files to quickly evaluate and customize the system. TI Designs help **you** accelerate your time to market.

Design Resources

TIDC-CC2540-BLE-USB	Design Folder
CC2540	Product Folder
TPS76933	Product Folder
CCDebugger	Product Folder
BLE Stack	Tools Folder
BLE SW Developer's Guide	Documentation
BLE Wiki	Wiki

TI E2E™ Community

Ask The BLE Experts
TI E2E BLE forum

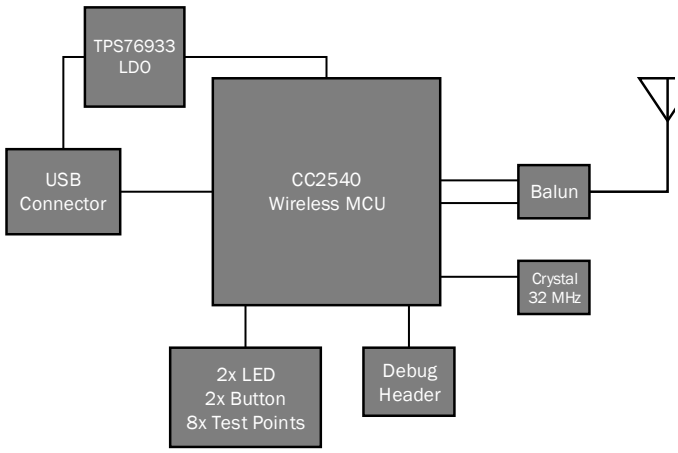
Design Features

- Enables Bluetooth Low Energy in systems with existing USB
- Debug and Development Capabilities
- PCB Antenna
- Small Integrated Balun

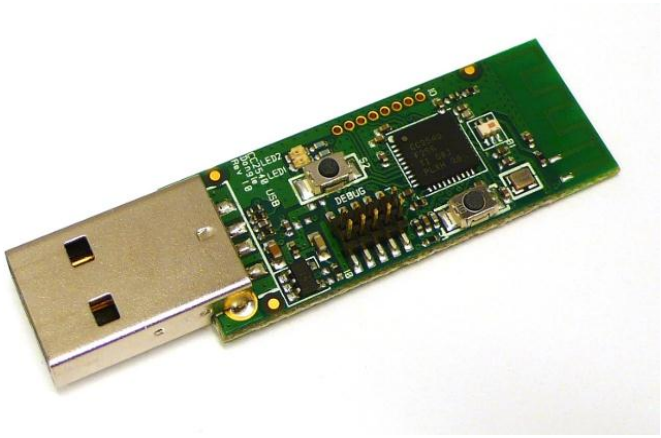
Featured Applications

- PC
- Home Automation
- BLE Beacon
- Development Tool

Block Diagram:



Board Image:



1 Key System Specifications

The CC2540 USB Dongle TI Design shows how you can easily connect the CC2540 low-power Wireless MCU with integrated USB to any system with existing USB host. The design is realized as a USB dongle which can be connected to any computer, but the design can also be integrated directly into systems such as Set-Top boxes.

The reference design demonstrates recommended layout for decoupling and the RF part to achieve best RF performance. An integrated balun is used due to board size constraints. Similarly a small-size, yet high performing, PCB antenna is used.

The USB Dongle additionally contains 2 push buttons, 2 LEDs, and 8 test points connected to GPIOs. There is also a debug header on the board which connects directly to the CCDebugger or SmartRF05EB for programming and debugging. All this makes the CC2540 USB Dongle well suited for SW development.

2 Block Diagram

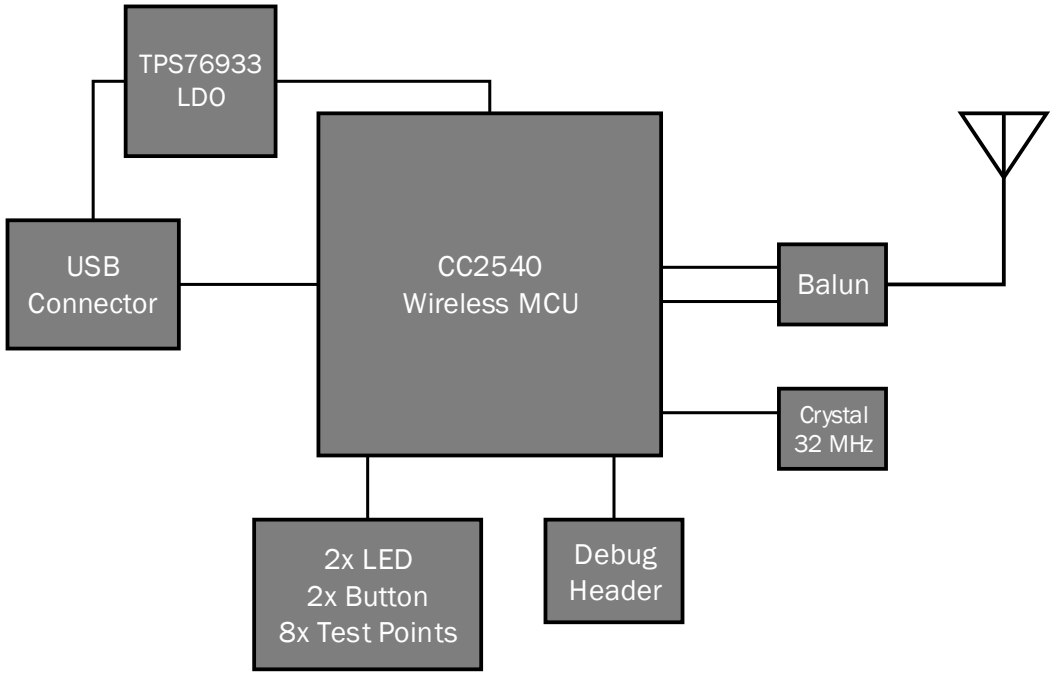


Figure 1: CC2540 USB Dongle Block Diagram

3 System Description

The CC2540 USB Dongle connects the CC2540 directly to a USB connector. The 5 V USB power rail is regulated down to 3.3 V through a TPS76933 low Iq, Low-Dropout regulator, to supply the CC2540.

3.1 CC2540

The CC2540 is a cost-effective, low-power, true system-on-chip (SoC) for *Bluetooth* low energy applications. The CC2540 combines an excellent RF transceiver with an industry-standard enhanced 8051 MCU, up to 256 kB in-system programmable flash memory, 8 kB RAM, and many other powerful supporting features and peripherals.

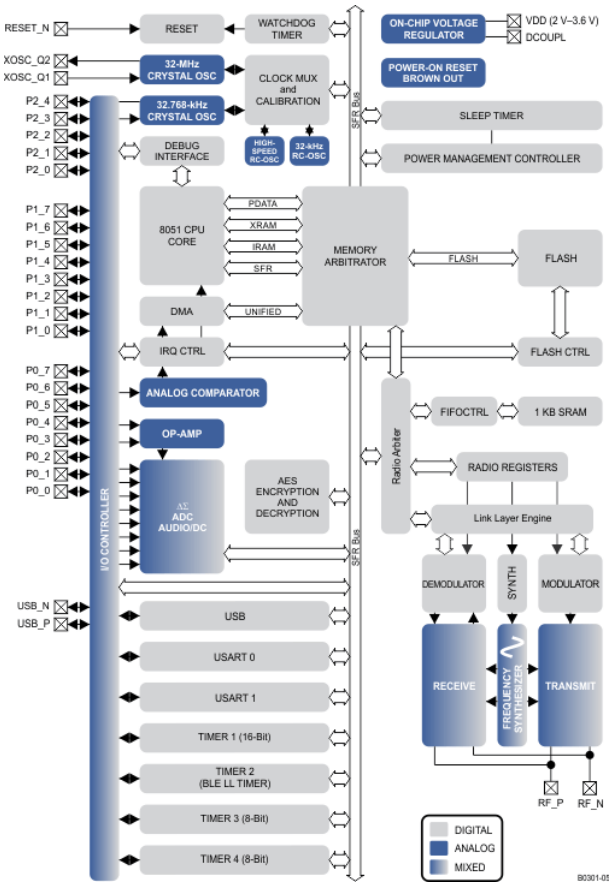


Figure 2: CC2540 Block Diagram

3.2 TPS76933

The TPS769xx family of low-dropout (LDO) voltage regulators offers the benefits of low dropout voltage, ultralow-power operation, and miniaturized packaging. These regulators feature low dropout voltages and ultralow quiescent current compared to conventional LDO regulators. Offered in a 5-terminal small outline integrated-circuit SOT-23 package, the TPS769xx series devices are ideal for micropower operations and where board space is at a premium.

4 Getting Started Hardware

The CC2540 USB Dongle can be used as is as a packet sniffer for Bluetooth Low Energy, as this is the SW the dongles are pre-programmed with when bought as an Evaluation Module Kit.

To use the USB dongle for other purposes, or for programming and SW development, a debugger is required. For this purpose either the CCDebugger or the SmartRF05 Evaluation Board can be used.

4.1 CC2540 USB Evaluation Module Kit

The CC2540 USB Dongle Evaluation Module Kit can be purchased from TI store here:
http://www.ti.com/tool/cc2540emk-usb

4.2 CCDebugger

The CCDebugger can be purchased from TI Store here:
http://www.ti.com/tool/cc-debugger

5 Getting Started Firmware

When purchased as an EMK the CC2540 USB Dongle comes pre-programmed with packet sniffer SW and will thus work with the free to download Packet Sniffer PC tool from Texas Instruments.

The TI BLE Stack download includes several pre-made SW examples for the CC2540 USB Dongle. The most versatile is the HostTestApp project. This will allow the USB dongle to receive an extended set of HCI commands. The dongle can then be used with the development tools (included in the BLE stack installer) BTool and Device Monitor.

The HostTestApp SW can also be used together with several of the PC (Windows and Linux) examples found on the TI BLE Wiki.

5.1 Subsection

Texas Instruments SmartRF Packet Sniffer PC Tool:
http://www.ti.com/tool/packet-sniffer

5.2 Subsection

Texas Instruments BLE Stack download page:
http://www.ti.com/tool/ble-stack

5.3 Subsection

Texas Instruments BLE Wiki article with PC examples:
http://processors.wiki.ti.com/index.php/CC254X_PC_Examples

6 Test Setup

The antenna radiation pattern is measured in a 3m RF shielded room (anechoic chamber), as shown in the picture below. The device under test (DUT) is programmed to transmit continuously and is then rotated both around its horizontal and vertical axis to create a full sphere antenna radiation pattern. The resolution used is 15 degrees.

The CC2540 USB Dongle was programmed to transmit 4 dBm at 2440 MHz in this specific test. The USB Dongle was connected to a battery pack when doing the measurements.

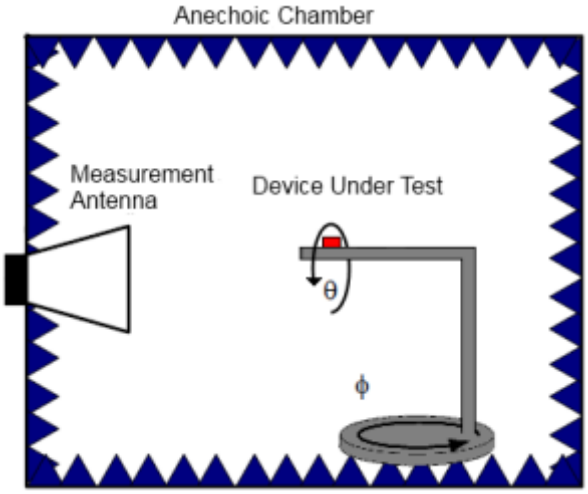


Figure 3: Radiation Pattern Test Setup

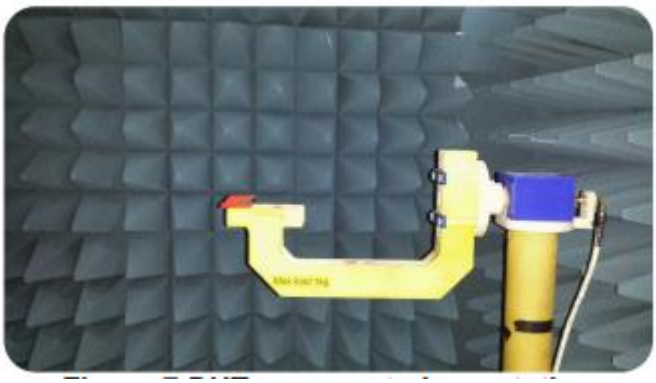


Figure 4: Anechoic Chamber DUT Placement

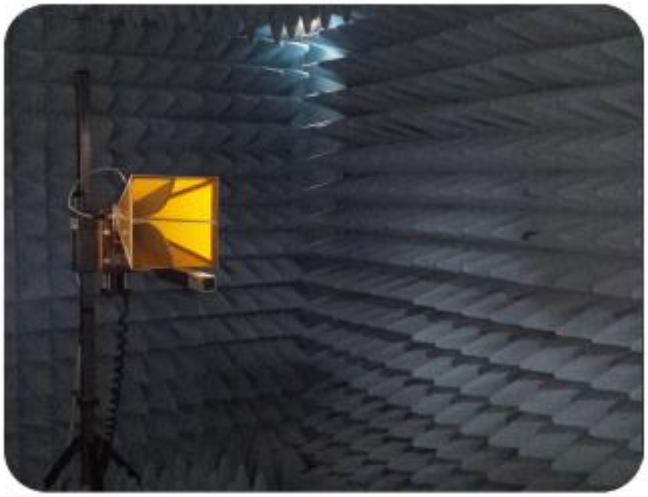


Figure 5: Anechoic Chamber Receive Antenna

7 Test Data

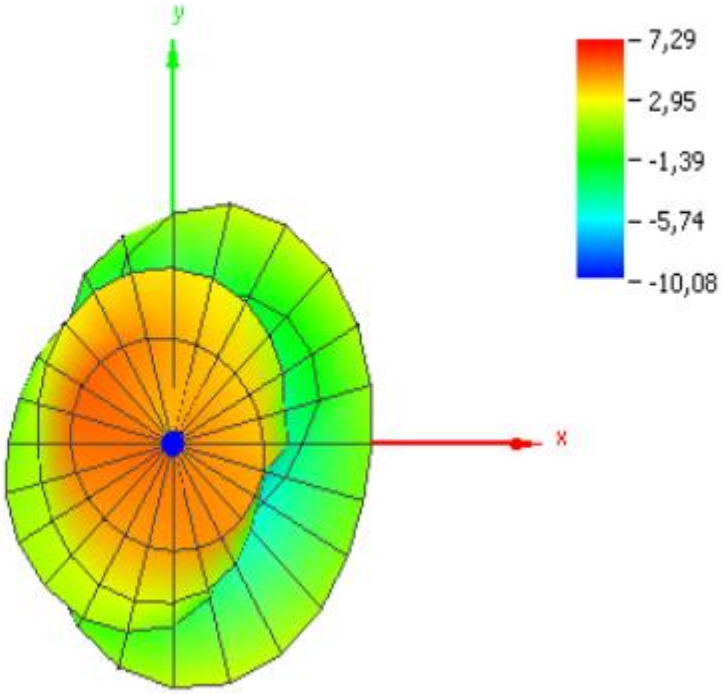
7.1 Radiated Performance

Total Radiated Power:	1,4	dBm
Peak EIRP:	7,3	dBm
Directivity:	5,9	dBi
Efficiency:	-2,6	dB
Efficiency:	55	%
Gain:	4,7	dBi

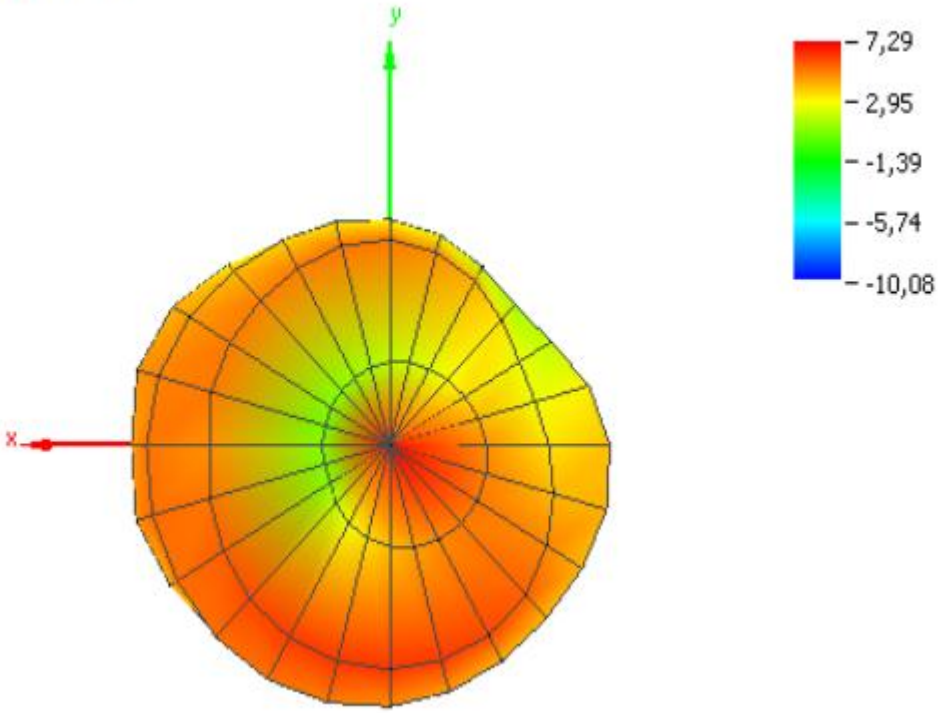
7.2 Antenna Pattern Plots

The next pages show the antenna pattern plots. The measurements are performed with the USB Dongle lying in the XZ-plane and the antenna pointing in the Z-direction. The component side of the PCB is in the positive Y-direction.

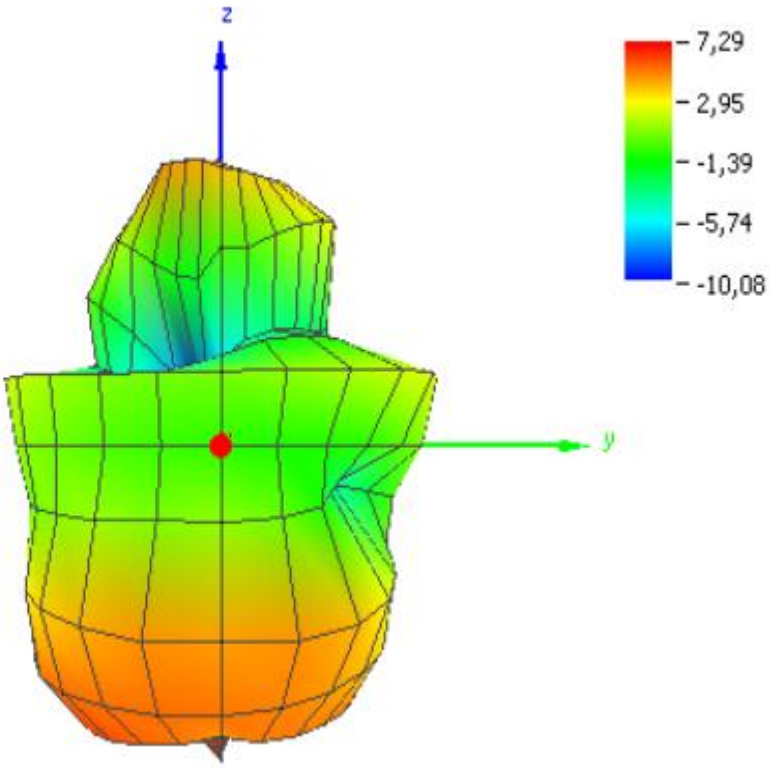
Theta = 0, Phi = 0



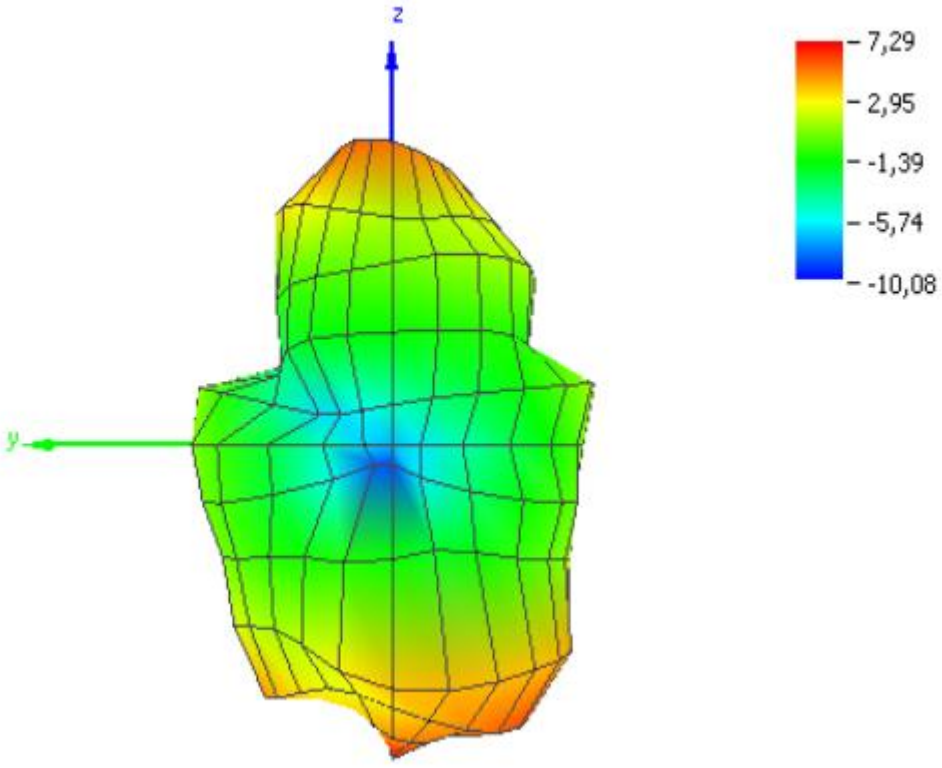
Theta = 180, Phi = 0



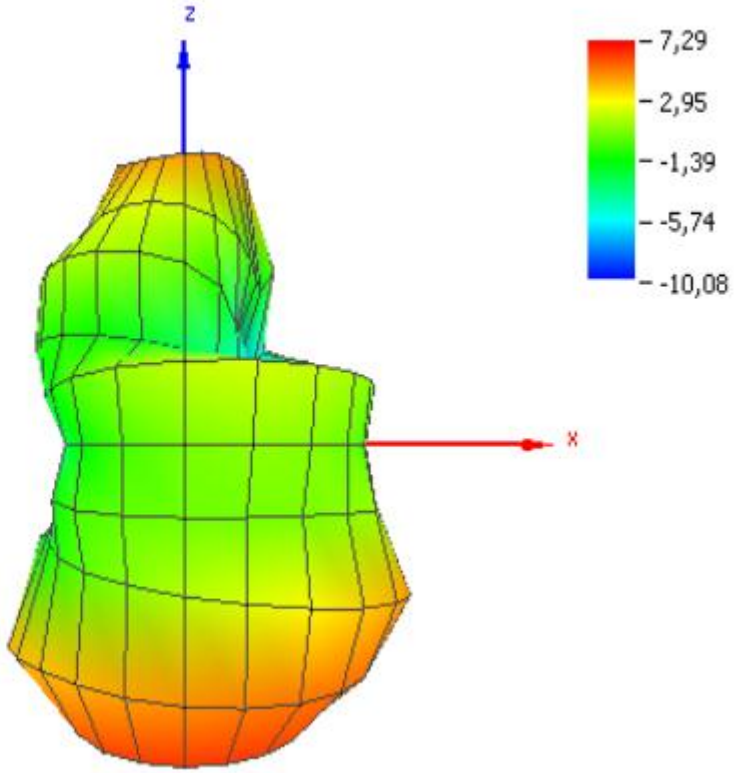
Theta = 90, Phi = 0



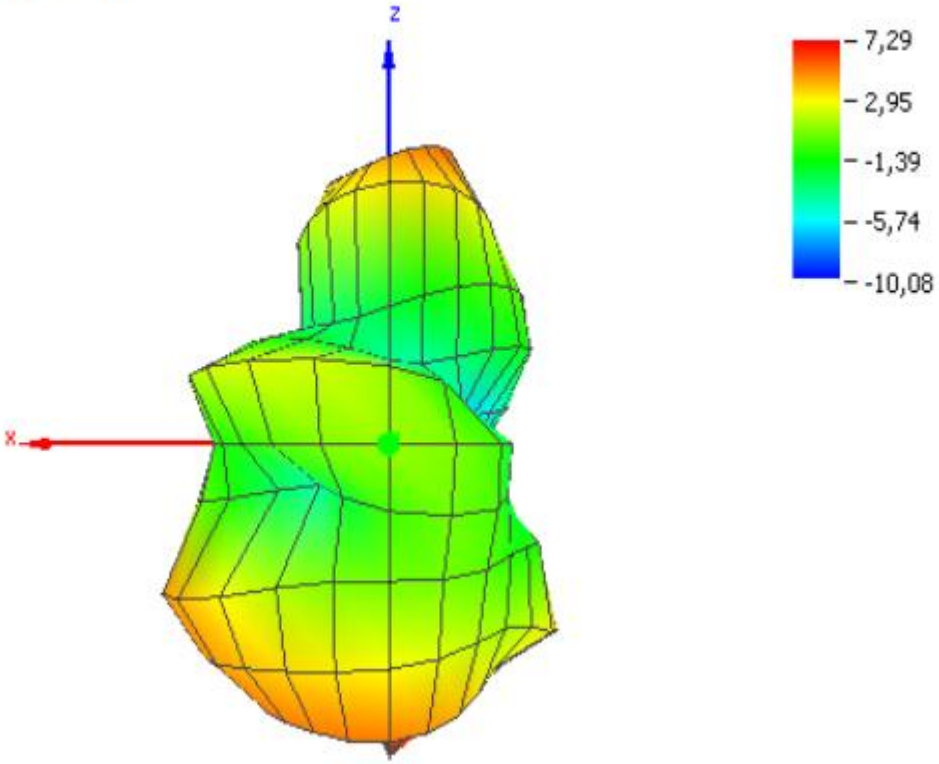
Theta = 90, Phi = 180



Theta = 90, Phi = 270



Theta = 90, Phi = 90



8 Design Files

All the design files for the CC2540 USB Dongle reference design are available for download from the TI Design page. The CAD tool used for this design is Zuken Cadstar.

9 About the Author

Fredrik Kervel is Manager for the Bluetooth Smart Applications team at Texas Instruments. Fredrik has more than 4 years' experience with developing and testing low power RF designs for 2.4 GHz systems (BLE / RF4CE / Zigbee / etc.). Fredrik earned his Master of Science in Electrical Engineering (MSEE) from the Norwegian University of Science and Technology (NTNU) in Trondheim, Norway.

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