

LoRa introduktion

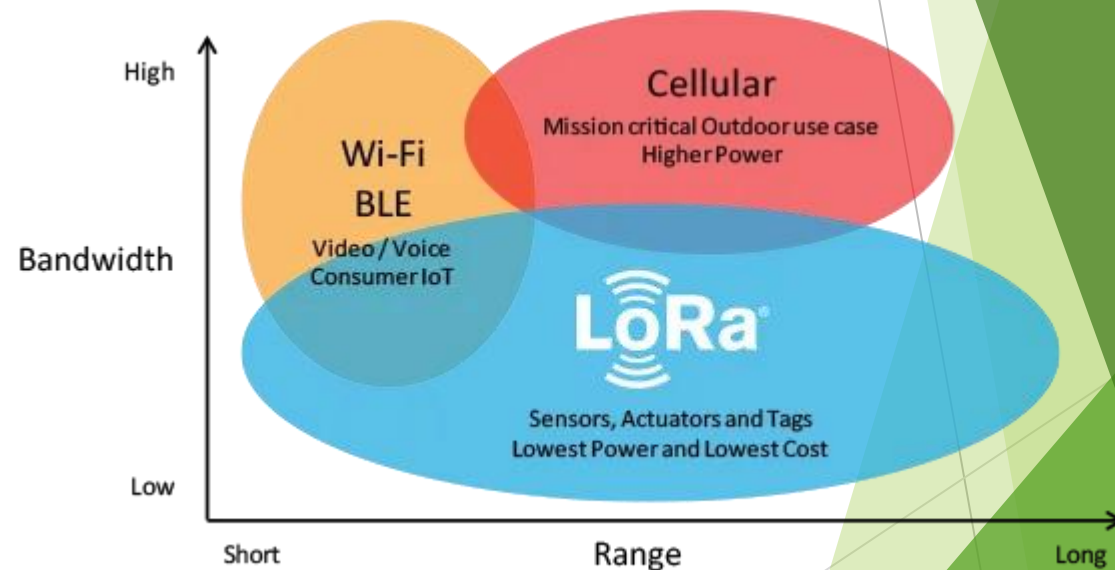


OZ6HR Horsens

Maj 2024 - Arne Paulsen

Anvendelse - karakteristika

- ▶ Transmission af små mængder data - f.eks. fra sensorer
- ▶ Relativ lang rækkevidde - afhænger af ønsket transmissionshastighed
- ▶ 868 MHz og 433 MHz - Chirp spread-spectrum modulation
- ▶ LoRa er den fysiske modulation
- ▶ LoRaWan er netværksprotokollen.
- ▶ Båndbredde: 125 kHz, 250 kHz or 500 kHz
- ▶ Lavt energiforbrug.
- ▶ Ingen behov for licens.
- ▶ Sikkerhed: AES-128 kryptering
- ▶ Frekvensplan DK: EU863-870 & EU433
- ▶ Regulativ: CEPT Rec. 70-03



<https://www.thethingsnetwork.org/docs/lorawan/>

Chirp spread-spectrum modulation

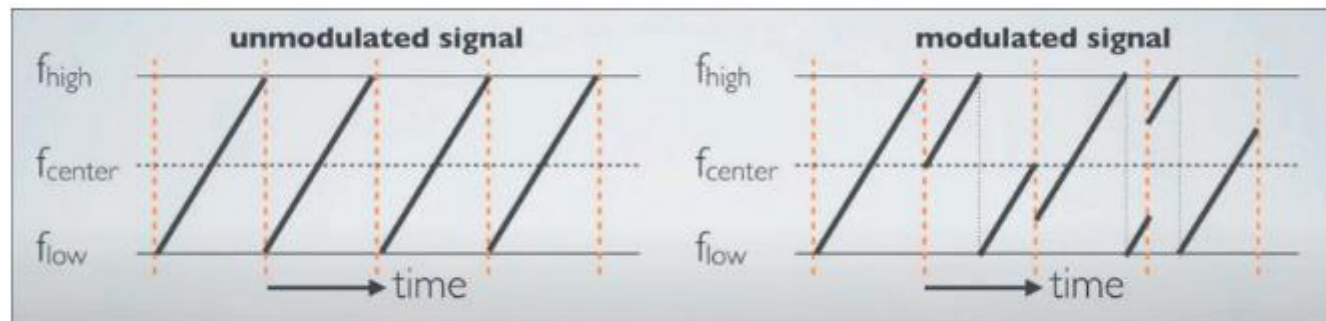
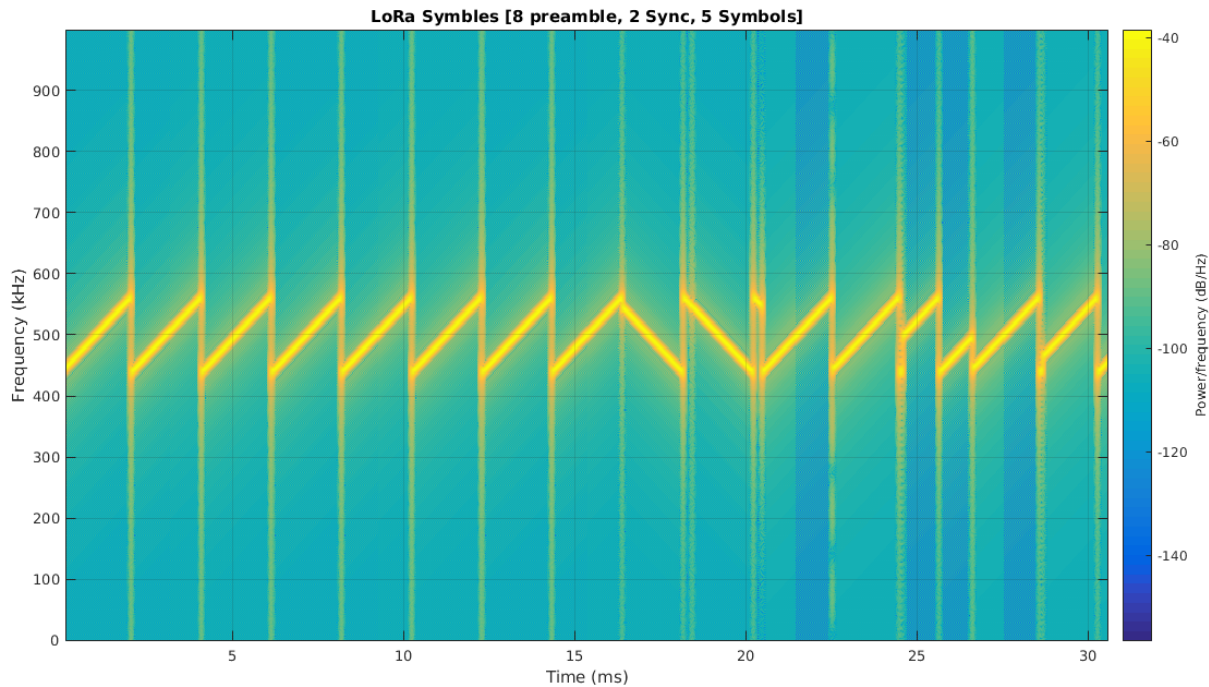
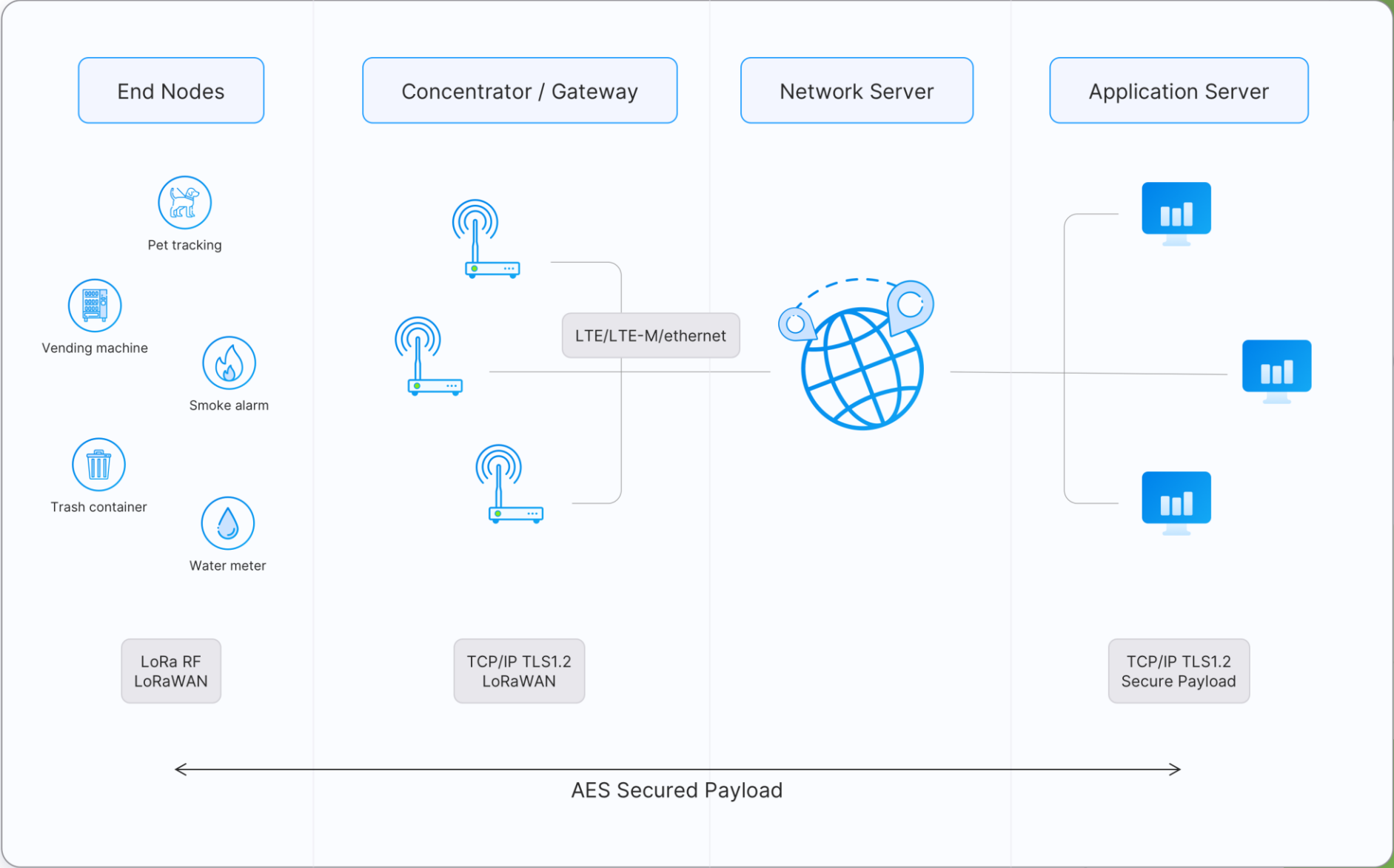


Figure 2.3: LoRa Modulation (Image: mobilefish.com).

LoRaWAN arkitektur



LoRaWAN frekvenser og kanaler i EU

- ▶ Frekvenser: 433,175 - 433,375 - 433,575 - 868,1 - 868,3 - 868,5 MHz
- ▶ Båndbredde: 125 kHz
- ▶ Data hastighed:

DataRate	Configuration	Indicative physical bit rate [bit/s]
0	LoRa: SF12 / 125 kHz	250
1	LoRa: SF11 / 125 kHz	440
2	LoRa: SF10 / 125 kHz	980
3	LoRa: SF9 / 125 kHz	1760
4	LoRa: SF8 / 125 kHz	3125
5	LoRa: SF7 / 125 kHz	5470
6	LoRa: SF7 / 250 kHz	11000
7	FSK: 50 kbps	50000
8..14	RFU	
15	Defined in LoRaWAN ¹	

Transmit power:

TXPower	Configuration (EIRP)
0	Max EIRP
1	Max EIRP – 2dB
2	Max EIRP – 4dB
3	Max EIRP – 6dB
4	Max EIRP – 8dB
5	Max EIRP – 10dB
6	Max EIRP – 12dB
7	Max EIRP – 14dB
8..14	RFU
15	Defined in LoRaWAN

Max EIRP is considered to be +16dBm (By default).

LoRaWAN data format

Radio PHY layer



<https://www.thethingsnetwork.org/airtime-calculator>

Restrictions 863 - 868 - 870 MHz

<https://lora.readthedocs.io/en/latest/#in-europe>

► General:

- Uplink power: Max 25 mW (14 dBm) + 2.15 dBi antenna gain (from node to gateway)
- Downlink power: Max 500 mW (27 dBm)
- Duty cycle (ToA): 0.1% or 1.0% depending on channel (Time on Air)
 - Sample 1%: ToA = 530ms => after sending we have to wait $99 \times 530\text{ms} = 52.47\text{s}$ before sending a new message.

► LoRaWAN network:

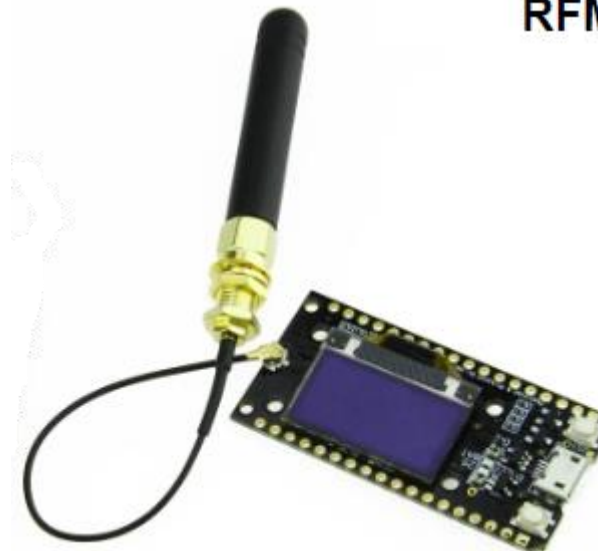
- Uplink air time: 30 seconds per day (24 hours)
- Downlink load: Max 10 messages per day

LoRa modules

- ▶ 433 or 868 MHz:
 - ▶ E49-400T20D CDEBYTE
 - ▶ RFM69HW
 - ▶ LILYGO® TTGO LoRa32 (ESP32 based with OLED display)
 - ▶ TOGO ESP32 SX1276 (ESP32 based w/o display)



RFM69HW



Vejrballon modtager: **MySondy GO v2**



Frekvens: 405,3 MHz
Effekt: 60 mW
Protokol: RS41

<https://mysondy.altervista.org/mysondygo.php>

https://github.com/dl9rdz/rdz_ttgo_sonde/wiki/Supported-boards

Dragino gateway

LG01-N -- Single Channel LoRa IoT Gateway



Click to open image!



LG01-N is an open source [single channel LoRa Gateway](#). It lets you bridge LoRa wireless network to an IP network via [WiFi, Ethernet, Or 3G/4G cellular via optional LTE module](#). The LoRa wireless allows users to send data and reach extremely long ranges at low data-rates. It provides ultra-long range spread spectrum communication and high interference immunity.

LG01-N has rich internet connection method such as WiFi interface, Ethernet port and USB host port. These Interfaces provide flexible methods for users to connect their sensor networks to Internet.

LG01-N can be used to provide a low cost IoT wireless solution to support 10~100 sensor nodes.

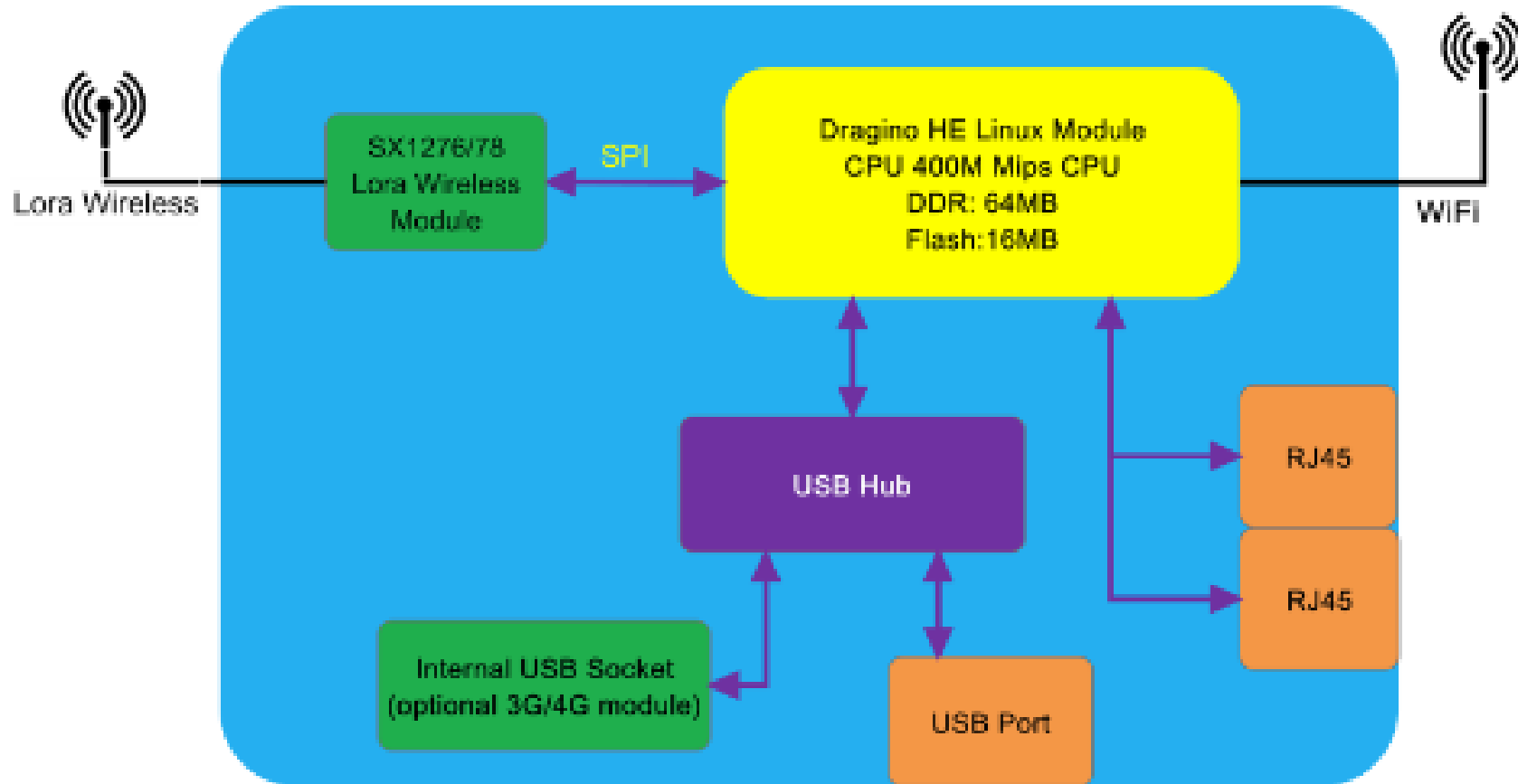
LG01-N can support [mutiply working mode](#) such as: MQTT mode, TCP/IP Client mode to fit different requirement for IoT connection.

Note: LG01-N is designed for Private LoRa Protocol, [Not recommend for LoRaWAN use.](#)

[Dragino LoRa Gateway Selection Guide](#)

Dragino gateway

LG01N System Overview:



The Things Network



<https://www.thethingsnetwork.org/>

The Things Industries



Free

Restrictions apply

Discovery plan is ideal to evaluate our service or for very small IoT projects.

- ✓ Test all Plus plan features for free
- ✓ Connect up to 10 devices and 10 gateways
- ✓ No time-limit, no risks, no lock-in
- ✓ Service with uptime

**The carrier-grade
LoRaWAN® Network Server
(LNS) that scales.**

Setup, manage and monitor your LoRaWAN networks with ease. Secure by design and ready to scale.

<https://www.thethingsindustries.com/stack/>

Mere info - links:

OZ 2021 november (5) side 46 og december (6) side 18: *LoRa for begyndere*

<https://www.thethingsnetwork.org/>

<https://www.thethingsnetwork.org/docs/lorawan/>

<https://www.thethingsindustries.com/stack/>

<https://www.thethingsnetwork.org/airtime-calculator>

<https://www.rfwireless-world.com/Terminology/LoRaWAN-Europe-Frequency-Bands-and-Channels.html>

<https://mysondy.altervista.org/mysondygo.php>

https://github.com/dl9rdz/rdz_ttgo_sonde/wiki/Supported-boards

<https://www.dragino.com/products/lora-lorawan-gateway/item/143-lg01n.html>

<https://www.mobilefish.com/>

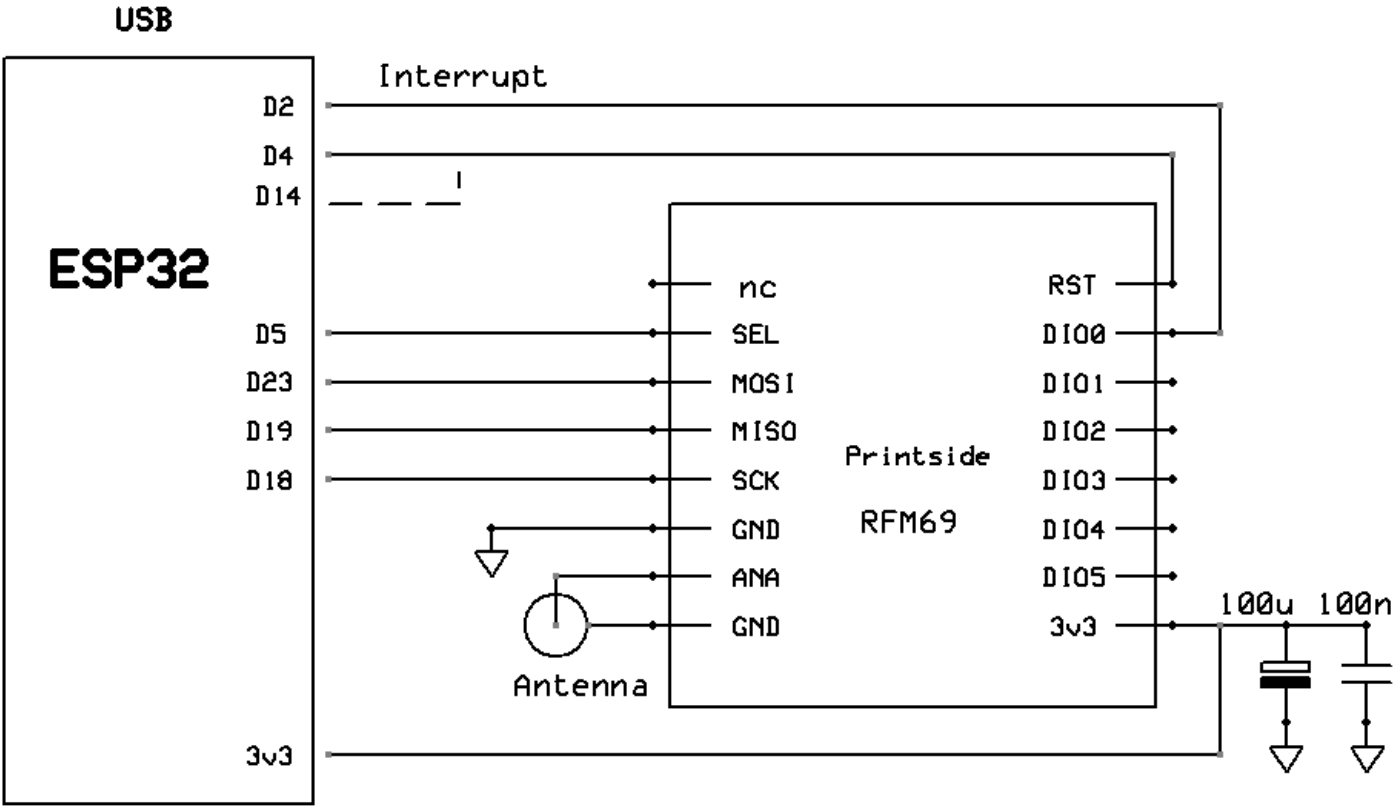
<https://www.elektormagazine.com/magazine/elektor-272/60932>

https://www.elektor.com/products/develop-and-operate-your-lorawan-iot-nodes?_pos=12&_fid=540d657f4&_ss=c

<https://download.e-bookshelf.de/download/0018/2912/77/L-G-0018291277-0079156192.pdf>

Demo hardware

ESP32 med RFM69 modul



Demo software

Arduino IDE version 2.3.2

```
// Module NodeMCU32S + RFM69H LoRa module
// Derived from ..\libraries\RFM69_LowPowerLab\Examples\TxRxBlinky

#include <RFM69.h>           //get it here: https://www.github.com/lowpowerlab/rfm69
#include <RFM69_ATC.h>      //get it here: https://github.com/lowpowerlab/RFM69

#define REMOTE              1
#define LOCAL               2

#define NETWORKID          100           //the same on all nodes that talk to each other
#define FREQUENCY           RF69_868MHZ
#define ENCRYPTKEY          "sampleEncryptKey" //exactly the same 16 characters/bytes on all nodes!
#define IS_RF69HW_HCW      //uncomment for RF69HW/HCW!
#define ENABLE_ATC         //comment out to disable AUTO TRANSMISSION CONTROL
#define ATC_RSSI            -90          //target RSSI for RFM69_ATC (recommended > -80)
#define RX_INT_PIN         2           //GPIO to set HIGH by the RECEIVER = interrupt
#define RESET_PIN          4           //RF69 page 77, active HIGH 100 uS, wait 5mS
```