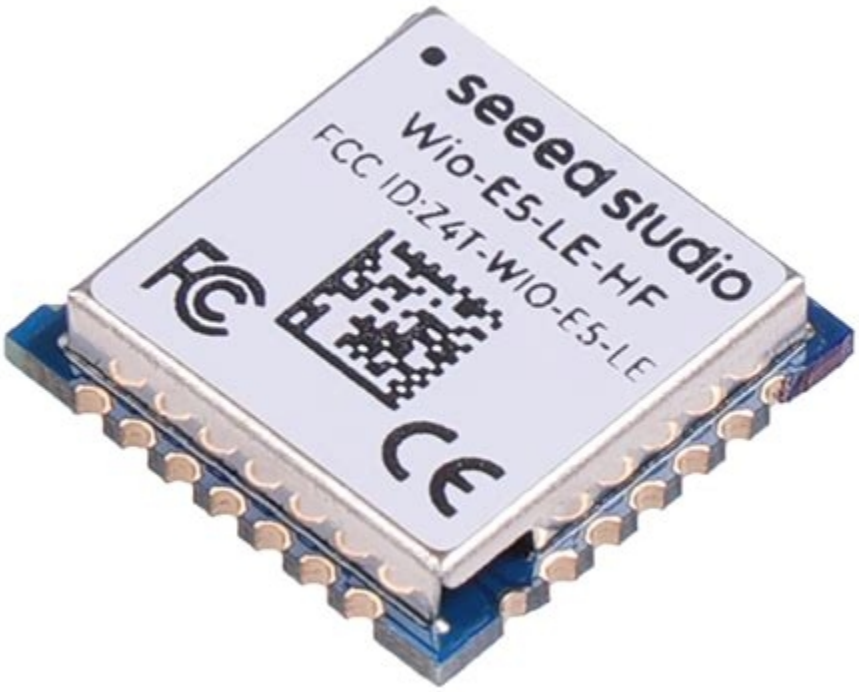
Wio-E5 LoRa Transceiver Peer to Peer Mode



Revision 3
12 May 2025

by Philip Munts N7AHL
***dba* Munts Technologies**
http://tech.munts.com

Introduction

LoRa is a low energy chirp spread spectrum wireless system commonly operating in unlicensed ISM (Industrial, Scientific, and Medical) radio frequency bands, at frequencies around 868 MHz or 915 MHz. LoRa was designed for minimum power consumption and short data messages sent infrequently but with very high probability of success. It is intended that all LoRa network nodes use LoRaWan, an encrypted RF networking protocol, and configured to connect to gateways that are also connected to the Internet cloud. LoRaWan gateways forward RF messages from sensors or other devices to IoT (Internet of Things) back-end providers such as Helium or The Things Network for processing and/or forwarding to IoT service subscribers.

The Seeed Studio Wio-E5 LoRa Transceiver Module contains an STMicroelectronics STM32WLE5JC wireless microcontroller with an on-chip sub-GHz digital radio subsystem and a LoRa modulator that comes preprogrammed with firmware that implements a Hayes AT command interpreter. Most of the Wio-E5 commands are devoted to LoRaWan operations. A small set of test commands enable operating the transceiver in test mode *aka* P2P (***Point to Point*** or ***Peer to Peer***) mode, sending and receiving LoRa Implicit Header frames that are:

- Broadcast (*i.e.* contain no sender or recipient address information).
- Unencrypted.
- 1 to 253 bytes of payload.
- 2 bytes of CRC checksum.

Point to Point is a bit of a misnomer, as all Wio-E5 transmissions in test mode are broadcasts and any Wio-E5 configured with the same RF parameters (center frequency, spreading, bandwidth, etc,) can passively monitor such transmissions. ***Peer to Peer*** is rather more correct, as a group of Wio-E5 modules in test mode can communicate freely among themselves instead of individually with an assigned LoRaWan gateway.

Adapting the Wio-E5 For Amateur Radio Service

You can operate an Wio-E5 under the authority of an amateur radio license in the 33 cm band (902 to 928 MHz in the United States). In contrast to unlicensed ISM operation, licensed amateur radio operation eliminates limits on duty cycle, dwell time, and ERP (Effective Radiated Power = transmit power x antenna gain).

U.S. amateur radio operators using spread spectrum in the 33 cm band are limited to 10 watts of transmit power without any limit on ERP. This allows an Wio-E5 operating under an amateur radio license in the 33 cm band to transmit at its full power (22 dBm or 158 milliwatts) into a high gain directional antenna without any fear of exceeding ISM ERP limits. It would also be entirely feasible and legal for an Wio-E5 to drive a 10 watt external power amplifier.

The following sections specify unicast network address schemes, that dedicate the first few bytes of the Wio-E5 P2P message payload to address information, for various flavors of amateur radio operations. Reference implementation device driver packages written in the Ada programming language for broadcast P2P as well as unicast ham radio flavors are available at:

https://github.com/pmunts/libsimpleio/tree/master/ada/devices.

Amateur Radio LoRa P2P Network Flavor #1 Protocol Specification

A Flavor #1 network shall consist of 2 to 255 stations owned and/or administered by a single amateur radio operator, each station consisting of a Wio-E5 LoRa Transceiver module (or a different compatible module) in test *aka* P2P mode with hardware CRC enabled.

Every station in a Flavor #1 network shall use the same RF settings (spreading, bandwidth, and center frequency)

Every station in a Flavor #1 network shall only transmit and receive unencrypted implicit header frames with 12 bytes of address header, 1 to 241 bytes of payload. and 2 CRC checksum bytes.

Every station in a Flavor #1 network shall use the same network ID, which shall be the call sign of the amateur radio operator who owns and/or administers the network.

Address Header Specification

The first twelve bytes of the implicit header frame payload shall be reserved for the network address header and shall contain the following fields:

- 10 ASCII characters for the network ID (call sign). The network ID characters shall be capitalized, left justified, and space padded.

  Examples: `W7AA      `, `WA7/WA7AAA`

- 1 binary byte for the destination node ID. The destination node ID shall be ARCNET address style: 0 for broadcast or 1 to 255 for unicast.

- 1 binary byte for the source node ID. The source node ID shall be ARCNET address style: 1 to 255.

Received Frame Processing

The Wio-E5 module shall silently discard any received RF frame that fails CRC checksum verification.

The Wio-E5 device driver shall silently discard any received RF frame without a matching network ID.

The Wio-E5 device driver shall silently discard any received RF frame without a matching destination node ID *or* the destination node ID set to the broadcast node ID.

The Wio-E5 device driver shall silently discard any received RF frame with the source node ID set to the broadcast node ID.

Amateur Radio LoRa P2P Network Flavor #2 Protocol Specification

A Flavor #2 network shall consist of a group of stations, each station consisting of a Wio-E5 LoRa Transceiver module (or a different compatible module) in test *aka* P2P mode with hardware CRC enabled.

Every station in a Flavor #2 network shall use the same RF settings (spreading, bandwidth, and center frequency).

Every station in a Flavor #2 network shall only transmit and receive unencrypted implicit header frames with 22 bytes of address header, 1 to 231 bytes of payload, and 2 CRC checksum bytes.

Every station in a Flavor #2 network shall use the call sign of the amateur radio operator who owns or administers that station for its network ID.

Address Header Specification

The first 22 bytes of the implicit header frame payload shall be reserved for the network address header and shall contain the following fields:

- 10 ASCII characters for the destination network ID (call sign for unicast, or one of `BEACON` , `BROADCAST` , or `CQ` for broadcast). The network ID characters shall be capitalized, left justified, and space padded.

  Examples: `CQ` `W7AA` `WA7/WA7AAA`

- 1 binary byte for the destination node ID. The destination node ID shall be ARCNET address style: 0 for broadcast or 1 to 255 for unicast.

- 10 ASCII characters for the source network ID (call sign). The network ID characters shall be capitalized, left justified, and space padded.

- 1 binary byte for the source node ID. The source node ID shall be ARCNET address style: 1 to 255.

Received Frame Processing

The Wio-E5 module shall silently discard any received RF frame that fails CRC checksum verification.

The Wio-E5 device driver shall silently discard any received RF frame without a matching destination network ID *or* the destination node ID set to a broadcast network ID.

The Wio-E5 device driver shall silently discard any received RF frame without a matching destination node ID *or* the destination node ID set to the broadcast node ID.

The Wio-E5 device driver shall silently discard any received RF frame with the source network ID set to a broadcast network ID *or* the source node ID set to the broadcast node ID.

Web Links

These links are provided for the benefit of printed document readers. They are listed in the order of appearance of hyperlinks in the text above.

LoRa:
https://www.semtech.com/lora/what-is-lora

ISM Radio Band:
https://en.wikipedia.org/wiki/ISM_radio_band

LoRaWan:
https://www.thethingsnetwork.org/docs/lorawan/what-is-lorawan

Internet of Things:
https://en.wikipedia.org/wiki/Internet_of_things

Helium:
https://www.helium.com/iot

The Things Network:
https://www.thethingsnetwork.org

Wio-E5 LoRa Transceiver Module:
https://wiki.seeedstudio.com/LoRa-E5_STM32WLE5JC_Module

STM32WLE5JC Sub-GHz Wireless Microcontroller:
https://www.st.com/en/microcontrollers-microprocessors/stm32wle5jc.html

Hayes AT Command Set:
https://en.wikipedia.org/wiki/Hayes_AT_command_set

LoRa-E5 AT Command Specification:
https://files.seeedstudio.com/products/317990687/res/LoRa-E5%20AT%20Command%20Specification_V1.0%20.pdf

LoRa Implicit Header Frame:
https://www.rfwireless-world.com/terminology/iot/lorawan-implicit-vs-explicit-headers

Amateur Radio 33 cm Band:
https://en.wikipedia.org/wiki/33-centimeter_band

Reference Implementation:
https://en.wikipedia.org/wiki/Reference_implementation