433 modem user manual

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Introduction

This document provides instructions on how to safely install and use a 433 modem. Vecly suggest you adhere to the following recommendations in order to avoid personal injuries and/or property damage.

Target audience: 433 modem end users.

General

Licensing

CC-Bootloader and 433 modem test firmware are licensed under GNU GPL version 2. PCI Express is a trademark of PCI-SIG. SmartRF is a trademark of Texas Instruments.

Vocabulary

Term	Definition
EN	European Standard
ESD	ElectroStatic Discharge
ETSI	European Telecommunications Standards Institute
IEC	International Electrotechnical Commission
ISM	Industrial Scientific and Medical
SoC	Sysem-On-Chip
RoHS	Restriction of Hazardous Substances Directive

Regulatory, compliance and safety information

The modem has been designed to be operated on an unlicensed 433 MHz Industrial Scientific and Medical (ISM) frequency band and it complies with the ETSI standard EN 300 220-2 V2.4.1 for short range devices. NB! National and/or regional limitations on use might apply on this equipment. The modem meets the receiver category 2 requirements as outlined in ETSI standard EN 300 220-1 V2.4.1.

The modem has been designed to be used within an enclosure. When using this product, make sure that the enclosure complies with the Information Technology Equipment Safety requirements as defined in IEC EN 60950-1.

This modem has been tested and found to meet the limits of Class B information technology equipment as established in European standard EN 55022. This product may cause radio interference, in which case the user may be required to take independent action to overcome such interference.
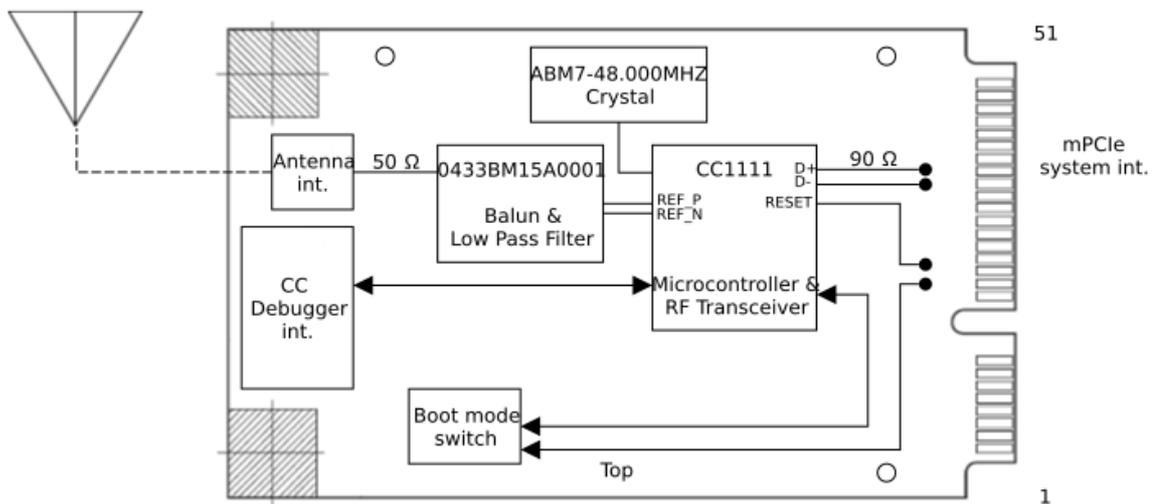
The 433 modem complies with the relevant provisions of the RoHS Directive of the European Union. Similarly to all electronic and electrical products, the 433 modem should not be disposed of in household waste.

Safe installation and operation instructions:

- **Study your national frequency usage regulations and restrictions before using this product.**
- **Do not exceed the maximum allowed transmission power, including the antenna gain.**
- **When using RF output power bigger than 7 dBm, please make sure that you are not causing unwanted emissions in spurious domain. Use additional filter if needed.**
- **Do not cause RF interference, specially when operating modem in areas where safety critical equipment is in use.**
- **433 modem contains ESD sensitive components. Handle it with care.**
- **Install and remove the modem only after electrical power has been disconnected and unloaded from the host device.**
- **Do not power the modem simultaneously via mPCIe system interface and CC Debugger interface. Use only either mPCIe or CC-Debugger interface.**
- **Make sure that the host device's mPCIe system interface pinout and voltage levels match the interface description in hardware specifications.**
- **Do not transmit without connected antenna or dummy load. Use 50 ohm antenna or dummy load.**
- **Vecly does not take any responsibility for third party products and accessories purchased and used separately.**
- **Do not dispose the modem in household waste. You can return it to Vecly for proper disposal.**

Product description

433 modem is an universal programmable radio transceiver for data communication. It can be used to receive data from various sensors and systems that operate on the 433 MHz ISM frequency band. The modem is equipped with a mini PCI Express system interface, therefore it can be installed to standard personal computers or network devices. The modem has been equipped with an open-source bootloader to allow the user to develop customised firmware. The SoC transceiver and micro-controller provide a well documented and standardised method for modem firmware development. Boot mode selector makes it possible to update firmware via bootloader's upgrade mode.

Installation and operation

Installation

The modem form factor is full size PCI Express Mini Card. This makes the installation easy and there is no need for dedicated tools. **NB! Please make sure that the host device's power is disconnected and power from CC-Debugger is not connected to the modem.** It is recommended to connect the antenna before powering the host device.

Bootloader

The modem comes with a modified CC-Bootloader and test firmware. The CC-Bootloader provides the option to deploy user code with the help of `bootload.py` Python script via USB interface available in mPCIe. Bootloader binary images, source code and bootload.py is available in Vecly public download site.

`bootload.by` usage is really simple.

For example, use the following commands do erase old user code, deploy new user code and run it.

```
$ bootload.py /dev/433-modem erase_all
$ bootload.py /dev/433-modem download firmware/m433-test-fw.ihx
$ bootload.py /dev/433-modem run
```

Help is available when running `bootload.py` without arguments.

To deploy the bootloader, you need Texas Instruments' CC-Debugger and Tag-Connect TC2050-IDC cable. Those items can be purchased from Vecly or from any other seller.

You can use the cc-tool or SmartRF Flash Programmer to deploy the bootloader to the modem. See respective tools' documentation for usage and help.

The modem is equipped with a Boot mode switch, which is used to control user code execution. **NB! Make sure that the switch is in the correct position depending on whether you want to deploy or run user code.** When deploying another bootloader or firmware, you need to keep in mind that the switch is connected to CC1111 `P1_2`.

The switch positions (from left on the CC-Debugger connector side) are the following:

Position	Function in CC-Bootloader
1	Connected to ground. User code is not run and can be updated.
2	Not connected. User code is run immediately.
3	Connected to mPCIe `W_DISABLE#`. User code run can be controlled from the host device.

Test firmware

The modem is shipped with test firmware. It enables the user to quickly try out functionality and troubleshoot the hardware.

Test firmware implements unmodulated transmission and reception, and FSK and QFSK data transmission and reception.

Data messages formats are compatible with Texas Instruments' SmartRF Studio 7. You can use a second modem that is connected to CC-Debugger and controlled by SmartRF Studio. SmartRF Studio configuration files are available in firmware download location in tooling directory.

When connected to the host device, the modem is exposed as serial port in USB. The device can be controlled via binary commands. For example, if the following binary command is sent to the modem, it responds with firmware name.

```
0x11 0x00 0x03
```

Any serial terminal capable of sending and receiving binary data can be used. For example: CoolTerm.

Test firmware and modem control protocol specifications are available on Vecly public download site.

Troubleshooting

The most common issues and solutions have been outlined below.

The modem does not turn on.

- Check that the power is on and that voltage is within the limits.
- Check that mPCIe PERST# (pin 22) is deasserted (high). It must have positive voltage to the Ground. This pin is connected to C1111 `RESET_N`. If the pin has not been deasserted, the modem will keep resetting. Generally, the mPCIe PERST# should be deasserted by the host device automatically, but there can be implementations where it is controlled manually by a PCI subsystem.

The modem is not recognised by a host device.

- Most likely there is no bootloader in the device. Use CC-Debugger and software mentioned above to read the modem flash and examine the read data. When it contains only zeros, there is no bootloader in the modem.
- Check that device drivers or respective kernel modules are loaded. The bootloader provided by Vecly exposes device as a communications device, a modem, via USB Communications Device Class Abstract Control Model (CDC-ACM).

User code does not run.

- Check that the boot mode switch is in correct position. It shall be in position 2 to run user code.
- Check that user code is in the device, by reading it from device. Start address shall be `0x1400`.
- User code can be faulty. Try to use the device with SmartRF studio to be sure that the hardware is in working condition.

Poor transmission or reception.

- Check that you are using the proper antenna designed for 433 MHz frequency band.
- Keep the antenna cable as short as possible.
- Move the device away from any other equipment which may cause interference.

In case of any other issues, contact the manufacturer (contact information below).

Manufacturer contact information

Vecly OÜ

Tallinn, Estonia.

Email: info@vecly.com

Homepage: www.vecly.com