

The background image shows a large, multi-towered castle with a blue roof, illuminated at night. A canal in the foreground reflects the castle and the surrounding lights. A tunnel entrance is visible in the lower center of the image. The sky is dark with some clouds, and the overall scene is lit with warm, yellowish lights from the buildings and street lamps.

# Workshop

# LoRa Netwerk Hands-On

**PA3AAA @ RCAMF**  
**Amersfoort, 2024**

# WAT JE GAAT LEREN

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## WAT IS LORA, WAAROM IS HET ANDERS

- Bandbreedte, Bereik, Vermogen
- Netwerk provider: The Things Network, en vele anderen

## RAK4270H LoRa module

- Handmatige setup d.m.v. seriële communicatie
- Nuttige AT commandos
- Anmelden bij een lokaal LoRa netwerk
- Verzenden van data naar een applicatie
- Ontvangen van data
- Visualiseer data in ThingSpeak

# WAT IS LORA?

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## Long range, low energy, radio datacommunicatie

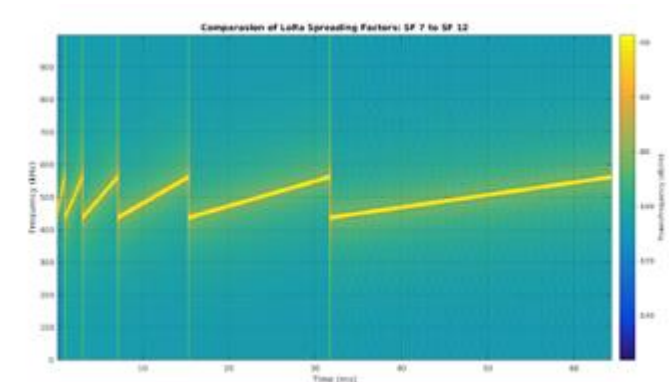
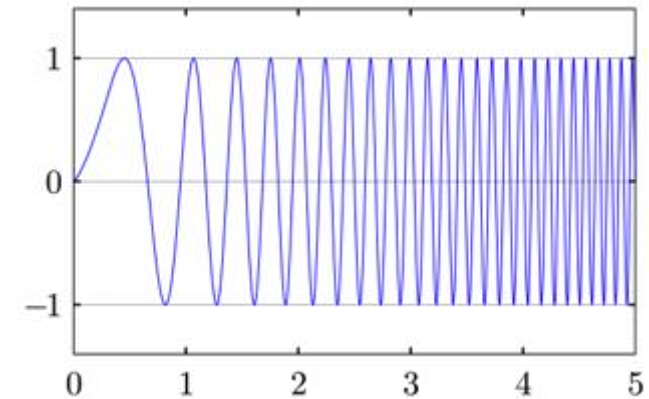
- 10 km bereik mogelijk bij direct zicht
- Geschikt voor batterijvoeding
- Kleine datapakketten, 30 seconden/dag air time  
~ iedere 15 - 30 minutes
- Ster-netwerk topology
- Een gateway kan honderden stations (nodes) ondersteunen

## Licentie-vrije frequentie banden

- USA 902 – 928 MHz, 64 kanalen
- Europe 863 – 870 MHz, 8 kanalen

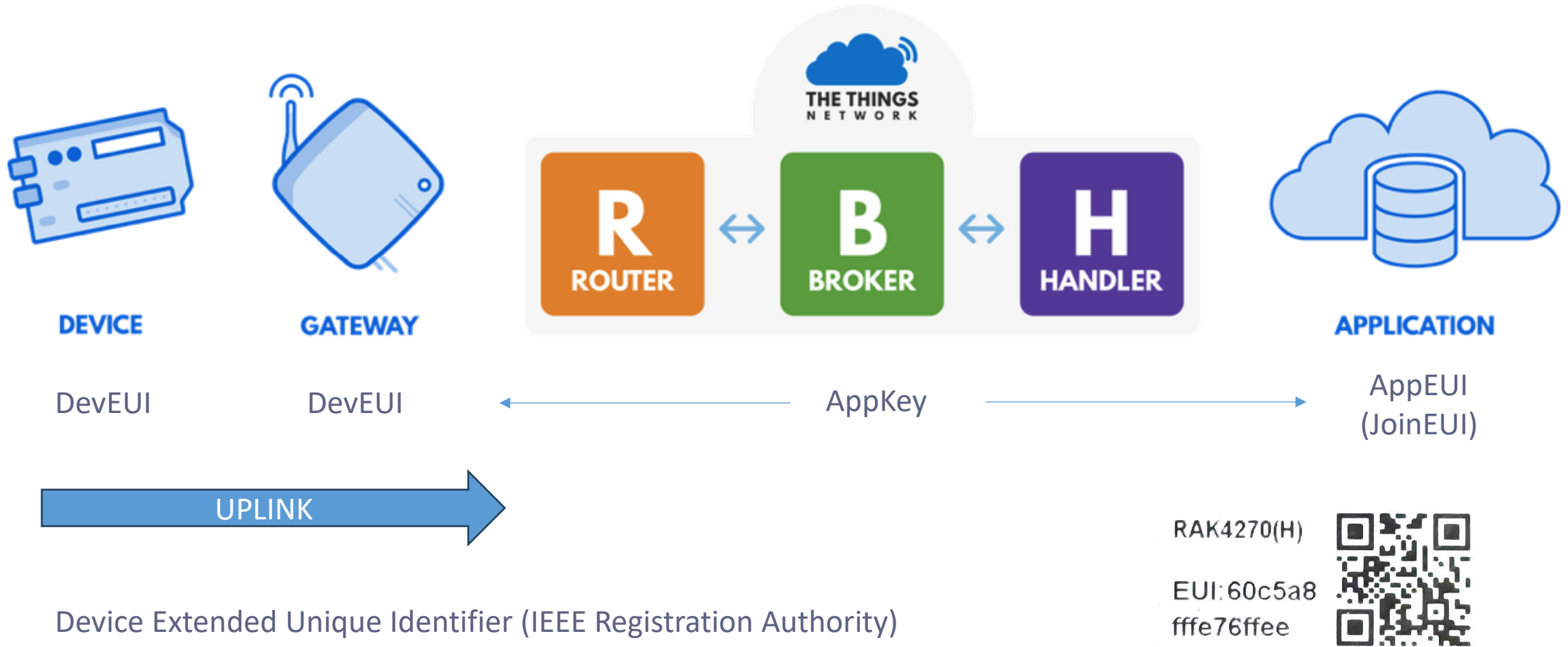
## Modulatie

- Chirp spread spectrum, 3 x groter bereik dan NB FSK
- Data rate afhankelijk van bandbreedte en spreading factor



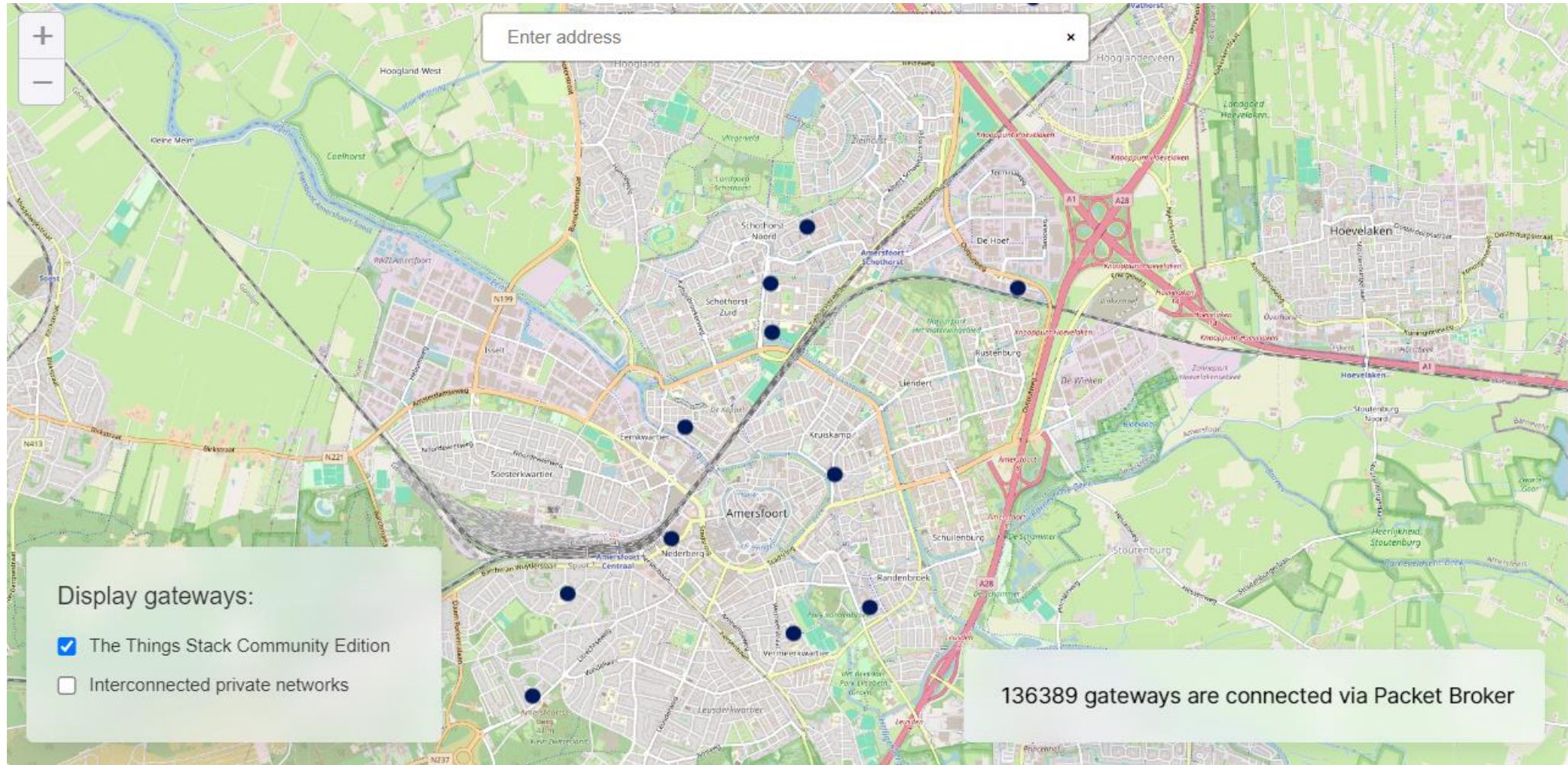
Sakshama Ghoslya

# LORA NETWERKTOPOLOGIE



Device Extended Unique Identifier (IEEE Registration Authority)

# TTN GATEWAYS AMERSFOORT



# WORKSHOP PLAYGROUND

## LORAWAN GATEWAY

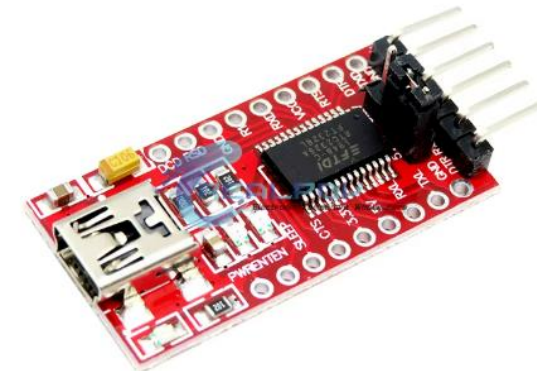
- Laird Sentrius RG186
- Aangesloten op TheThingsNetwork

## LORA NETWORK PROVIDER: TTN

- Gratis LoRaWAN networking
- Community beheert het netwerk
- >> 136k gateways wereldwijd

## WORKSHOP KIT

- RAK 4270H LoRa radio module
- FTDI USB-2-Serial adapter, 3.3V
- 868 MHz Antenne
- kabel

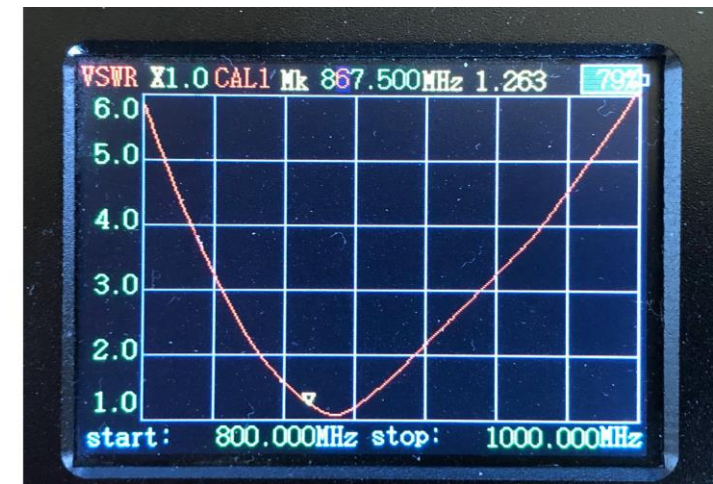


Vinduino - LoRa node antenna

# RAK 4270H

Hardware Specificatie	
Chipset	SEMTECH LoRa SX1262, STM32L071
LoRaWAN Class	Class A/C device, Receives after Tx
Frequency	862-870MHz (EU) EU433, CN470, IN865, EU868, AU915, US915, KR920, and AS923-1/2/3/4)
Transmission Power	100mW (22dBm max.)
UART	Baud Rate : 115200 bps Parity: 8N1
Operation Voltage	3.3V
Current Consumption	Receiving: 21 mA (typical) Transmitting: 125 mA (typical) Sleeping: 2 uA (typical)
Transmission Distance	1KM~10KM
Receiving Sensitivity	-148 dBm

Module Pin Definitie			
Pin	Signal Name	I/O	Description
1	GND	-	Ground
2	VCC	-	3.3 V
3	RXD1	Input	3.3V UART input
4	TXD1	Output	3.3V UART output



# NUTTIGE INFORMATIE

## WIFI

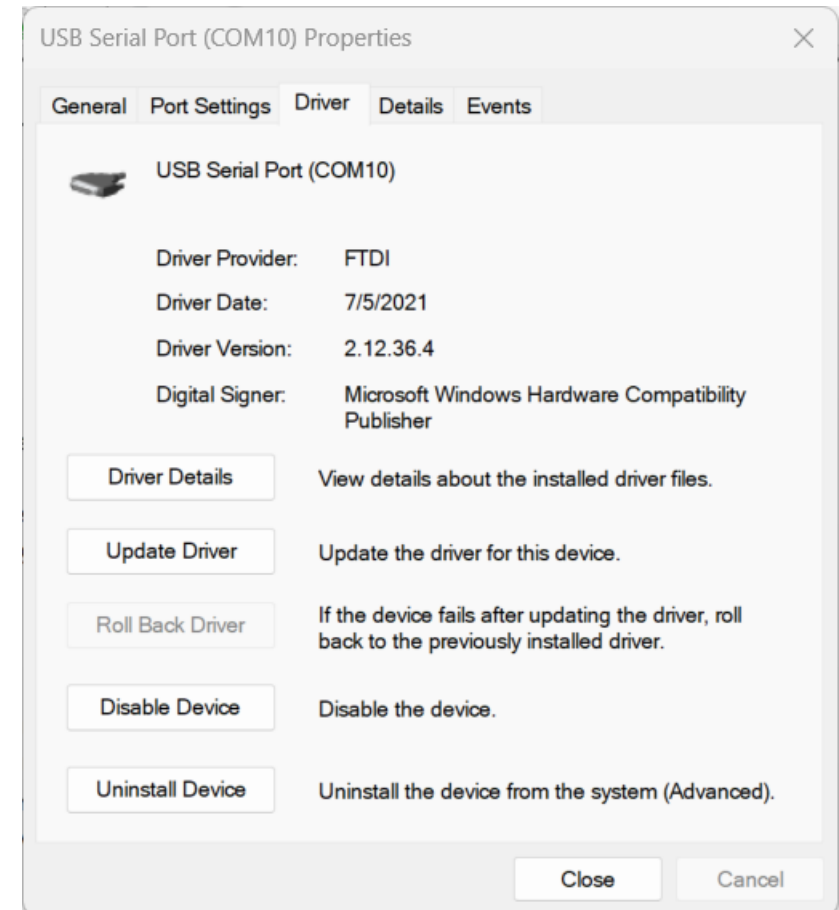
- SSID: RCAMF
- Pass: XXXXXX

## USB SERIAL DRIVER

- Installeer FTDI USB serial driver (indien nodig)  
<https://ftdichip.com/drivers/>
- USB bord jumper naar **3.3V!!**

## IEDEREEN

- Installeer CoolTerm serial communications program  
<http://freeware.the-meiers.org>

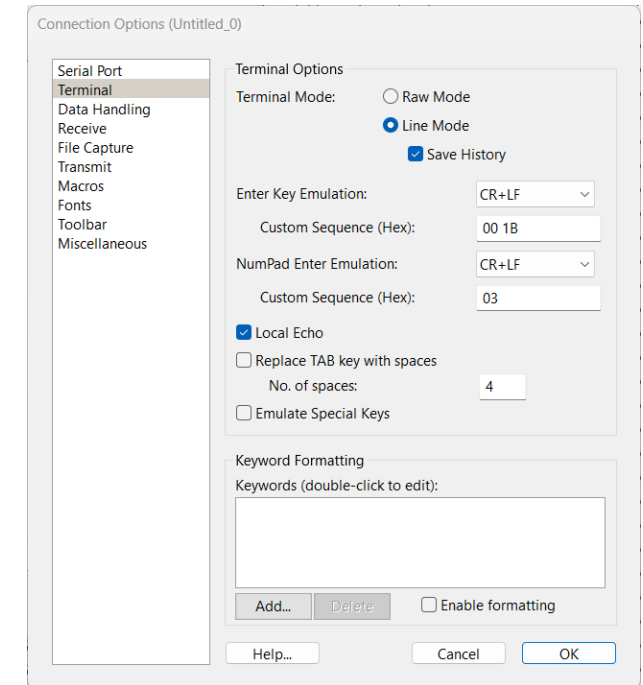
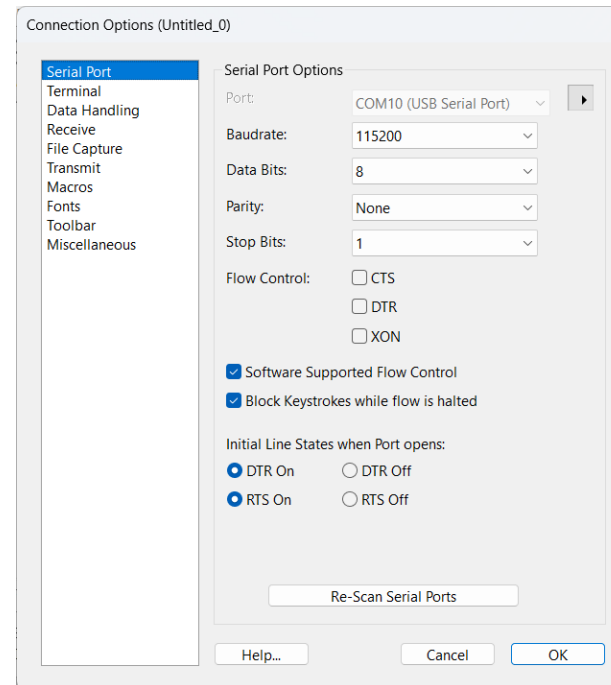




# NUTTIGE INFORMATIE-2

## CoolTerm Settings

- Select correct serial port
- Baudrate:  
115200, 8 bits, no parity, 1 stop bit
- Terminal: Local Echo, Line mode

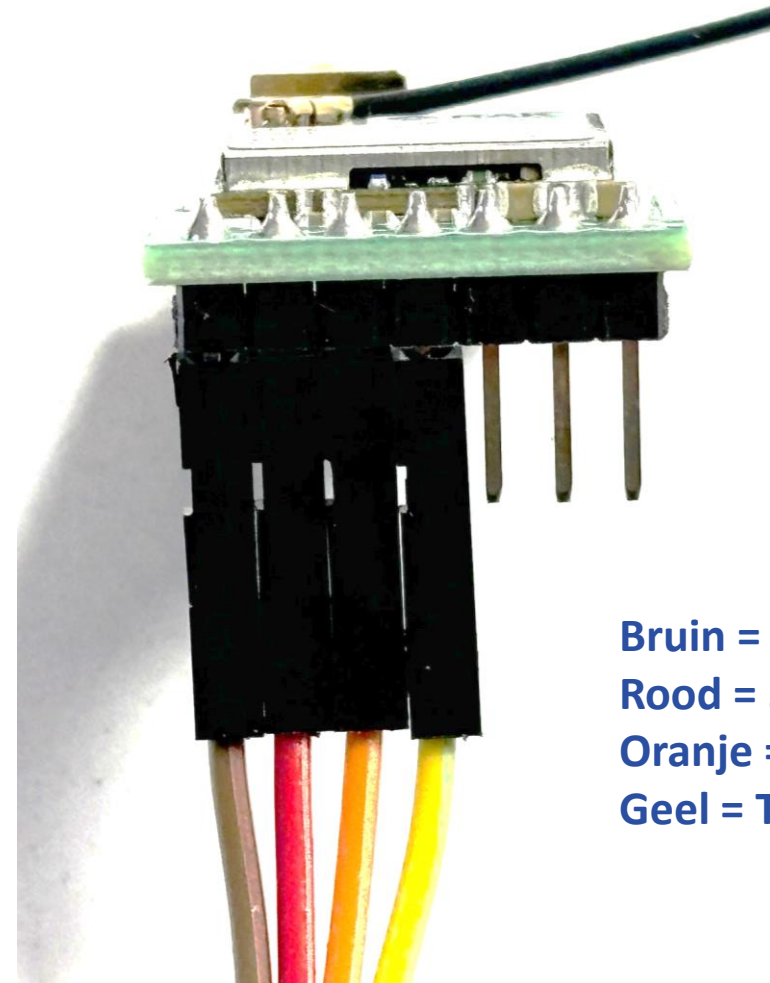
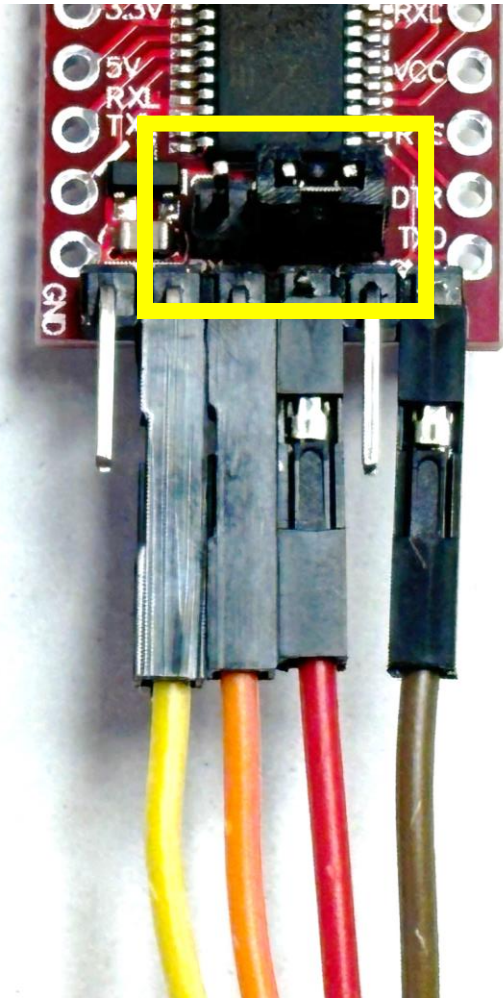


## The Things Network

- <https://www.thethingsnetwork.org/>
- User: RCAMF Password: fTp2GQ.RNdKj\*6P

# MODULE AANSLUITEN

Jumper naar 3.3V!!



Bruin = massa  
Rood = 3.3V  
Oranje =RXdata  
Geel = TXdata

# AT COMMANDS QUICK REFERENCE

---

Command	Description	Response
at+help	List of commands	OK + commands
at+set_config=lora:region:EU868	Save parameters to flash	OK
at+set_config=lora:class:0	LoRaWAN class A mode	OK
at+set_config=lora:join_mode:0	OTAA activation mode	OK
at+get_config=lora:status	Get DevEUI	Long settings list
at+set_config=lora:app_eui:XXXX	Application identifier	OK
at+join	Aanmelden TTN netwerk	OK Join Success
at+set_config=lora:app_key:<app_key>	Encryption key	OK
at+send=lora:2:AABBCC (hex payload)	Send data	OK Rx ...

<https://docs.rakwireless.com/Product-Categories/WisDuo/RAK4270-Module/AT-Command-Manual/>  
<https://downloads.rakwireless.com/#LoRa/Tools/>

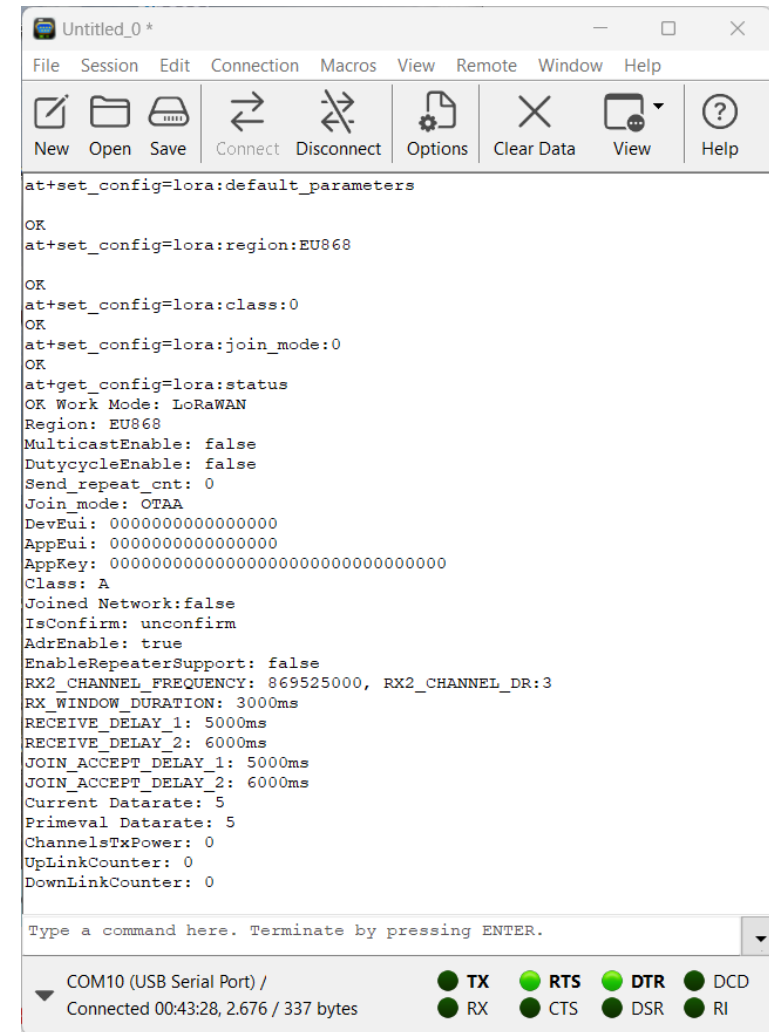
# MODULE CONFIGURATIE

at+set\_config=lora:region:EU868

at+set\_config=lora:class:0

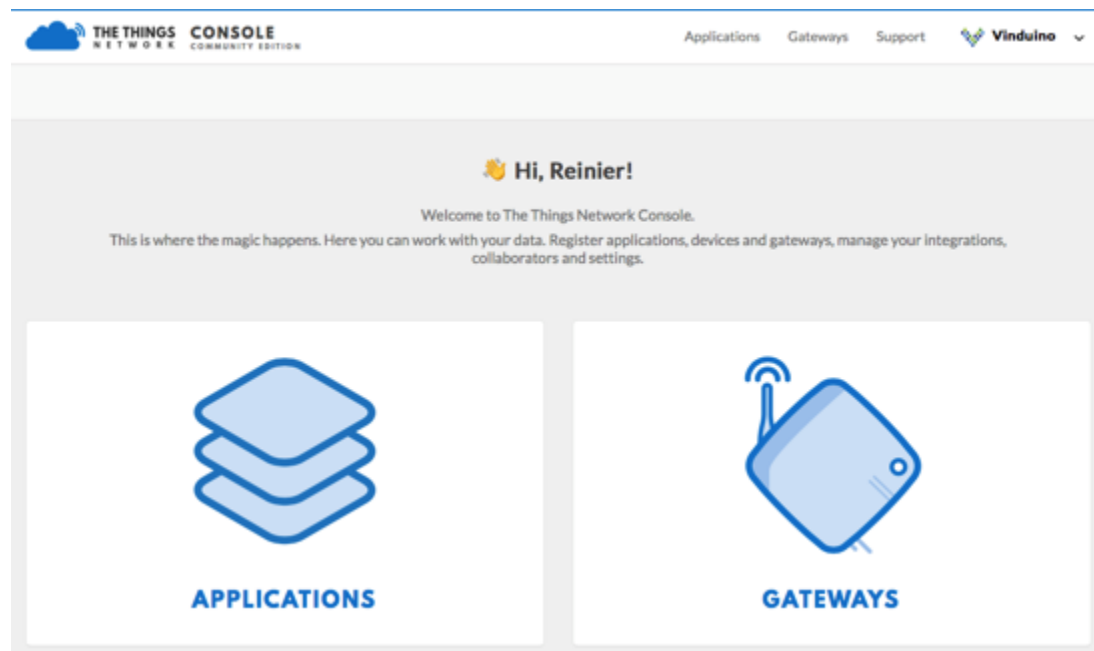
at+set\_config=lora:join\_mode:0

at+get\_config=lora:status

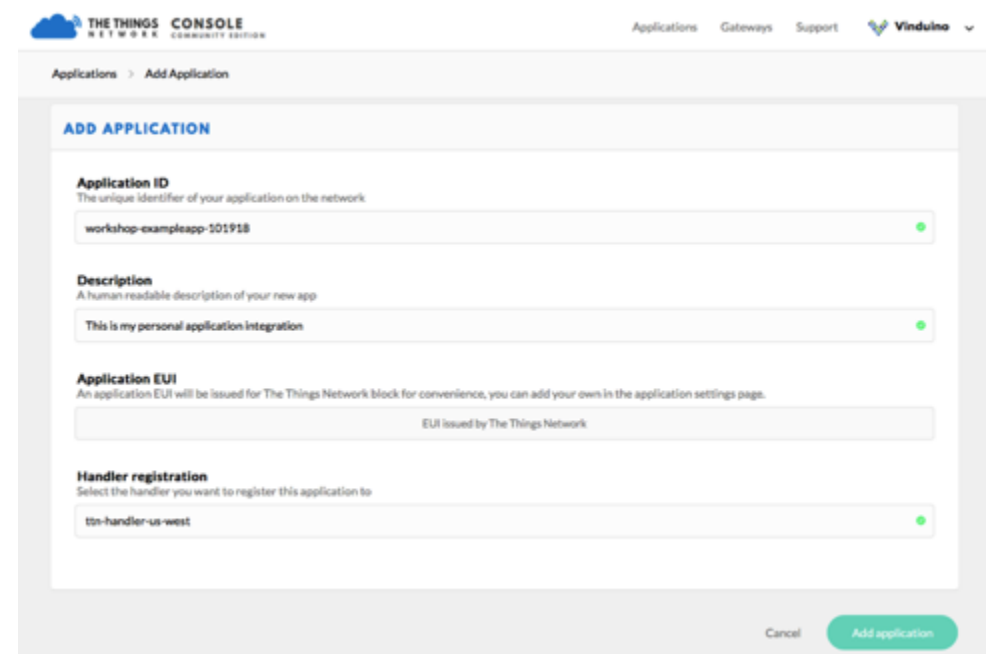


```
Untitled_0 *
File Session Edit Connection Macros View Remote Window Help
New Open Save Connect Disconnect Options Clear Data View Help
at+set_config=lora:default_parameters
OK
at+set_config=lora:region:EU868
OK
at+set_config=lora:class:0
OK
at+set_config=lora:join_mode:0
OK
at+get_config=lora:status
OK Work Mode: LoRaWAN
Region: EU868
MulticastEnable: false
DutycycleEnable: false
Send_repeat_cnt: 0
Join_mode: OTAA
DevEui: 0000000000000000
AppEui: 0000000000000000
AppKey: 00000000000000000000000000000000
Class: A
Joined Network:false
IsConfirm: unconfirm
AdrEnable: true
EnableRepeaterSupport: false
RX2_CHANNEL_FREQUENCY: 869525000, RX2_CHANNEL_DR:3
RX_WINDOW_DURATION: 3000ms
RECEIVE_DELAY_1: 5000ms
RECEIVE_DELAY_2: 6000ms
JOIN_ACCEPT_DELAY_1: 5000ms
JOIN_ACCEPT_DELAY_2: 6000ms
Current Datarate: 5
Primeval Datarate: 5
ChannelsTxPower: 0
UpLinkCounter: 0
DownLinkCounter: 0
Type a command here. Terminate by pressing ENTER.
COM10 (USB Serial Port) /
Connected 00:43:28, 2.676 / 337 bytes
TX RTS DTR DCD
RX CTS DSR RI
```

# TTN APPLICATION AANMAKEN



The screenshot shows the TTN Console home page. At the top, there is a navigation bar with the logo 'THE THINGS NETWORK CONSOLE COMMUNITY EDITION' on the left and 'Applications Gateways Support Vindulno' on the right. The main content area features a welcome message: 'Hi, Reinier!' with a flame icon, followed by 'Welcome to The Things Network Console. This is where the magic happens. Here you can work with your data. Register applications, devices and gateways, manage your integrations, collaborators and settings.' Below this, there are two large white cards. The left card has a blue icon of three stacked squares and the text 'APPLICATIONS'. The right card has a blue icon of a gateway device and the text 'GATEWAYS'.



The screenshot shows the 'ADD APPLICATION' form in the TTN Console. The navigation bar at the top is the same as in the previous screenshot. The main content area is titled 'ADD APPLICATION' and contains several form fields. The first field is 'Application ID' with the description 'The unique identifier of your application on the network' and the value 'workshop-exampleapp-101918'. The second field is 'Description' with the description 'A human readable description of your new app' and the value 'This is my personal application integration'. The third field is 'Application EUI' with the description 'An application EUI will be issued for The Things Network block for convenience, you can add your own in the application settings page.' and the value 'EUI issued by The Things Network'. The fourth field is 'Handler registration' with the description 'Select the handler you want to register this application to' and the value 'ttn-handler-us-west'. At the bottom right, there are two buttons: 'Cancel' and 'Add application'.

# MODULE CONFIGURATIE-2

DevEui=zie code op module  
60c5a8fffe76ffee

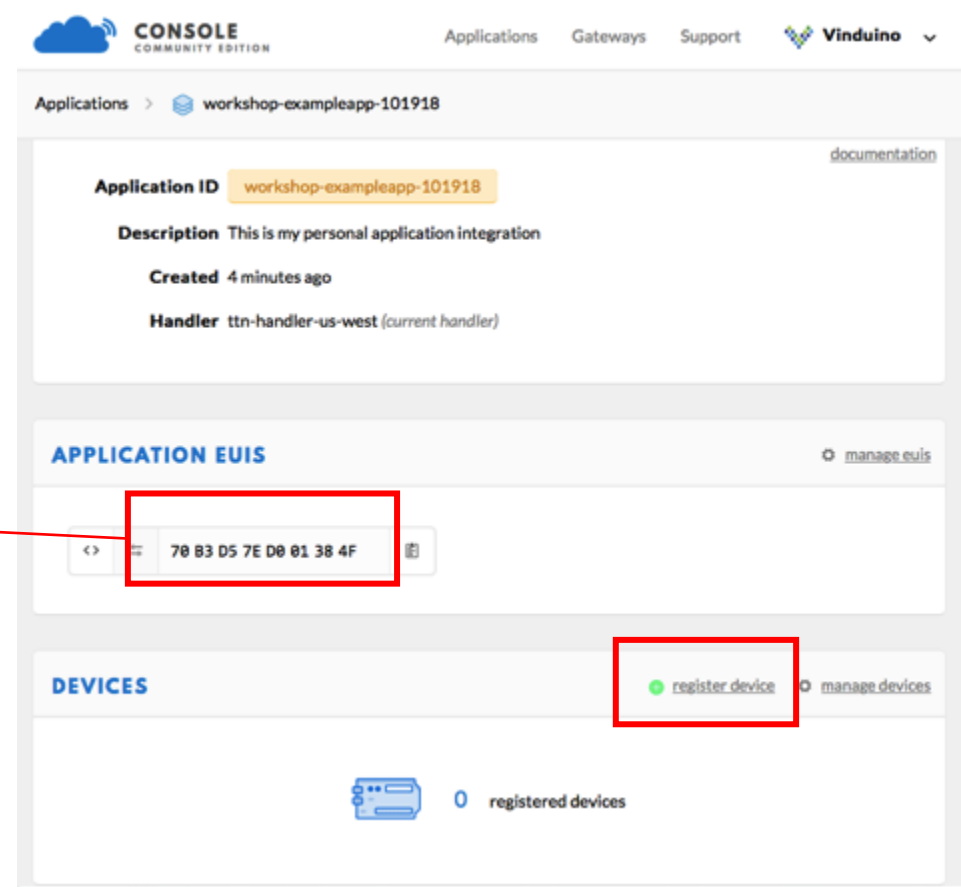
DevEUI is nodig  
voor TTN registratie

RAK4270(H)



EUI: 60c5a8  
fffe76ffee

at+set\_config=lora:app\_eui:AC1F09FFF8684270



The screenshot shows the TTN Console interface for an application named 'workshop-exampleapp-101918'. The interface includes a navigation bar with 'CONSOLE COMMUNITY EDITION', 'Applications', 'Gateways', 'Support', and 'Vinduino'. The main content area displays the application details, including the Application ID, Description, Created time, and Handler. Below this, there is a section for 'APPLICATION EUIS' with a 'manage euis' link. A red box highlights the EUI value '70 B3 D5 7E D0 01 38 4F'. Below the EUIS section, there is a 'DEVICES' section with a 'register device' button highlighted by a red box and a 'manage devices' link. The devices section shows '0 registered devices'.

# TTN REGISTREREN VAN DE NODE

at+set\_config=lora:app\_key:85F6125592D82E29CD7EFD43316CC34A

The screenshot shows the 'REGISTER DEVICE' form in the TTN Console. The form includes the following fields:

- Device ID:** workshop-test-device-1
- Device EUI:** 00 0D B5 39 08 64 36 81
- App Key:** this field will be generated
- App EUI:** 70 83 D5 7E D0 01 38 4F

Buttons for 'Cancel' and 'Register' are visible at the bottom right.

The screenshot shows the 'DEVICE OVERVIEW' page for the device 'workshop-test-device-1'. The page displays the following information:

- Application ID:** workshop-exampleapp-101918
- Device ID:** workshop-test-device-1
- Activation Method:** OTAA
- Device EUI:** 00 0D B5 39 08 64 36 81
- Application EUI:** 70 83 D5 7E D0 01 38 4F
- App Key:** 85F6125592D82E29CD7EFD43316CC34A (highlighted with a red box)
- Status:** never seen
- Frames up:** 0 (with a link to 'reset frame counters')
- Frames down:** 0

# VERBINDEN MET HET LORA NETWORK

The image shows a terminal window on the left and a web browser window on the right, both displaying Lora network connection information.

**Terminal Window (Untitled\_0\*):**

```
File Session Edit Connection Macros View Remote Window Help
New Open Save Connect Disconnect Options Clear Data View Help
at+join
OK Join Success
```

**Web Browser Window (Application data - rcamf-demo):**

eu1.cloud.thethings.network/console/applications/rcamf-demo/data

THE THINGS STACK SANDBOX

rcamf-demo  
ID: rcamf-demo  
Last activity 7 minutes ago • 1 End devices

TIME	ENTITY ID	TYPE	DATA PREVIEW
↑ 17:49:32	rak-76fee	Forward join-accept message	DevAddr: 26 0B 57 68 JoinEUI: AC 1F 09 FF F8 68 42 70 DevEUI: 60 C5 A8 FF FE 76 FF EE
↑ 15:58:33	rak-76fee	Forward uplink data message	
↑ 15:57:44	rak-76fee	Forward uplink data message	
↑ 15:49:25	rak-76fee	Forward uplink data message	
↑ 15:42:26	rak-76fee	Forward uplink data message	
↑ 15:30:16	rak-76fee	Forward uplink data message	
↑ 15:29:56	rak-76fee	Forward uplink data message	
↑ 15:27:54	rak-76fee	Forward join-accept message	
↑ 13:11:14	rak-76fee	Forward join-accept message	

COM10 (USB Serial Port) / 115200 8-N-1  
Connected 00:03:10, 27 / 16 bytes

TX RTS  
RX CTS



# NU KUNNEN WE DATA ZENDEN!!

The image shows a terminal window on the left and a web browser console on the right. The terminal window, titled 'Untitled\_0 \*', shows the following text:

```
at+join
OK Join Success
at+send=lora:2:FF
OK
Type a command here. Terminate by pressing ENTER.
COM10 (USB Serial Port) / 115200 8-N-1
Connected 00:24:07, 31 / 39 bytes
```

The web browser console, titled 'Application data - rcamf-demo', shows a list of messages. The top message is highlighted with a red box:

TIME	ENTITY ID	TYPE	DATA PREVIEW
↑ 18:10:41	rak-76ffee	Forward uplink data message	DevAddr: 26 0B 57 68 Payload: { elevation: 0, field1: 255, field2: null, field3: null, fi
↑ 17:49:32	rak-76ffee	Forward join-accept message	DevAddr: 26 0B 57 68 JoinEUI: AC 1F 09 FF F8 68 42 70 DevEUI: 60 C5 A8 FF FE 76 FF EE
↑ 15:58:33	rak-76ffee	Forward uplink data message	
↑ 15:57:44	rak-76ffee	Forward uplink data message	
↑ 15:49:25	rak-76ffee	Forward uplink data message	
↑ 15:42:26	rak-76ffee	Forward uplink data message	
↑ 15:30:16	rak-76ffee	Forward uplink data message	
↑ 15:29:56	rak-76ffee	Forward uplink data message	
↑ 15:27:54	rak-76ffee	Forward join-accept message	

# ONTVANGEN VAN DATA

Screenshot of the The Things Network console showing the configuration for a downlink message. The device ID is 'rak-76ffee'. The 'Schedule downlink' section is active. Under 'Insert Mode', 'Replace downlink queue' is selected. The 'FPort' is set to 2. Under 'Payload type', 'Bytes' is selected. The 'Payload' field is highlighted with a red box and contains the text 'AA BB CC'. Below the payload field, it says 'The desired payload bytes of the downlink message'. There is a 'Confirmed downlink' checkbox which is unchecked. A 'Schedule downlink' button is at the bottom.

Screenshot of a terminal window showing AT commands and responses. The terminal title is 'Untitled\_0 \*'. The menu bar includes File, Session, Edit, Connection, Macros, View, Remote, Window, and Help. The toolbar includes icons for New, Open, Save, Connect, Disconnect, Options, Clear Data, View, and Help. The terminal output shows the following commands and responses:

```
at+join
OK Join Success
at+send=lora:2:FF
OK

at+send=lora:2:bb
OK
at+send=lora:2:FF
OK
at+recv=2,-43,14,3:aabbcc
```

The response 'at+recv=2,-43,14,3:aabbcc' is highlighted with a red box. A blue callout box points to this response with the text 'Class A device ontvangt alleen na zenden'. The terminal prompt is 'Type a command here. Terminate by pressing ENTER.'. At the bottom, the terminal is connected to 'COM10 (USB Serial Port) / 115200 8-N-1' and shows status indicators for TX, RX, RTS, CTS, DTR, DSR, DCD, and RI.

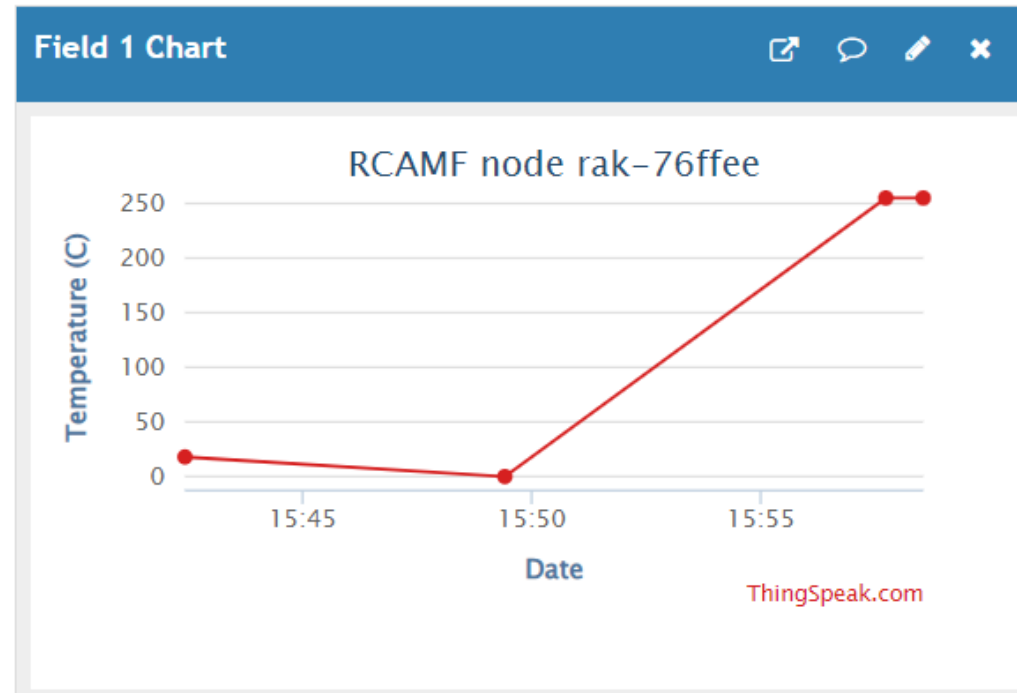
# VISUALISEER SENSOR DATA

## TOEVOEGEN VAN THINGSPEAK INTEGRATIE

- [https://nl.mathworks.com/help/thingspeak/write\\_things\\_network.html](https://nl.mathworks.com/help/thingspeak/write_things_network.html)

## TEST INTEGRATIE

- `at+send=lora:2:ff`
- `02=data channel`
- `ff= HEX Value = 255`



# THINGSPEAK MODULE TABEL

ThingSpeak Publiek Internet adres		
60C5A8FFFE76FFEE	rcamf-demo	https://thingspeak.com/channels/2655069
60C5A8FFFE7703F2	rcamf-demo-2	https://thingspeak.com/channels/2656342
60C5A8FFFE76FE1C	rcamf-demo-3	https://thingspeak.com/channels/2657134
60C5A8FFFE78179D	rcamf-demo-4	https://thingspeak.com/channels/2657147
60C5A8FFFE770456	rcamf-demo-5	
60C5A8FFFE7703DE	rcamf-demo-6	
60C5A8FFFE770397	rcamf-demo-7	
60C5A8FFFE78179E	rcamf-demo-8	
60C5A8FFFE770400	rcamf-demo-9	
60C5A8FFFE7703C2	rcamf-demo-10	

The screenshot displays the ThingSpeak pricing calculator. It includes a navigation bar with 'Channels', 'Apps', 'Devices', and 'Support' menus, along with 'Commercial Use' and 'How to Buy' links. The calculator is divided into two main sections: 'Pricing calculator' and 'Purchase'. In the 'Pricing calculator' section, there are two input fields: 'How many channels?' with a current value of 4 and a 'To be added' value of 6, and 'How often will they collect data?' with a frequency of 1 hour. Below these fields, it states 'Calculated number of channels needed: 10'. The 'Purchase' section shows a 'License type' of 'Home', 'ThingSpeak units' of 1, and a 'Total' price of 'USD 95.00/year'. A green 'Purchase' button is located at the bottom of the purchase section, with a note below it: 'You will be taken to the MathWorks store to complete your purchase.'

# THINGSPEAK PAYLOAD FORMATTER

The screenshot shows the ThingsSpeak console interface for an application named 'rcamf-demo'. The page title is 'Default uplink payload formatter'. A notification states: 'You can use the "Payload formatter" tab of individual end devices to test uplink payload formatters and to define individual payload formatter settings per end device.' Under the 'Setup' section, the 'Formatter type\*' is set to 'Custom Javascript formatter'. The 'Formatter code\*' field contains the following JavaScript code:

```
1 function Decoder(b, port) {
2
3   var var1 = b[0];
4   var var2 = b[1];
5   var var3 = b[2];
6   var var4 = b[3];
7   var var5 = b[4] | b[5] << 8;
8   var var6 = b[6] | b[7] << 8;
9   var var7 = b[8] | b[9] << 8;
10  var var8 = ( b[10] | b[11] << 8 )/100;
```

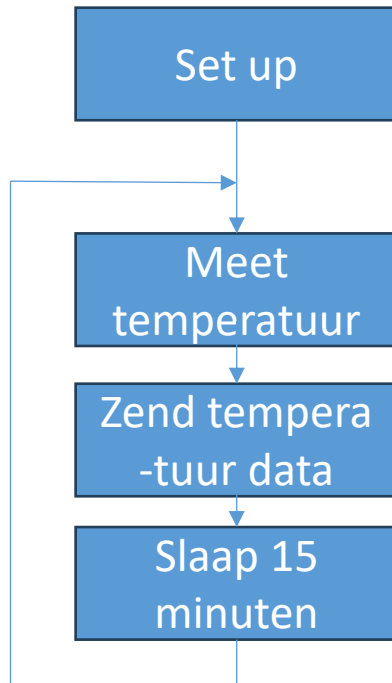
```
function Decoder(b, port) {
```


```
  var var1 = b[0];
  var var2 = b[1];
  var var3 = b[2];
  var var4 = b[3];
  var var5 = b[4] | b[5] << 8;
  var var6 = b[6] | b[7] << 8;
  var var7 = b[8] | b[9] << 8;
  var var8 = ( b[10] | b[11] << 8 )/100;
  var lat = ( b[12] | b[13] << 8 | b[14] << 16 | ( b[14] & 0x80 ? 0xFF << 24 : 0 ) ) / 10000;
  var lon = ( b[15] | b[16] << 8 | b[17] << 16 | ( b[17] & 0x80 ? 0xFF << 24 : 0 ) ) / 10000;
  var elev = b[18] | b[19] << 8;
```

```
  return {
    field1: var1,
    field2: var2,
    field3: var3,
    field4: var4,
    field5: var5,
    field6: var6,
    field7: var7,
    field8: var8,
    latitude: lat,
    longitude: lon,
    elevation: elev
  }
}
```

# VOORBEELDTOEPASSING MET ARDUINO

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**73, PA3AAA**

**RCAMF**

**Amersfoort, 2024**