



TINYGS

EINE SATELLITENBODENSTATION

IM HEIMBAU

NICO MAAS

PI AND MORE 13

WER BIN ICH?

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AGENDA

- Einführung
 - TinyGS
 - LoRa (Exkurs)
- Eine eigene Groundstation bauen
- Ende


EINFÜHRUNG TINYGS





Welcome to TinyGS, the Open Source Global Satellite Network

TinyGS is an open network of Ground Stations distributed around the world to receive and operate LoRa satellites, weather probes and other flying objects, using cheap and versatile modules.

This project is based on ESP32 boards and currently it is compatible with sx126x and sx127x LoRa modules but we plan to support more radio modules in the future.


3015
Members


1246
Active stations


3298414
Received packets

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

- Home
- Stations
- Satellites
- Packets

FEES

FEES (Flexible Experimental Embedded Satellite) is a self funded, collaborative project by the Italian GP Advanced Projects aimed at developing a low cost platform for In Orbit Testing and Validation of Electronics components.

The whole satellite, including the electronics boards, is entirely design and manufactured within the project. The flight will be also the validation of this platform and components. The 0.3 kg satellite is built to a 0.3UCubeSat (10 cm x 10 cm x 3 cm) form factor.

FEES Mission had three main goals. First of all, we aimed to obtain an in-orbit qualification of both an attitude determination architecture and a commercial GPS receiver. FEES also validated the exploitation of IRIDIUM global network to receive data, testing and supporting on-board traditional radio transmissions, which allowed us to manage the mission without a direct link to ground station and receiving early notifications. Finally, we meant to test a low cost UHF receivers with advanced modulation protocols.

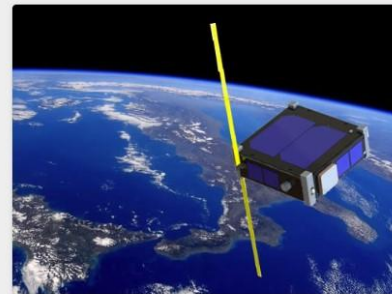
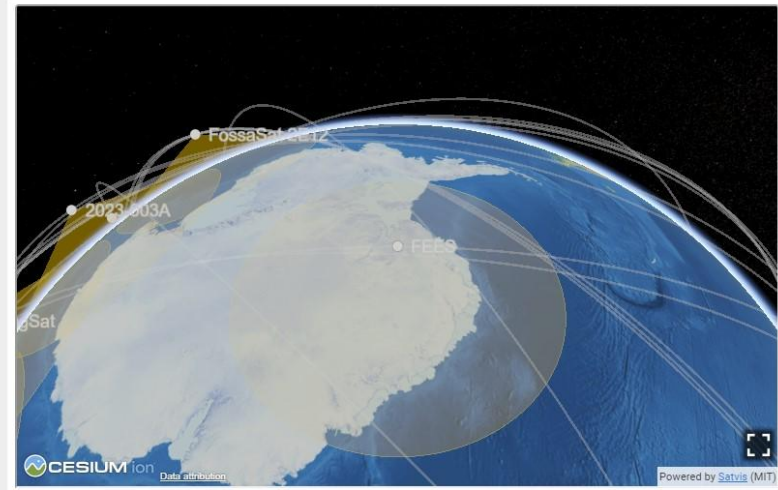
- **Status:** Supported
- **Launch Date:** Mar 22, 2021 6:07 AM

TLEs

```
FEES
1 48082U 21022AL 23098.71199112 .00032873 00000+0 14181-2 0 9991
2 48082 97.5049 0.7229 0011208 180.3496 179.7734 15.22411078111272
```

Last telemetry

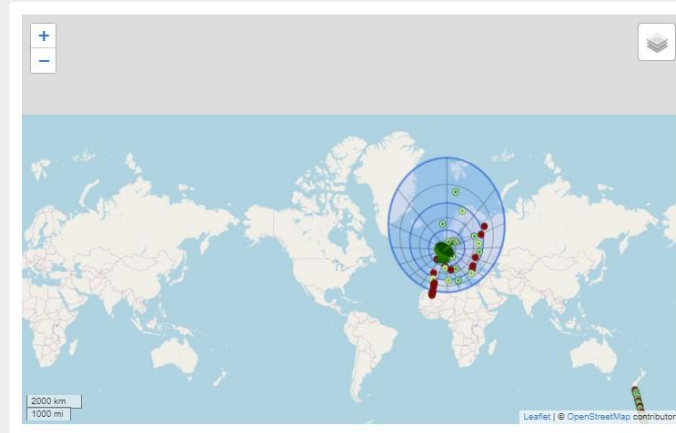
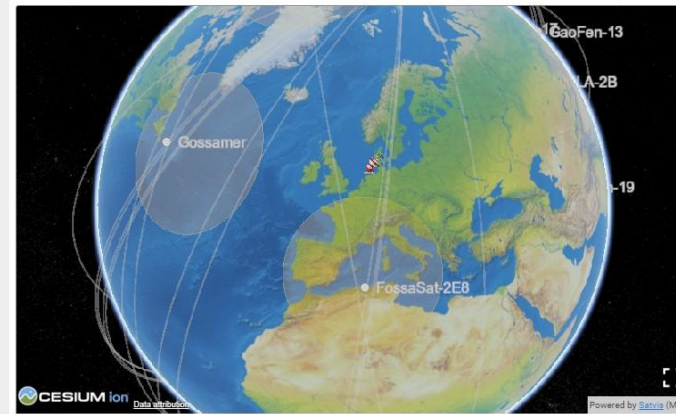
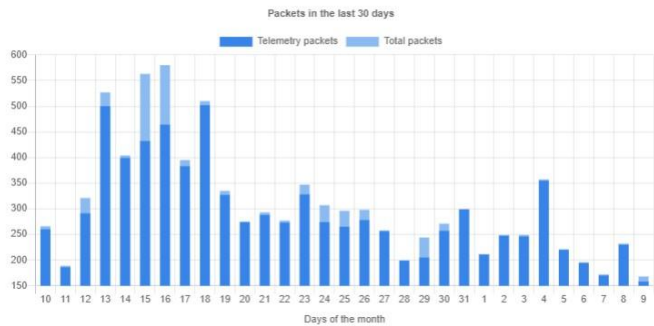
500mW 3722mV 212.75mA
188.74mV 303.81mA
1.11604846



| | | | |
|---|--------------------|---------------------------|---|
| FEES Apr 9, 2023 3:01 PM (13 minutes ago) | Mode LoRa@437.2 | Received by 2 stations | 500mW 3722mV 212.75mA 188.74mV 303.81mA 1.11604846 |
| FEES Apr 9, 2023 2:59 PM (15 minutes ago) | Mode LoRa@437.2 | Received by 5 stations | 500mW 3726mV 213.65mA 202.05mV 303.91mA 1.11604728 |

| | | | |
|--------------------------------|-----------------------------------|--------------------------------------|-------------------------------|
| Status ● Online | Listening FossaSat-2E8 | Version 2303291 | Creation date 2 years ago |
| Last seen a few seconds ago | Last Packet a few seconds ago | Position (Lat, Long) 53.546, 7.58 | QTH Locator JO33sn |
| Elevation 9.00 m | Auto tuning ON | Test mode OFF | Confirmed packets 56146 |
| Telemetry packets 47924 | Type of antenna 5/8λ Collinear | Band 400 - 465 MHz | Record distance 13236.5 Km |

Description
Antenna: X-5000 Preamplifier: SSB DBA 270 Receive: LILYGO® TTGO LoRa 433MHz OLED 0.96 Inch



| | | | | | | | | | | |
|--|--------------------|----------------|--------------------|---------------------|--------------------|-----------------|---------------------------------|------------------------------|-----------|-----------------------------|
| FossaSat-2E8 Apr 9, 2023 3:22 PM (a few seconds ago) | Mode LoRa@401.7 | Power 158mW | Distance 1254Km | Elevation 17.68° | RSSI -94.75 dBm | SNR -2.75 dB | Predicted Doppler -9024.40Hz | Frequency Error 5643.96Hz | CRC Error | Received by 138 Stations |
|--|--------------------|----------------|--------------------|---------------------|--------------------|-----------------|---------------------------------|------------------------------|-----------|-----------------------------|

| | | | | | | | | | | |
|----------------|------|-------|----------|-----------|------|-----|-------------------|-----------------|-----------|-------------|
| Unknown | Mode | Power | Distance | Elevation | RSSI | SNR | Predicted Doppler | Frequency Error | CRC Error | Received by |
|----------------|------|-------|----------|-----------|------|-----|-------------------|-----------------|-----------|-------------|

FEES

Received on: April 9, 2023 2:59 PM
LoRa 437.2 Mhz SF: 9 CR: 5 BW: 125 kHz
Sat in Umbra Eclipse Depth: 26.07°
Theoretical coverage 4940 km

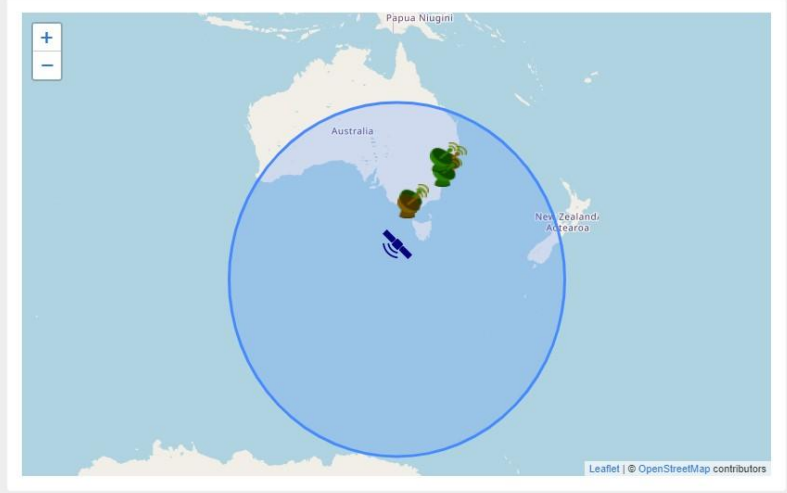
- 500mW 3726mV 213.65mA
- 202.05mV 303.91mA
- 1.11604728

Hexadecimal view

[Download](#)

```
0 1 2 3 4 5 6 7 8 9 A B C D E F 0123456789ABCDEF
0000 00 FE E5 2F B0 F8 12 B1 00 7C 00 00 00 01 00 00 .../.....|.....
0010 00 00 F8 07 CB 0B CA 08 7A 00 7D 00 15 00 77 00 .....z.}...w.
0020 79 00 02 01 6F 01 A3 00 B3 00 A9 00 BF 87 59   y...o.....Y
```




```
{
  header: {
    msgTypeId0: [
      0: 0
    ],
    msgTypeId1: 254,
    msgTypeId2: 229
  },
  payload: {
    frameId: 45103,
    timestamp: 11604728,
    automaticFwCheckerCounter: 124,
    commandedFwCheckerCounter: 1,
    unknown4: 0,
    vanalog: 2040,
    vacd2v5: 3019,
    vbat: 2250,
    vsol: 122,
    pxCellV: 125,
    mxCellV: 21,
    pyCellV: 119,
    pzCellV: 121,
    iload: 258,
    icharger: 367,
    pxCellI: 163,
    mxCellI: 179,
    pyCellI: 169,
  }
}
```



| Station Name | Distance | Elevation | Time | RSSI | SNR | Predicted Doppler | Frequency Error | CRC Error |
|---------------|----------|-----------|--------------|-------------|-----------|-------------------|-----------------|-----------|
| GosfordHill_1 | 1580 Km | 12.18° | 14:59:55.399 | -129.75 dBm | -11.75 dB | -9197.33 Hz | 2678.063 Hz | |

FEES

Received on: April 9, 2023 2:59 PM
LoRa 437.2 Mhz SF: 9 CR: 5 BW: 125 kHz
Sat in Umbra  Eclipse Depth: 26.07°
Theoretical coverage 4940 km

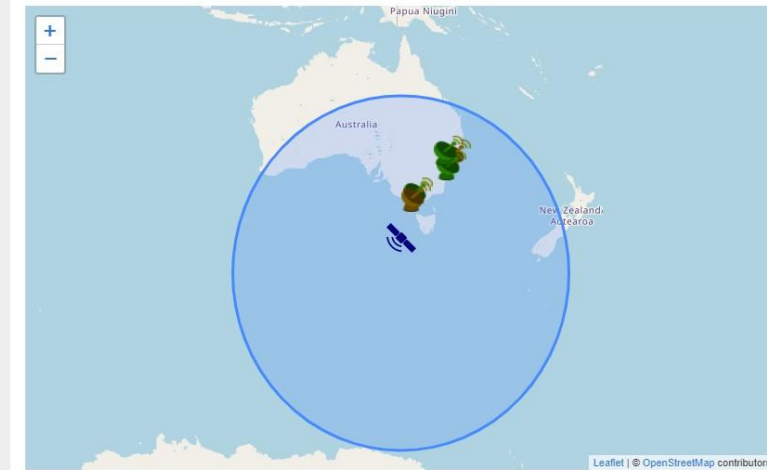
 500mW  3726mV  213.65mA
 202.05mV  303.91mA
 1.11604728

Hexadecimal view

[Download](#)

```
0 1 2 3 4 5 6 7 8 9 A B C D E F 0123456789ABCDEF
0000 00 FE E5 2F 80 F8 12 01 00 7C 00 00 01 00 00 .../.....|.....
0010 00 00 F8 07 CB 08 CA 08 7A 00 7D 00 15 00 77 00 .....z.}...w.
0020 79 00 02 01 6F 01 A3 00 B3 00 A9 00 BF 87 59   y...o.....Y
```

```
pyCell: 169,
unknown13: 191,
unknown14: 22919,
vSol: 0.20205366015236834,
tinygsTxPower: 500,
tinygsSolarVoltage: 202.05366015236834,
iPxCell: 0.134978469691951,
vPyCell: 0.09854256376283538,
vMxCell: 0.01738986419344154,
vPxCell: 0.10351109638953296,
iCharger: 0.3039085789996688,
tinygsChargeCurrent: 303.9085789996688,
iLoad: 0.21364690294799601,
coefficient: 0.00028088771162637,
tinygsLoadCurrent: 213.646902947996,
iPyCell: 0.13994700231864857,
vBat: 3.7263994700231864,
tinygsTimestamp: 11604728,
vPzCell: 0.10019874130506791,
iMxCell: 0.14822789002981118,
tinygsBatVoltage: 3726.3994700231865
},
type: "Beacon",
telemetry: true
}
```



Station Name

 GosfordHill_1

 Distance

1580 Km

 Elevation

12.18°

 Time

14:55:39.99

 RSSI

-129.75 dBm

 SNR

-11.75 dB

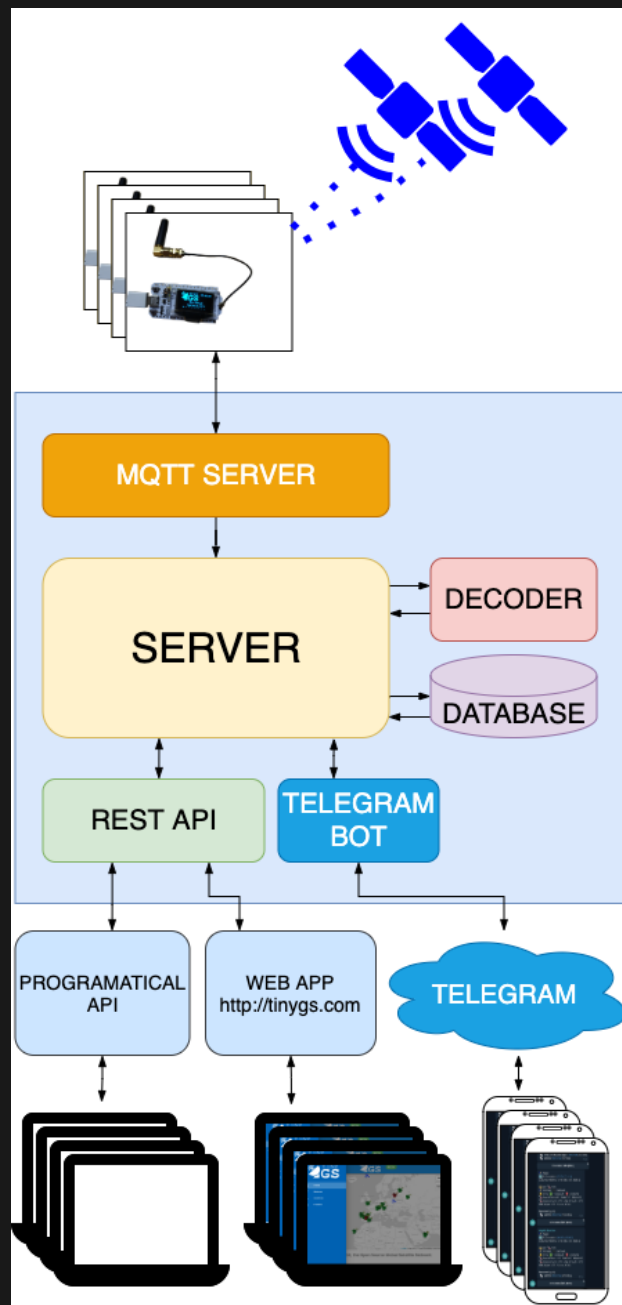
 Predicted Doppler

-9197.33 Hz

 Frequency Error

2678.063 Hz

 CRC Error



EINFÜHRUNG

LORA (EXKURS)

LORA

- proprietärer, energiesparender Funkstandard der Firma Semtech (USA)
- Verwendet u.a. das ISM (433,05 - 434,79 MHz) und SRD (863 - 870 MHz) Band in Europa
- Ermöglicht Datenraten von 0,3 - 50 kbit/s bei hoher Reichweite (Stadt ca. 2 km, Land ca. 40 km) und niedrigem Energiebedarf
- Aktuelle Verbreitung ca. 178 Millionen Geräte weltweit (März 2021)

LORAWAN

- Offener Standard der LoRa implementiert zur Entwicklung von LPWAN-IoT (Low Power Wide Area Networks)
- z.T. kostenfrei durch die Community betriebene Netzwerke für Sensoren aller Art (quasi Freifunk für Sensoren...)
- Verwenden AES 256 Bit Verschlüsselung
- Down- & Uplink möglich
- The Things Network (zentralisiert)
- Chirp Stack (selfhosted)

We are a global collaborative Internet of Things ecosystem that creates networks, devices and solutions using LoRaWAN®.

[Start building](#)

[Learn more](#)



91.9K
Forum posts

65.3M
Messages today

153
Countries

1.3K
Certified developers

188.8K
Members

21.2K
Gateways

1.4M
YouTube views

16.5K
YouTube subscribers

812
GitHub sta



Powered by
Raspberry Pi



2

WisGate OS





RAK

RAK11300

FCC ID: 2AF6B-RAK11300

Made in China







CE

LoRa

Entfernungen

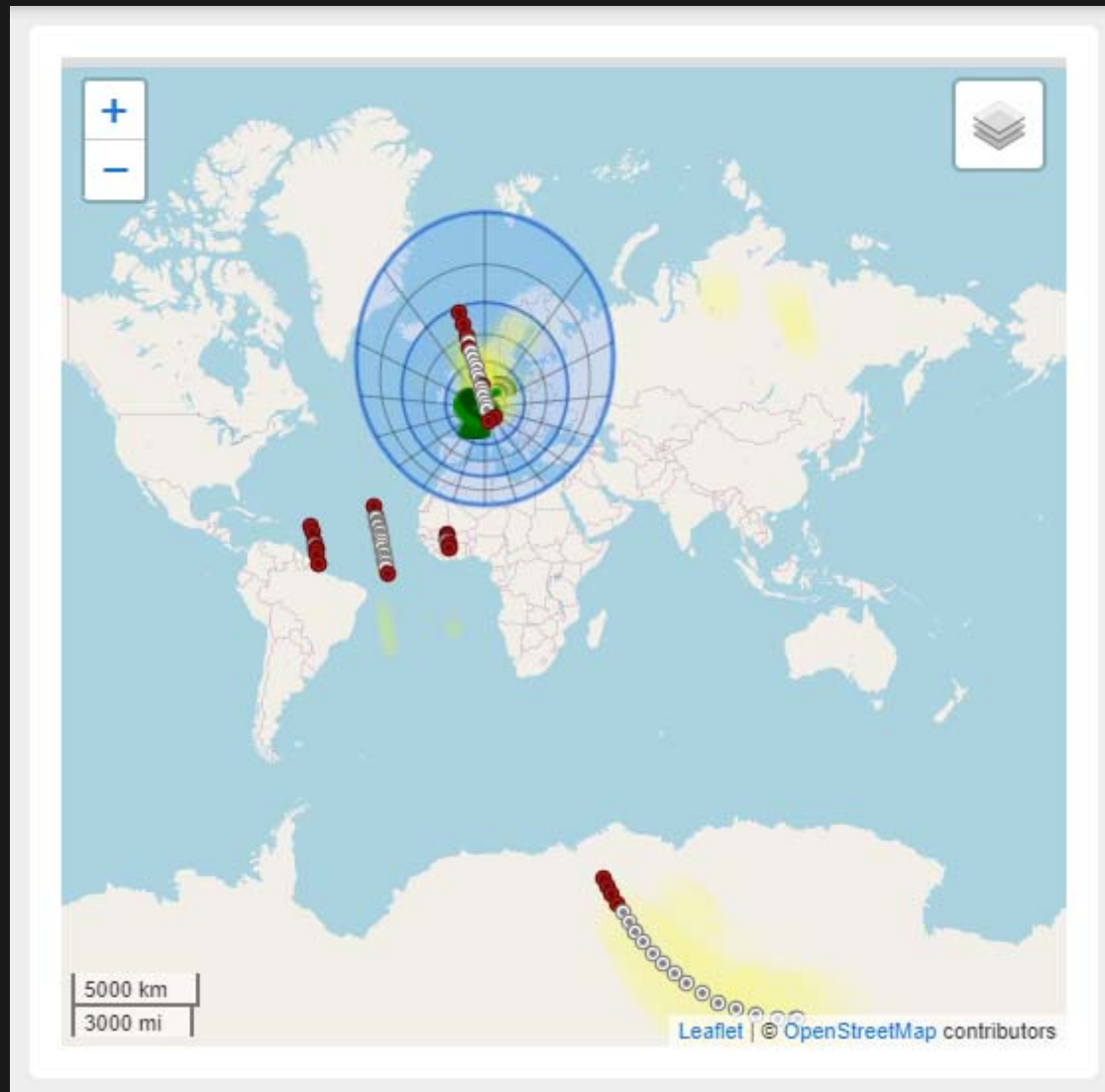
- Stadt ca. 2 km
- Land ca. 40 km

Bei geringen Sendeleistungen... Wie sieht das bei
“freiem Feld” von einem Satellit in ca. 400 km Orbit
und 3 Watt Sendeleistung aus?

| | | | | | | | |
|--|-------------|---|--|---|--|----------|-------------------|
|  2023-003A  | Mode |  Power |  Distance |  Elevation |  RSSI | SNR | Predicted Doppler |
| Feb 7, 2023 10:36 PM (9 hours ago) | LoRa@400.13 | -- | 12607Km | -71.29° | -107.25 dBm | -3.25 dB | 2996.09Hz |
| Frequency Error | CRC Error | Received by | | | | | |
| 15359.54Hz | | 114 Stations | | | | | |

12607 km...

Bei -3.25 dB SNR



(114 Zeugen)

EINE EIGENE GROUNDSTATION BAUEN?

<https://github.com/G4lile0/tinyGS/wiki>

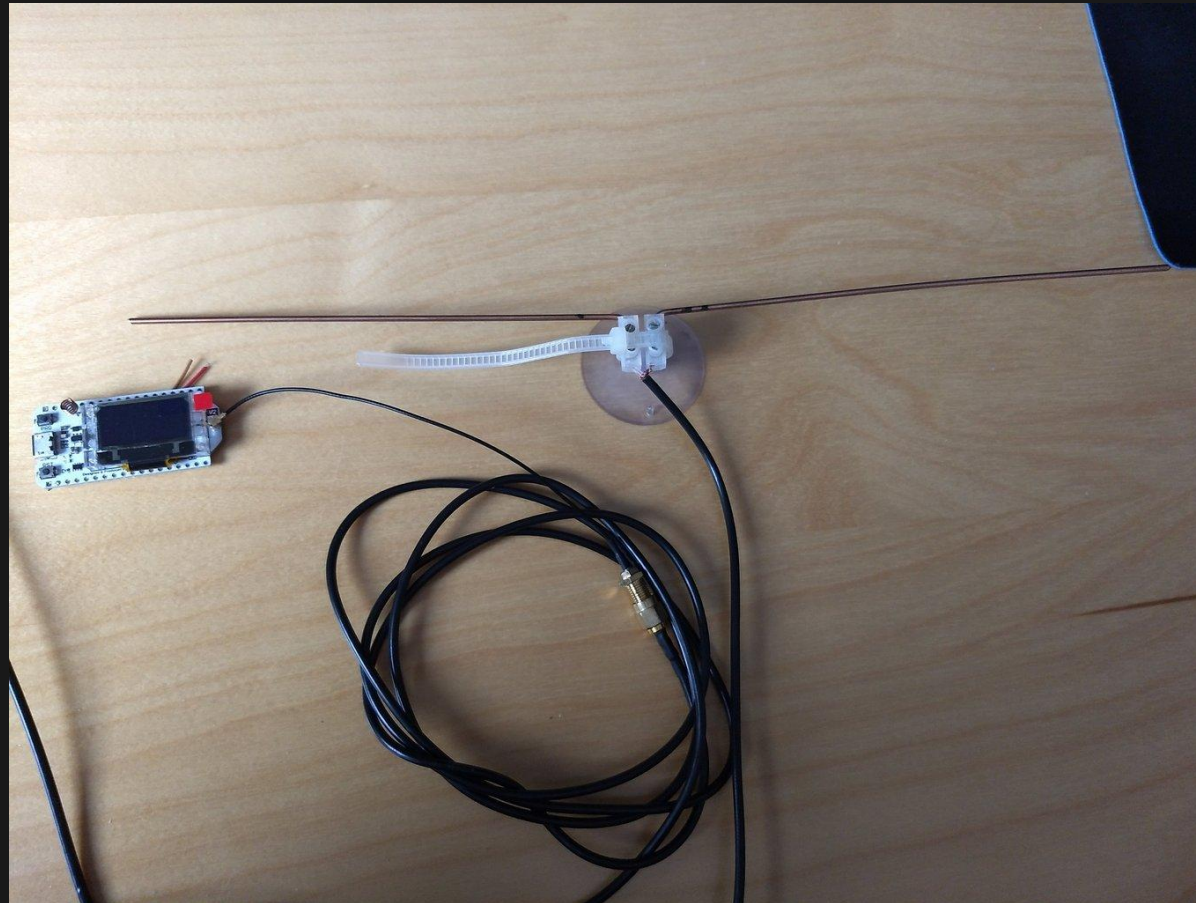
HARDWARE

- Kompatibles LoRa / ESP32 Modul + Netzteil
 - z.B. Heltec WiFi LoRa 32 V2 @ 433 MHz
- U.FL / SMA Female Adapter (“Pigtail”)
- 433 MHz Antenne
 - kaufen
 - Selbstbau
- WLAN
- Handy (+Telegram)

LAMBDA/4 ANTENNE IM SELBSTBAU

- SMA Male Koaxial Kabel, abisoliert
- 2x Lüsterklemmen
- 2x Schweißdraht (ca. 17 cm Elemente)
- ein Element an Ground anschließen
- das andere an Signal anschließen

BEISPIEL FÜR FERTIGE GROUND STATION



WICHTIG

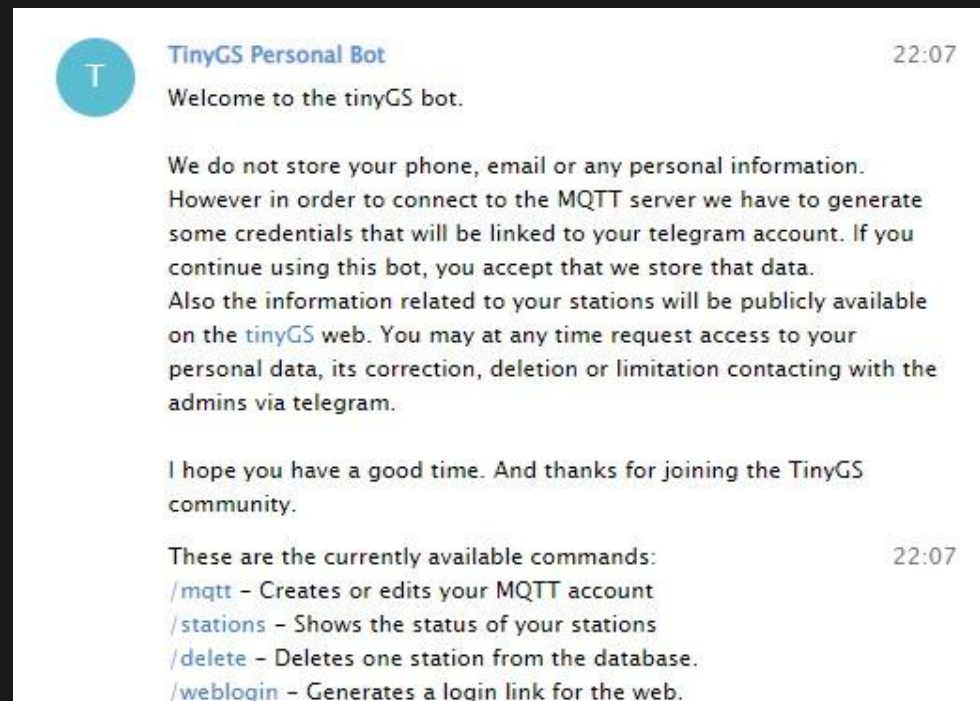
- Bitte niemals ein Radio/Sender-/Empfänger ohne Antenne betreiben!
- Senden außerhalb bestimmter Bänder und Leistungen sind nur mit entsprechender Lizenz erlaubt!

GROUND STATION ANMELDEN 1/2

Telegram Gruppe beitreten,

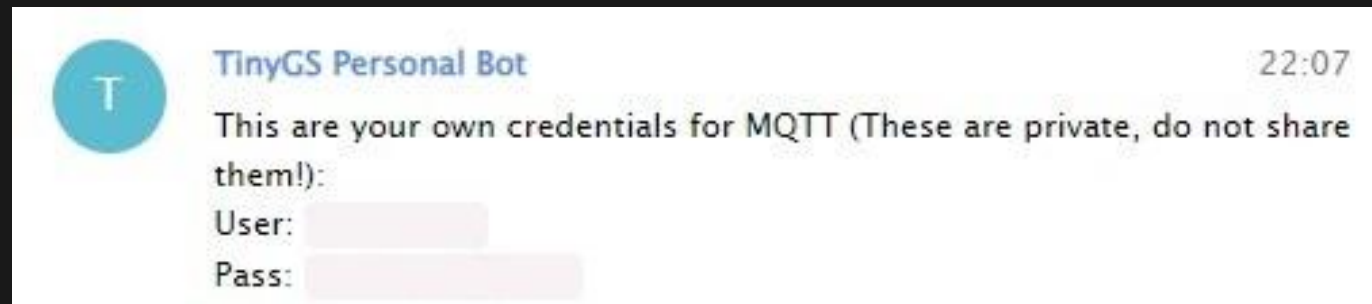
<https://t.me/joinchat/DmYSElZahiJGwHX6jCzB3Q>

TinyGS Personal Bot mit /start anschreiben:



GROUND STATION ANMELDEN 2/2

TinyGS Personal Bot mit /mqtt anschreiben:



Die erhaltenen Logindaten aufschreiben für später

SOFTWARE

- <https://github.com/G4lile0/tinyGS/releases>
- Uploader für Win/Lin/Mac herunterladen und damit das Modul flashen
- Modul startet neu, auf Handy das WLAN “My TinyGS” suchen und damit verbinden
- Browser öffnen und zu <http://192.168.4.1> navigieren





System configuration

GroundStation Name (will be seen on the map)

Password for this dashboard (user is **admin**)

WiFi SSID

WiFi password

Latitude (will be public)

Longitude (will be public)

KONFIGURATION 1/4

- GROUNDSTATION NAME
- PASSWORD Dashboard
 - lokales TinyGS Passwort
- WiFi SSID and WiFi PASSWORD
 - Login lokales WLAN
- TIME ZONE
- LATITUDE / LONGITUDE
 - Koordinaten GS
- MQTT_USER / MQTT_PASS
 - vom Telegram Bot erhalten

KONFIGURATION 2/4

- BOARD TYPE
 - wichtig, gemäß eigenem einstellen
- OLED Bright
 - kann auf 0 gesetzt werden um Display auszuschalten
- Enable TX
 - wenn keine Funkamateurlizenz immer aus(!)

KONFIGURATION 3/4

- Automatic tuning
 - immer an, stellt sich selbst auf den nächsten Satelliten ein
- Telemetry to third party
 - kann ausgeschaltet werden um keine Daten an third-parties weiterzugeben
- Automatic Firmware Update
 - kann ausgeschaltet werden wenn man bedenken hat

KONFIGURATION 4/4

- Apply
 - Speichert die Optionen, dann im Hauptmenü
Restart Station wählen
- Station startet neu, verbindet sich mit dem WLAN und bezieht sich per DHCP eine Adresse (zeigt diese im OLED an falls nicht ausgeschaltet)
- Station kann jederzeit über diese IP und Admin Password im lokalen LAN konfiguriert, überwacht und neugestartet werden



Groundstation Status

| | |
|-------------|-----------|
| Name | |
| Version | 2105260 |
| MQTT Server | CONNECTED |
| WiFi | CONNECTED |
| Radio | READY |
| Test Mode | DISABLED |

Modem Configuration

| | |
|------------------|---------------|
| Listening to | FossaSat-2E12 |
| Modulation | LoRa |
| Frequency | 401.70 |
| Spreading Factor | 11 |
| Coding Rate | 8 |
| Bandwidth | 125.00 |

Last Packet Received

| | |
|-----------------|------------|
| Received at | 15:38:50 |
| Signal RSSI | -123.50 |
| Signal SNR | -9.50 |
| Frequency error | 5714.21 |
| | CRC ERROR! |

```
00:00:01 0 - reboot the board
00:00:01 p - send test packet to nearby stations (to check transmission)
00:00:01 -----
14:51:22 Attempting MQTT connection...
14:51:22 If this is taking more than expected, connect to the config panel on the ip:
14:51:27 Attempting MQTT connection...
14:51:27 If this is taking more than expected, connect to the config panel on the ip:
14:51:28 Connected to MQTT!
14:52:28 [SX12x8] Starting to listen to FossaSat-2E8
15:08:28 [SX12x8] Starting to listen to GaoFen-17
15:25:28 [SX12x8] Starting to listen to FossaSat-2E12
15:35:42 [SX12x8] RSSI: -136.000000 dBm
[SX12x8] SNR: -21.000000 dB
[SX12x8] Frequency error: -3488.088135 Hz
15:35:42 [SX12x8] CRC error! Data cannot be retrieved
15:38:50 [SX12x8] RSSI: -123.500000 dBm
[SX12x8] SNR: -9.500000 dB
[SX12x8] Frequency error: 5714.214844 Hz
15:38:50 [SX12x8] CRC error! Data cannot be retrieved
15:43:05 [SX12x8] Starting to listen to 2023-003A
15:43:28 [SX12x8] Starting to listen to FossaSat-2E12
```

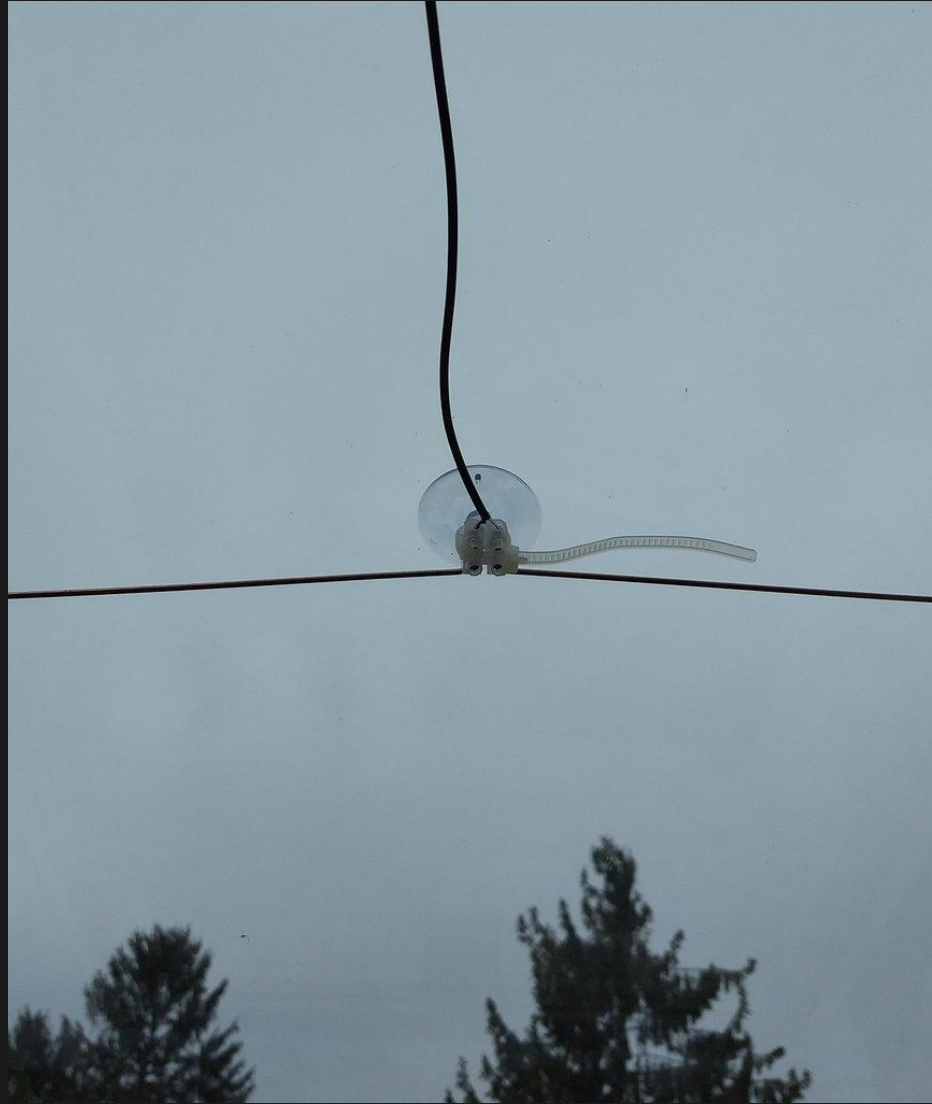
to review the MQTT connection credentials.
to review the MQTT connection credentials.

Enter command

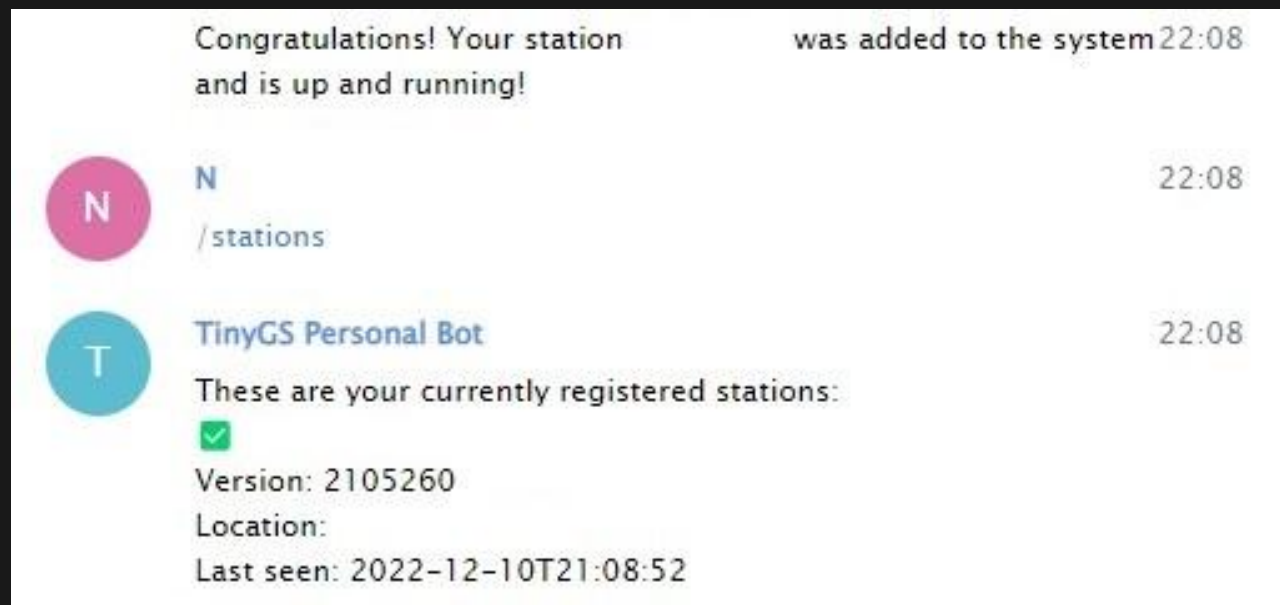
Go Back

AUFSTELLEN & ANSCHLIESSEN

- ideal: Dachfenster mit freiem Blick zum Himmel
- allgemein Indoor vorzuziehen für den Testbetrieb
 - Blitzschutz/Stromdurchführung nicht benötigt
 - (bei großen Antenne) Windlastprobleme egal
 - Erlaubnis vom Vermieter nicht benötigt
 - ...

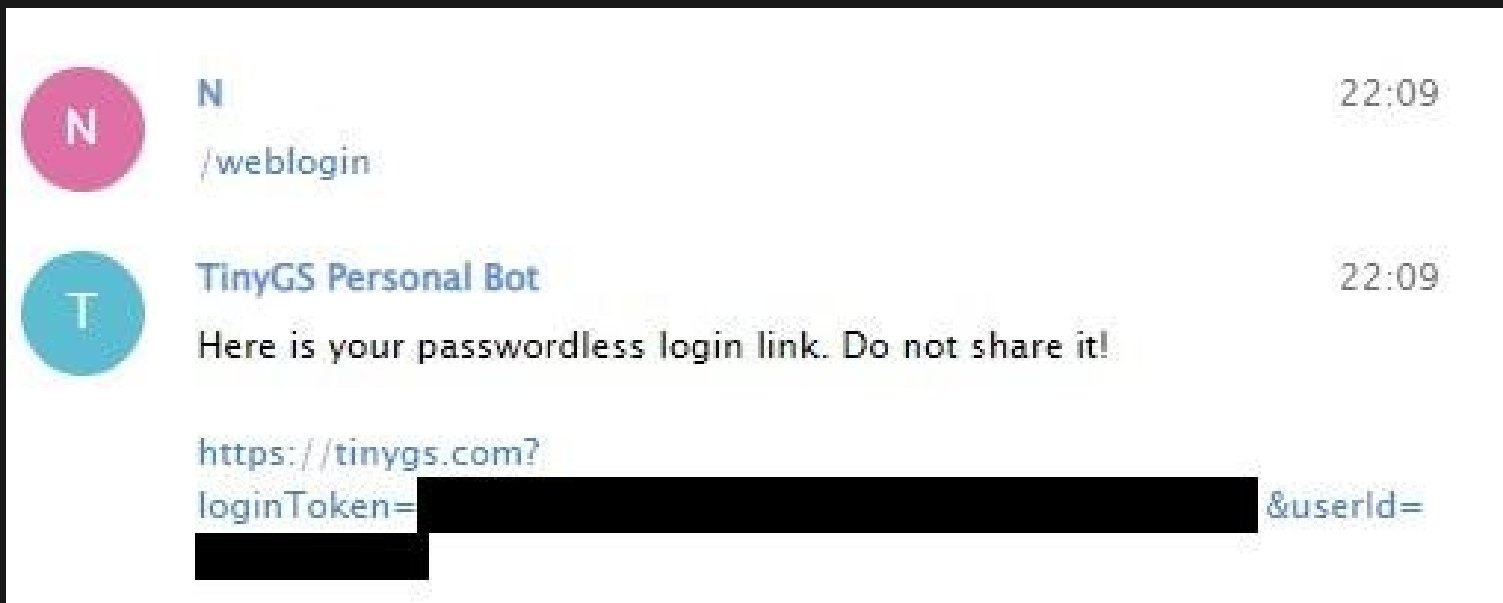


WAS SAGT DER TELEGRAM BOT?



REMOTE LOGIN BESORGEN

mittels /weblogin






The screenshot shows a chat interface with two messages. The first message is from a user with a pink circular profile picture containing the letter 'N'. The second message is from a user with a teal circular profile picture containing the letter 'T', identified as 'TinyGS Personal Bot'. The bot's message contains a URL with a redacted login token and user ID.

N /weblogin 22:09

TinyGS Personal Bot 22:09
Here is your passwordless login link. Do not share it!

[https://tinygs.com?
loginToken=\[REDACTED\]&userId=\[REDACTED\]](https://tinygs.com?loginToken=[REDACTED]&userId=[REDACTED])

TINYGS LOGIN

BETASIGN OUT

User Console

We are still working on this component ;)

We are still working on this component ;)

| Station Name | Listening | Version | Last packet | Auto tune | Test mode | Telemetry packets | Confirmed packets |
|--------------|-----------|---------|----------------|-----------|-----------|-------------------|-------------------|
| [REDACTED] | GaoFen-17 | 2105260 | 44 minutes ago | ON | OFF | [REDACTED] | [REDACTED] |

[GITHUB](#) [WIKI](#) [FAQ](#) [TELEGRAM](#) [TWITTER](#)

2023 – TinyGS

TINYGS CONSOLE

☰ TINYGS BETA 👤 SIGN OUT




← BACK ✎ EDIT STATION 🖨 OPERATE

| | | | |
|----------------------------|----------------------|-------------------|--------------------------|
| Status | Listening | Version | Creation date |
| ● Online | FossaSat-2E12 | 2105260 | 4 months ago |
| Last Packet an hour ago | Position (Lat, Lang) | QTH Locator | Elevation |
| | | | 59.00 m |
| Auto tuning | Test mode | Confirmed packets | Telemetry packets |
| ON | OFF | | |
| Type of antenna | Band | Record distance | Local IP |
| Dipole | 394 - 495 MHz | 13192.2 Km | 192.168. |

Packets in the last 30 days

| Days of the month | Telemetry packets | Total packets |
|-------------------|-------------------|---------------|
| 1 | 30 | 35 |
| 2 | 75 | 80 |
| 3 | 150 | 155 |
| 4 | 115 | 120 |
| 5 | 100 | 105 |
| 6 | 110 | 115 |
| 7 | 95 | 100 |
| 8 | 90 | 95 |
| 9 | 70 | 75 |
| 10 | 65 | 70 |
| 11 | 80 | 85 |
| 12 | 95 | 100 |
| 13 | 100 | 105 |
| 14 | 90 | 95 |
| 15 | 85 | 90 |
| 16 | 70 | 75 |
| 17 | 60 | 65 |
| 18 | 55 | 60 |
| 19 | 65 | 70 |
| 20 | 55 | 60 |
| 21 | 70 | 75 |
| 22 | 75 | 80 |
| 23 | 68 | 73 |
| 24 | 55 | 60 |
| 25 | 75 | 80 |
| 26 | 68 | 73 |
| 27 | 88 | 93 |
| 28 | 45 | 50 |
| 29 | 40 | 45 |
| 30 | 68 | 73 |

TINYGS CONSOLE STATION PARAMETERS

  BETA  [SIGN OUT](#)

Edit station parameters

Name

Description 0 / 500

Antenna Type
Dipole

Antenna range 394 - 495 MHz

[CANCEL](#) [SAVE](#)

Drag and drop to upload photos of your station!
...or click to select a picture from your computer

[GITHUB](#) [WIKI](#) [FAQ](#) [TELEGRAM](#) [TWITTER](#)

2023 – TinyGS

TINYGS CONSOLE OPERATION

The screenshot displays the TINYGS console interface. At the top, there is a blue header with the TINYGS logo, a 'BETA' badge, and a 'SIGN OUT' button. The main content area is partially obscured by a white modal window titled 'Operation'. Inside this modal, the 'Automatic Tuning' section has a dropdown menu set to 'Enabled 433'. The 'Manual Tuning' section contains several input fields: Satellite Name (FossaSat-2E12), NORAD (52773), Frequency (401.7 MHz), Mode (LoRa), Spreading Fa... (11 MHz), Bandwidth (125 kHz), Coding Rate (8), Syncword (18), CRC (Enable), Preamble L... (8), FLDR0 (Disable), Current limit (120), Gain (0), and TX Power (5). A 'CONFIG SAVED' button is located below these fields. The 'Transmission' section is currently selected and shows two radio buttons: 'TEXT' (selected) and 'BINARY'. Below the radio buttons, there is a text input field labeled 'Message to transmit' and two blue buttons: 'SEND TX (⌘)' and 'SEND TEST FRAME (⌘)'. The background of the console shows a map with a satellite icon and some data plots.

Operation

Automatic Tuning

Auto Tune
Enabled 433

Manual Tuning

| | | | | | | | |
|----------------|----------|-----------|---------------|-----------------|---------------|------|----------|
| Satellite Name | NORAD | Frequency | Mode | Spreading Fa... | Bandwidth | | |
| FossaSat-2E12 | 52773 | 401,7 MHz | LoRa | 11 MHz | 125 kHz | | |
| Coding Rate | Syncword | CRC | Preamble L... | FLDR0 | Current limit | Gain | TX Power |
| 8 | 18 | Enable | 8 | Disable | 120 | 0 | 5 |

CONFIG SAVED

Transmission

The following options will physically transmit from your station hardware. Make sure you follow your local regulations, that your antenna is connected and there is no LNA connected.

TEXT BINARY

This option will transmit a plain text message from your station. It will be encoded in 8 bit ASCII.

Message to transmit

SEND TX (⌘) SEND TEST FRAME (⌘)

FRAGEN?

Danke für Ihre Aufmerksamkeit -
und viel Spaß auf der Pi And More 13 :)!

www.nico-maas.de