Adafruit Feather M0 with LoRa Radio

Hands-on example for the
Pervasive Systems course
A.A. 2017/2018
University of Rome La Sapienza

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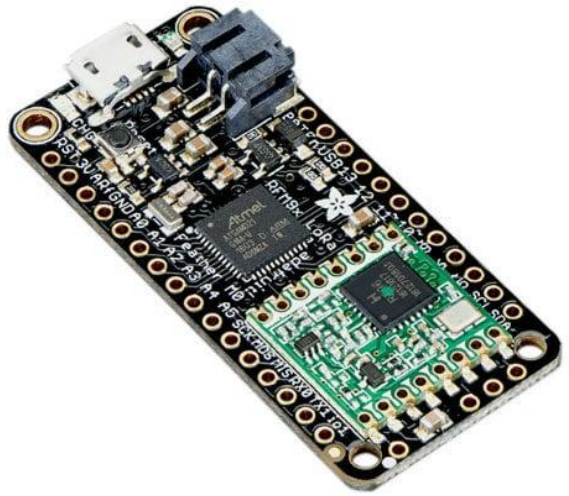
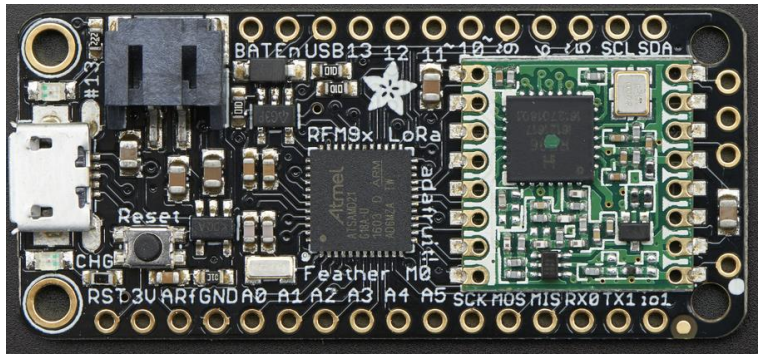


LoRa™

Adafruit Feather M0 Radio with LoRa Radio Module : Board/Processor

- ATSAMD21G18 (32-bit ARM Cortex M0+) @ 48MHz with 3.3V logic/power
- Embedded with lithium battery management chip and status indicator led
- 20 GPIOs (All pins but only 8 are PWM)
- 1 x analog output (10-bit DAC)
- 10 x analog inputs (12-bit ADC)
- 3 x pins for RFM/SemTech control
- 3.3V regulator with 500mA output
- Flash Memory : 256 kb
- SRAM : 32 kb
- Reset button
- 1 x pin for antenna (no built-in antenna)

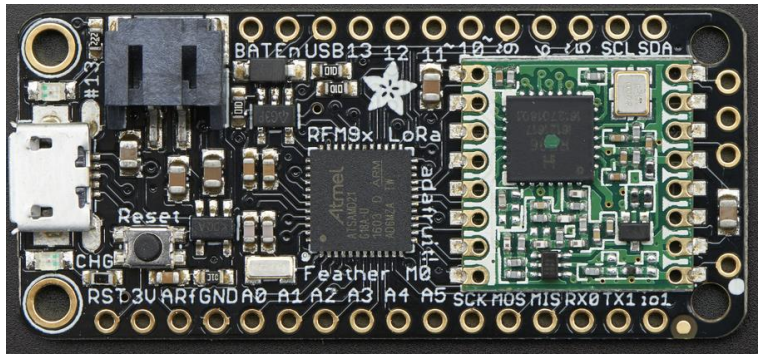


Adafruit Feather M0 Radio with LoRa Radio Module : Board/Modules

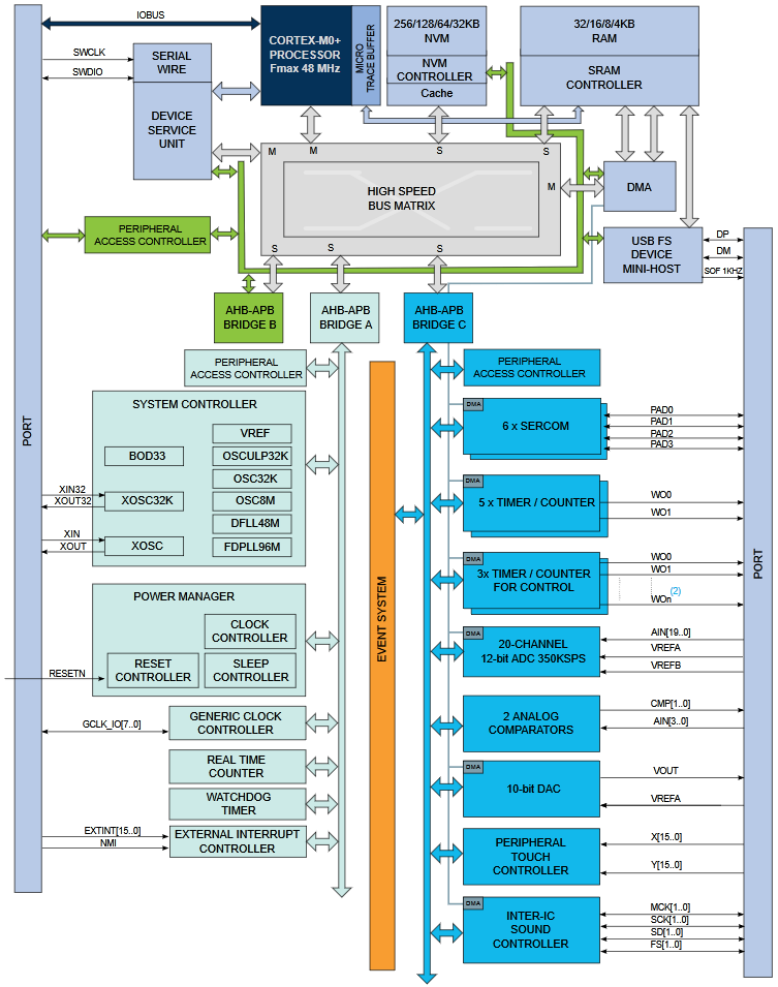
- RFM9x LoRa 868/915 MHz radio module embedded by SX1276 transceiver.
- High link budget of 160dB. -140dBm sensitivity and 19dBm Output power.
- Support Class A/C LoRaWAN protocol
- 1.45uA sleep current in WOR mode
- Dual band:

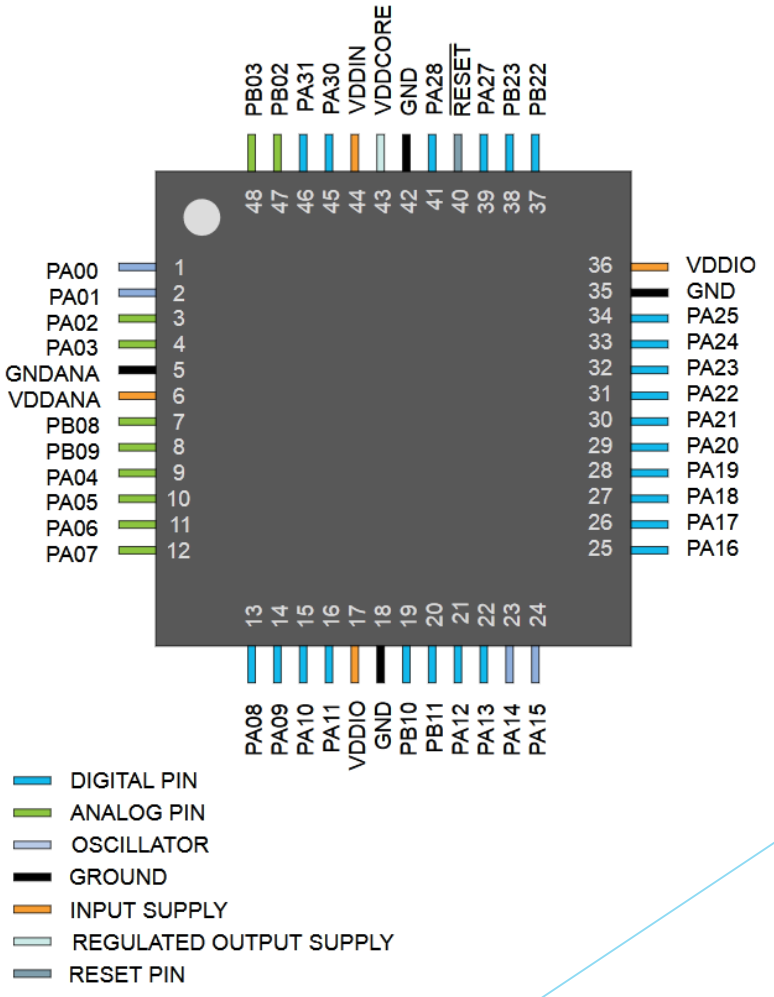
  19dBm@434MHz/470MHz

  14dBm@868MHz/915MHz



ATSAMD21G18 : Block Diagram





RFM9x LoRa : Block Diagram

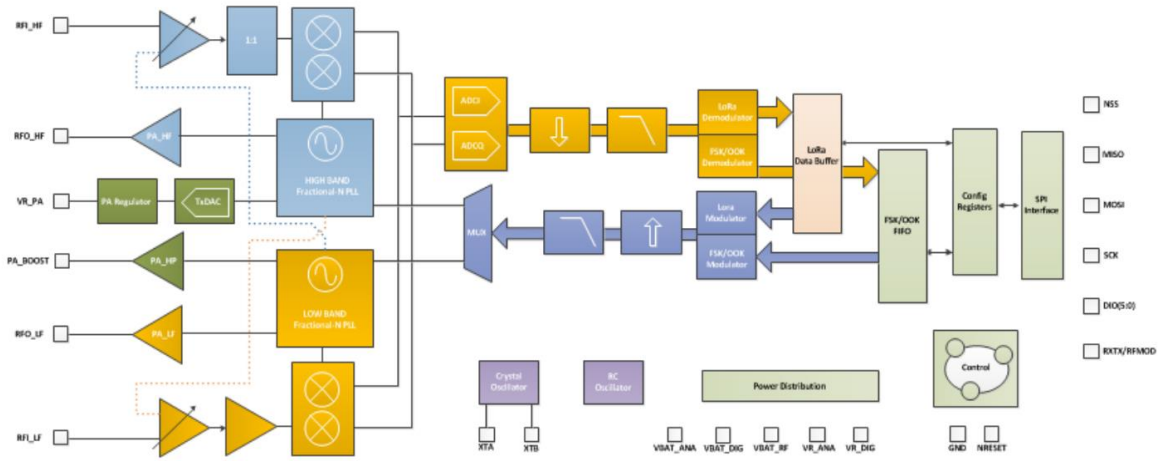


Figure 3. RFM95/96/97/98(W) Block Schematic Diagram

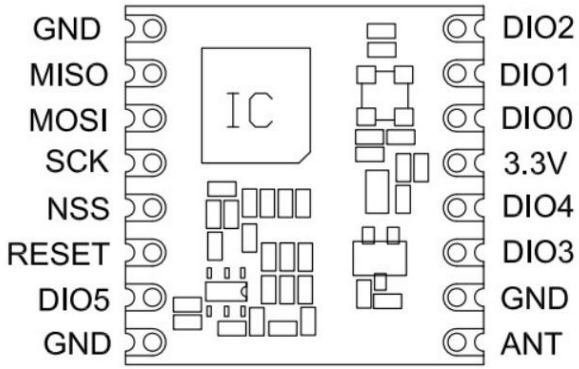


Figure 2. Pin Diagrams

SX1276 : Block Diagram

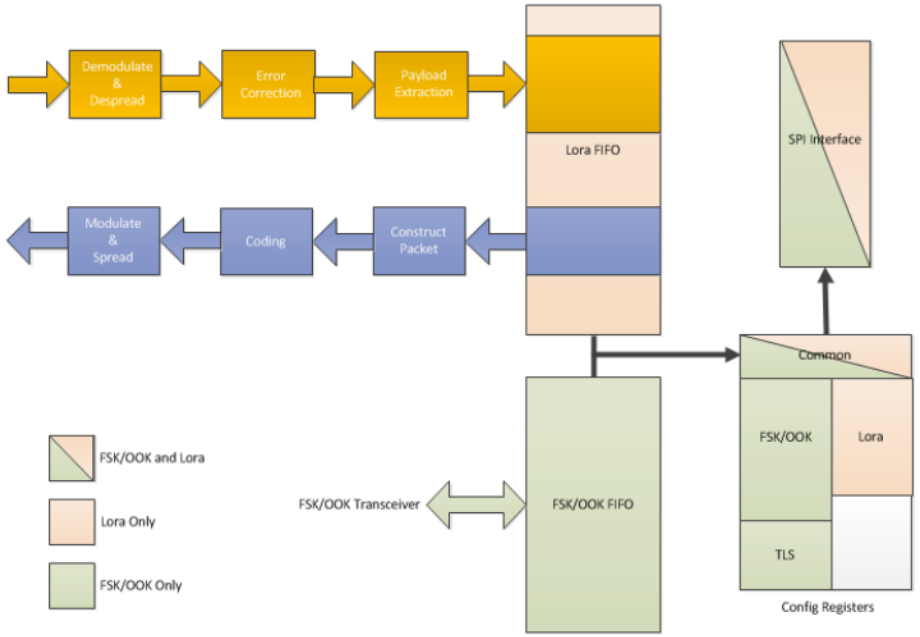
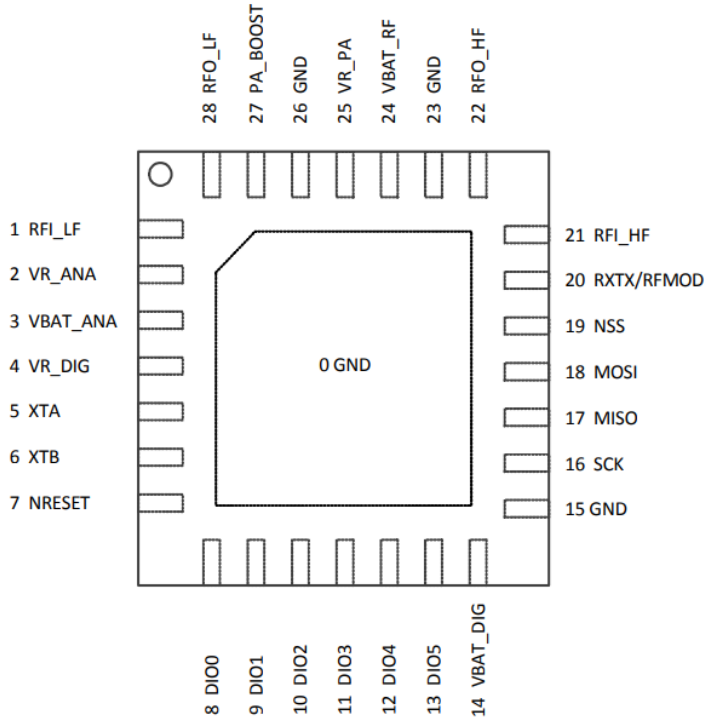


Figure 4. LoRa™ Modem Connectivity



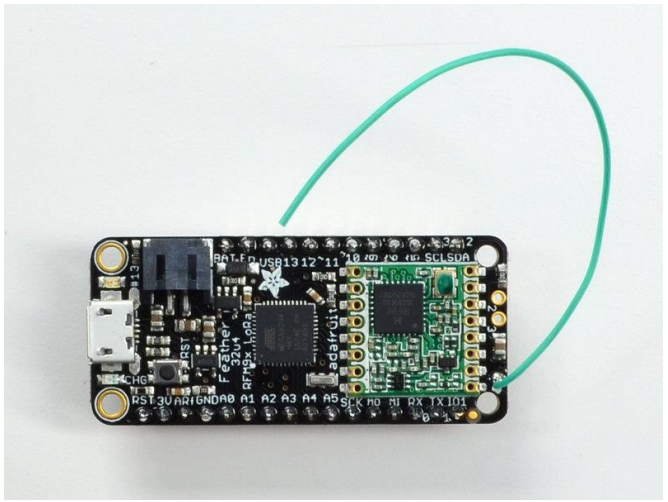
SX1276/77/79

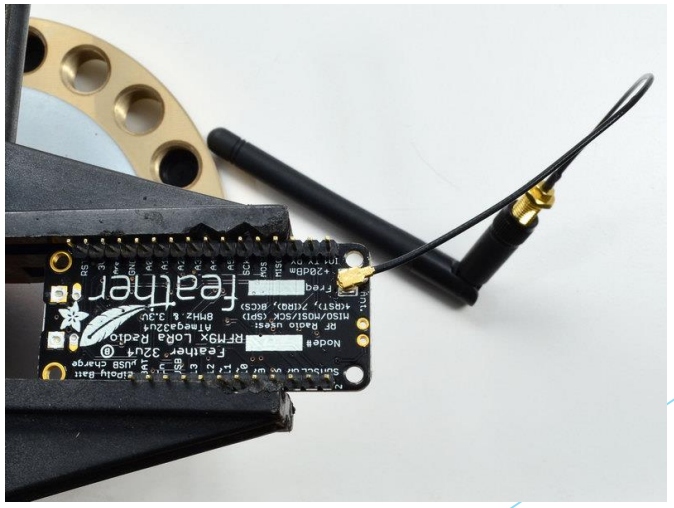
LoRa : Frequency regulation

- LoRa supports a wide range of license free frequency bands
- Every State has its own unlicensed bands but each one can add other constraints (such as power use, time of transmission and so on)
- In Italy (and Europe) we can use the **434 MHz** and **868 MHz** frequency bands

Adafruit Feather M0
Radio with LoRa Radio Module : Antenna

- **No internal antenna**
- In order to achive long distance we need one **based** on the **frequency** used
  - **433 MHz** - 6.5 inches, or 16.5 cm
  - **868 MHz** - 3.25 inches or 8.2 cm
  - **915 MHz** - 3 inches or 7.8 cm





SX1276 : Configuration

SpreadingFactor [RegModulationCfg]	SpreadingFactor (Chips / symbol)	LoRa Demodulator SNR
6	64	-5 dB
7	128	-7.5 dB
8	256	-10 dB
9	512	-12.5 dB
10	1024	-15 dB
11	2048	-17.5 dB
12	4096	-20 dB

CodingRate (RegTxCfg1)	Cyclinc Coding Rate	Overhead Ratio
1	4/5	1.25
2	4/6	1.5
3	4/7	1.75
4	4/8	2

Name	Frequency Limits	Products
Band 1 (HF)	862 (*779)-1020 (*960) MHz	SX1276/77/79
Band 2 (LF)	410-525 (*480) MHz	SX1276/77/78/79
Band 3 (LF)	137-175 (*160) MHz	SX1276/77/78/79

Bandwidth (kHz)	Spreading Factor	Coding rate	Nominal Rb (bps)
7.8	12	4/5	18
10.4	12	4/5	24
15.6	12	4/5	37
20.8	12	4/5	49
31.2	12	4/5	73
41.7	12	4/5	98
62.5	12	4/5	146
125	12	4/5	293
250	12	4/5	586
500	12	4/5	1172

SX1276 : Modem behaviour

Operating Mode	Description
SLEEP	Low-power mode. In this mode only SPI and configuration registers are accessible. LoRa FIFO is not accessible. Note that this is the only mode permissible to switch between FSK/OOK mode and LoRa mode.
STANDBY	Both Crystal oscillator and LoRa baseband blocks are turned on. RF part and PLLs are disabled.
FSTX	This is a frequency synthesis mode for transmission. The PLL selected for transmission is locked and active at the transmit frequency. The RF part is off.
FSRX	This is a frequency synthesis mode for reception. The PLL selected for reception is locked and active at the receive frequency. The RF part is off.
TX	When activated the SX1276/77/78/79 powers all remaining blocks required for transmit, ramps the PA, transmits the packet and returns to Standby mode.
RXCONTINUOUS	When activated the SX1276/77/78/79 powers all remaining blocks required for reception, processing all received data until a new user request is made to change operating mode.
RXSINGLE	When activated the SX1276/77/78/79 powers all remaining blocks required for reception, remains in this state until a valid packet has been received and then returns to Standby mode.
CAD	When in CAD mode, the device will check a given channel to detect LoRa preamble signal.

LoRa: Packet structure

The LoRa modem employs **two types of packet** format, **explicit** and **implicit.**

The explicit packet includes a short header that contains information about the **number of bytes**, **coding rate** and whether a **CRC is used** in the packet.

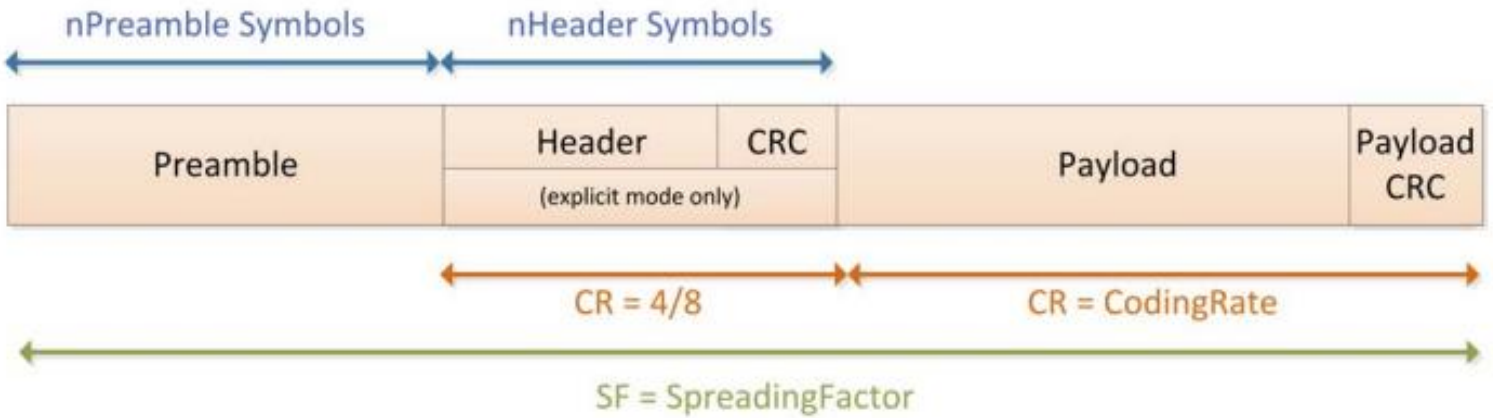


Figure 6. LoRa™ Packet Structure

SX1276 : Driver

In order to use the **RFM9x** radio module with **SX1276** we need a driver.

This is the **RadioHead Packet Radio library** for embedded microprocessors.

It provides a complete **object-oriented library** for sending and receiving packetized messages via a variety of common data radios and other transports on a range of embedded microprocessors.

http://www.airspayce.com/mikem/arduino/RadioHead/

Hands-on example

The example is a simple **Ping Pong application** with two different LoRa boards communicate each other.

One board is the **Adafruit Feather M0 with LoRa Radio module** the other one is the **Seeduino LoRaWAN**.

Both boards use the same Arduino sketch, the first using the **RadioHead Driver**, the other one instead use **AT commands over serial communication.**

https://github.com/claudiopastorini/PingPong