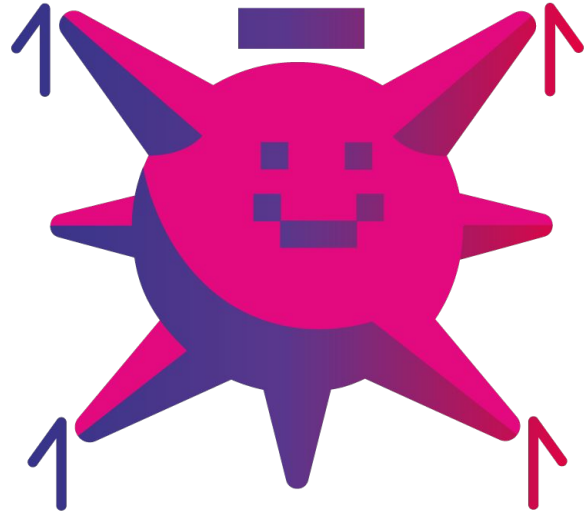# Recibiendo telemetría satelital por diversión
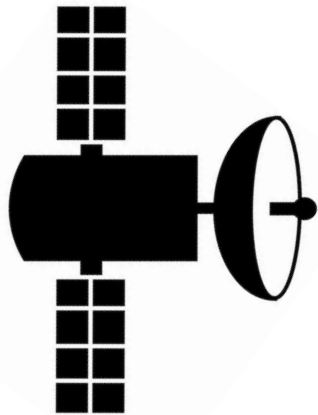
Manuel Rábade

Contenido

- Satélites en órbita baja
- Modulación LoRa
- Estacion receptora
  - Partes
  - Antena
  - TinyGS
- Casos de estudio, uso y diversion
- Predicción de órbitas

En onda corta
— ¿Qué tal se escucha?
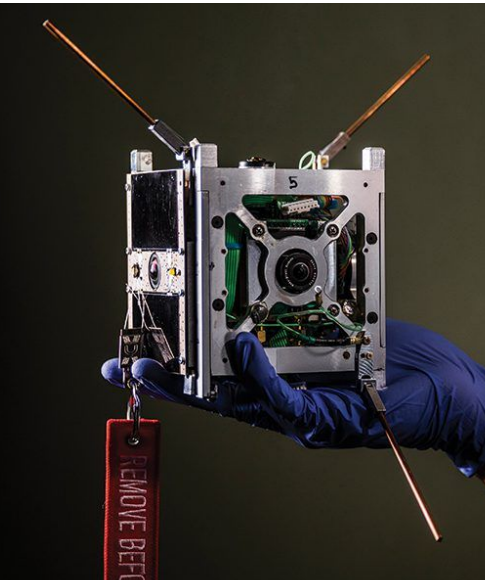— ¡Bien!

The Big Picture
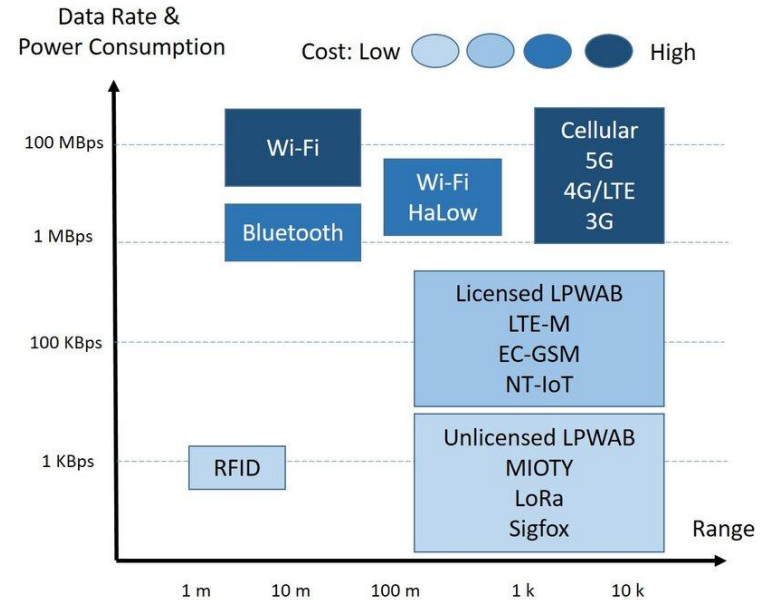

LoRa

433 Mhz

# Satélites en órbita baja

Comparando satélites y aviones

Vehículo/satélite	Altitud	Peso	Velocidad	Periodo
Aviones comerciales	10 - 13 Km	70 - 400 t	900 km/h	-
CanSats	15 Km	0.05 - 0.1 Kg	-	-
Aviones militares	15 - 20 Km	10 - 40 t	2,000 km/h	-
Concorde	15 - 18 Km	78 t	2,180 km/h	-
Satélites en órbita baja (LEO)	200 - 2,000 Km	100 - 2,000 Kg	28,000 km/h (7.8 km/s)	90 - 120 min
Estación espacial internacional	400 - 420 Km	420 t		
CubeSats	350 - 700 Km	1 - 20 Kg		
Satélites GPS (MEO)	20,200 Km	1 - 2 t	14,000 km/h (3.9 km/s)	2 - 12 horas
Satélites en órbita geoestacionaria (GEO)	35,786 Km	2 - 6.5 t	11,000 km/h (3.1 km/s)	24 horas

Modulación LoRa

- LOng RAnge
- Bitrate: 0.3 - 50 kbit/s
- Payload: 51 - 255 bytes
- Bandas que no requieren licencia ISM
  - 169 MHz
  - 433 MHz
  - 868/915 MHz
  - 2.4 GHz

Estacion receptora

Placa LoRa+ESP32

TinyGS Firmware

TinyGS Network

Antena → LoRa ↔ ESP32 ↔ Internet
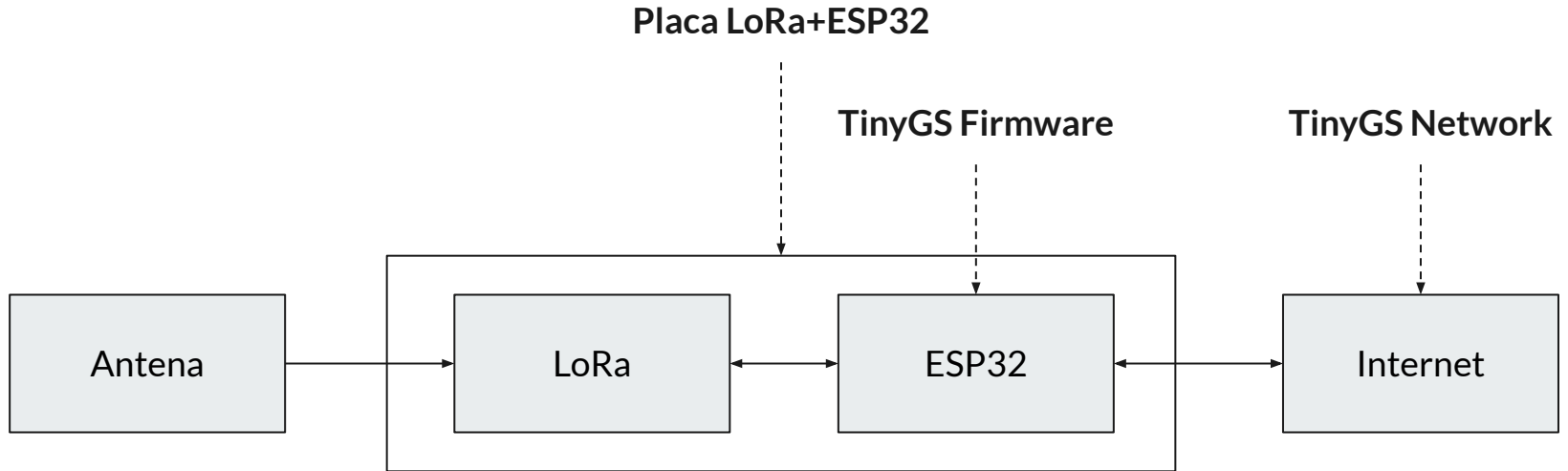
Lista de partes

Cantidad	Parte	Precio
1	Antena 433Mhz	$ 169
1	LILYGO TTGO LoRa32 433 Mhz	$ 599
2	Separador M3 - 20 mm	$ 16
2	Separador M3 - 10 mm	$ 10
	Total	**$ 794**

https://gist.github.com/manuel-rabade/3e20432e063050936ab2534ee6deee56

Optimizando la antena
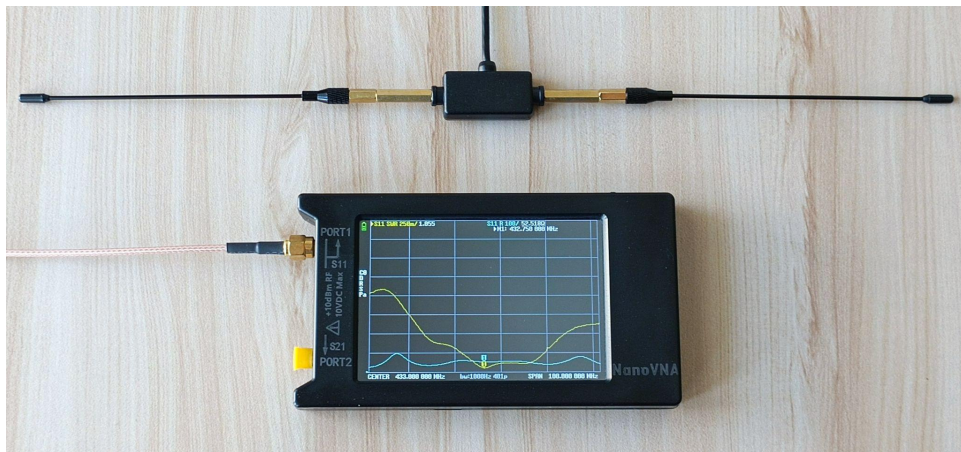
Zerone 433MHZ gsm GPRS SMA
Amplificador de señal de Antena de
claxon Macho Plug 3 Metros

★★★★☆ ⌄ 57

$162⁰⁰
$16.44 x 12 meses
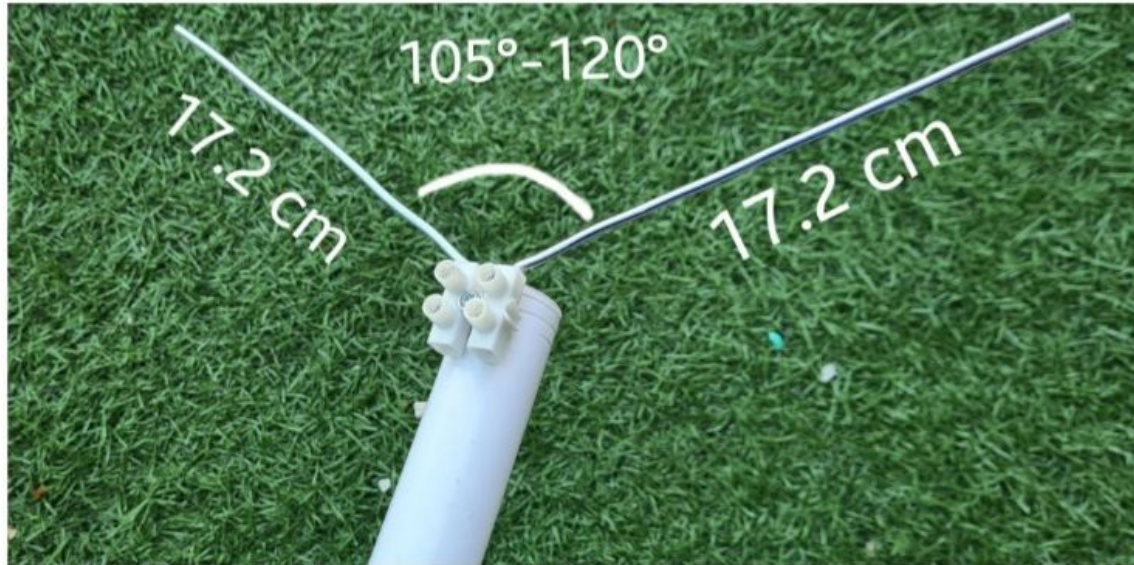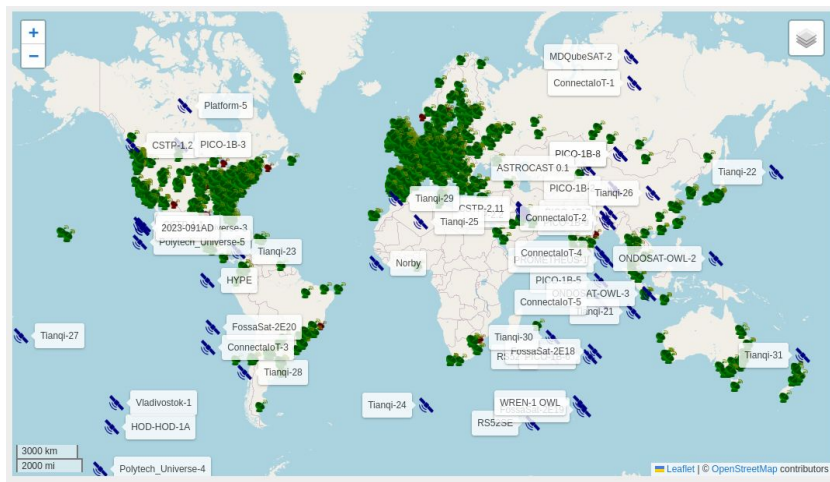
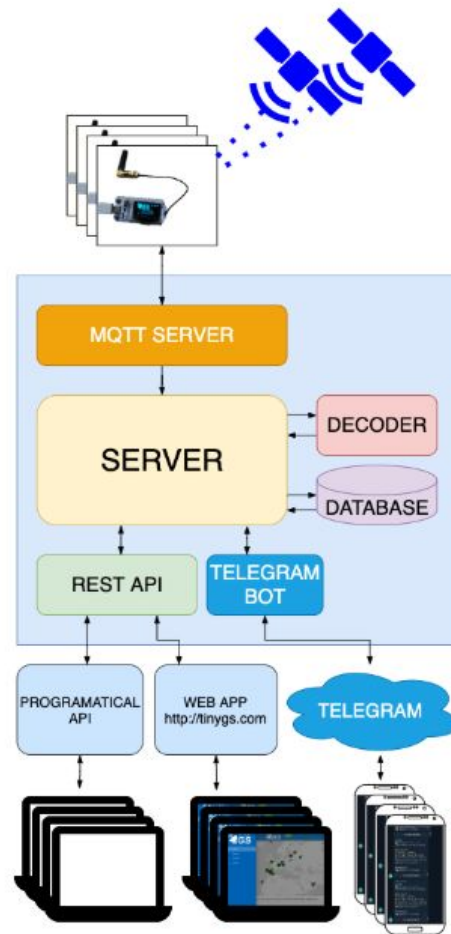Entrega GRATIS entre el **11 - 20 de mar**

Importación

Construir la antena

TinyGS

https://tinygs.com

tinyGS Community
6 926 members, 128 online

General
In tinyGS Community

Pinned Message
This video might be interesting...

General 07:32
Hernedy Arrieta: 😀

🖋 🛰📡 Antenna Building 21:07
Lua: What kind of antenna would you rec...

🪀 Technical problems 14:30
Juan Pablo: 📺 Test you a rabbit ear, it's...

🔋 Beta firmware testing 13:49
Nick: The 868/915 MHz LoRa excels in i...

📈 🛰 statistics 🔒 06:15
tinyGS: 🛰 GaoFen 27/February/2025 📦...

🔍 Space situational awaren... 🔒 05:26
tinyGS: Found 🛰: Tianqi-36 TLE ▶ TIAN...

📅 Events:tinyGS 🛰📡📍📊 Thu
Juan Pablo: 🖼 Album, Does to its succ...

📚 Learning Resources 🔒 Wed
Germán: 📟 📉 Understanding S Param...

🖥 📉 TinyGS (share your setup) Tue
Carlo: TinyGS and MeshCom on the roof.

‼ 🛰🚀 New satellites Feb 23
Stefan/OE6ISP: Finally it's the CG

❗ NEW Announcements 🔒 Jan 29
G4lile0: Everything is back to normal op...

🎃 Where to buy Jan 27
wind: Anyone is using RAK19003?

🌐 🔴 Balloons Jan 24

Juan Pablo
> **Stefan/OE6ISP**
> Maybe in autotune mode and nothing to tune so far ...

Tnks 10:55

Stefan/OE6ISP
> **Juan Pablo**
> Tnks

Can you see any sats in range on the map? 10:56

Antonio
Hola a todos desde Murcia, España / Hello everyone from Murcia, Spain
👍 🅽 ⚫ 12:01

Today

Hernedy Arrieta
Hola Hernedy Arrieta desde Venezuela, Saludos. 07:00

Hello Hernedy Arrieta from Venezuela, Greetings. (YV1GAG) 07:01

What is the procedure to obtain the credentials and activate my station? 07:02

Stefan/OE6ISP
> **Hernedy Arrieta**
> What is the procedure to obtain the credentials and activate my station?

open @tinygs_personal_bot and enter /mqtt 07:13

😀
07:32

👌 ⅅ

Message

Welcome to the TinyGS web installer!

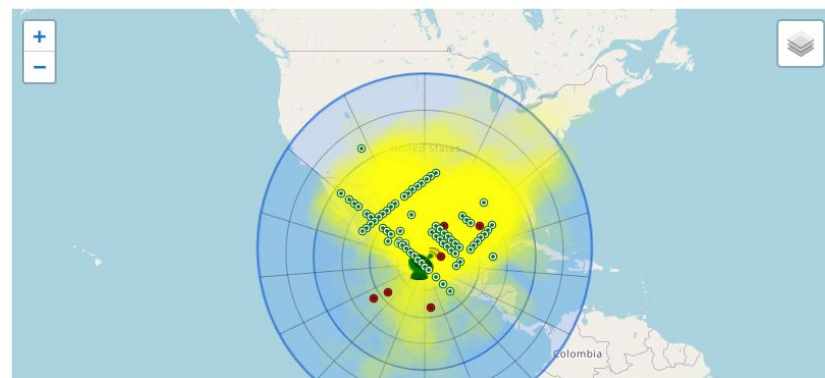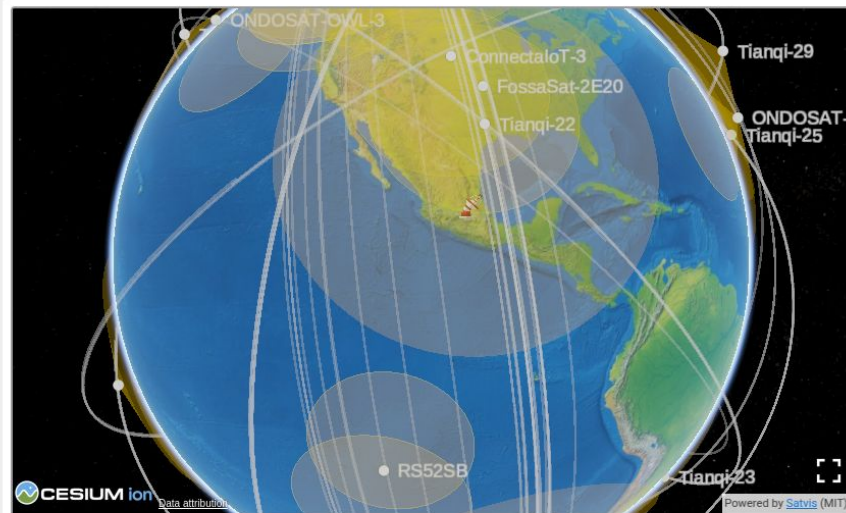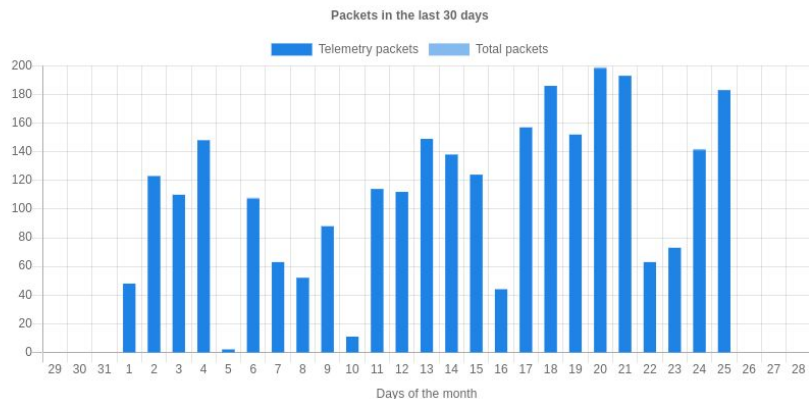1. Plug in your ESP to a USB port. We will install TinyGS 2403242 to it.
2. Hit "Install" and select the correct COM port. No device found?
3. MQTT credentials (First join the group here)
   Then open a private chat with @tinygs_personal_bot and ask /mqtt
4. First time board boot, connect to the wifi AP "My TinyGS" to configure it.
5. Get TinyGS installed and connected in less than 5 minutes!

Install

2403242

Status	Listening	Version	Creation date
● Online	FossaSat-2E20	2403242	3 months ago
Last seen	Last Packet	Position (Lat, Long)	QTH Locator
a minute ago	2 days ago	19.385, -99.145	EK09kj
Elevation	Auto tuning	Test mode	Confirmed packets
2231.00 m	433	OFF	5023
Telemetry packets	Type of antenna	Band	Record distance
4996	Dipole	400 - 500 MHz	2506.8 Km

Packets in the last 30 days

Telemetry packets   Total packets

Days of the month

ONDOSAT-OWL-3
ConnectaIoT-3
FossaSat-2E20
Tianqi-22
Tianqi-29
ONDOSAT-Tianqi-25
RS52SB
Tianqi-23

CESIUM ion
Data attribution
Powered by Satvis (MIT)

Colombia

🛰️ **Norby** 🌙	Mode	🔋 Power	📏 Distance	📐 Elevation	📶 RSSI	SNR	Predicted Doppler
Feb 26, 2025 04:31:59 (3 days ago)	LoRa@436.703	7000mW	564Km	56.27°	-119.75 dBm	-10.75 dB	2418.86Hz
Frequency Error	CRC Error	Received by					
-4020.24Hz		42 Stations					

🛰️ **Norby** 🌙	Mode	🔋 Power	📏 Distance	📐 Elevation	📶 RSSI	SNR	Predicted Doppler
Feb 26, 2025 04:30:58 (3 days ago)	LoRa@436.703	7000mW	799Km	33.80°	-118.25 dBm	-9.25 dB	7842.07Hz
Frequency Error	CRC Error	Received by					
-9909.04Hz		45 Stations					

🛰️ **Tianqi-24** 🌙	Mode	🔋 Power	📏 Distance	📐 Elevation	📶 RSSI	SNR	Predicted Doppler
Feb 26, 2025 01:04:22 (3 days ago)	LoRa@400.265	9000mW	1204Km	39.14°	-127.25 dBm	-14.25 dB	-5460.45Hz
Frequency Error	CRC Error	Received by					
4725.93Hz		1 Stations					

🛰️ **Tianqi-24** 🌙	Mode	🔋 Power	📏 Distance	📐 Elevation	📶 RSSI	SNR	Predicted Doppler
Feb 26, 2025 01:03:07 (3 days ago)	LoRa@400.265	9000mW	981Km	54.43°	-127.5 dBm	-13.5 dB	-2138.65Hz
Frequency Error	CRC Error	Received by					
1005.58Hz		4 Stations					

Norby

Received on: November 19, 2024 4:42 AM

LoRa 436.703 Mhz SF: 10 CR: 5 BW: 250 kHz

Sat in Umbra 🌑 Eclipse Depth: 11.21°

Theoretical coverage 4853 km

📟 7000mW 🌡️ 21°C

🔋 8238mV 🔋 1896mW 🌡️21°C

☀️0mW 🔋 13011mAh 🔋 -2482mW

🌡️ Board PMM: 12°C PAM: 12°C PDM: 9°C

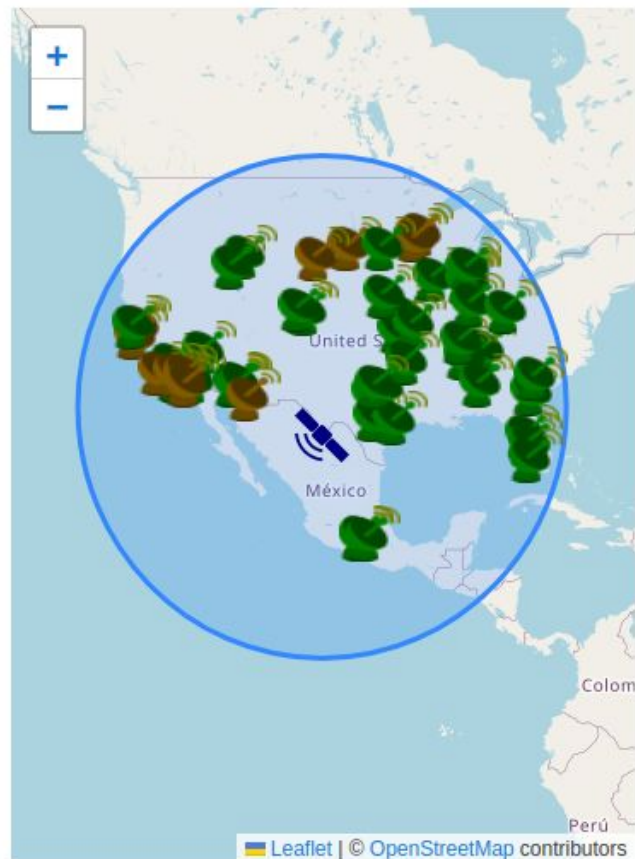🌡️ Solar Array X-: -5°C X+: -6°C

🔶: 3013.42344

Hexadecimal view

Download

```
        0  1  2  3  4  5  6  7  8 012345678
0000 8E FF FF FF FF 0A 06 01 C9 .........
0009 34 84 00 00 00 00 F1 0F 00 4........
0012 00 68 A5 5C 8A CF 2E 42 52 .h.\...BR
001B 4B 20 4D 57 20 56 45 52 3A K MW VER:
0024 30 35 61 5F 30 31 00 00 00 05a_01...
```

Casos de uso, estudio y diversión

1. Recibir telemetría
2. Mejorar tu estación
3. Ingeniería inversa
4. Retransmitir información
5. Diagnóstico de satelites
6. Descubrir satélites

Norby

Received on: November 19, 2024 4:42 AM

LoRa 436.703 Mhz SF: 10 CR: 5 BW: 250 kHz

Sat in Umbra ▨ Eclipse Depth: 11.21°

Theoretical coverage 4853 km

📇 7000mW 🌡 21°C

🔋 8238mV 🔋 1896mW 🌡21°C

☀0mW 🔋13011mAh 🔌 -2482mW

🌡 Board PMM: 12°C PAM: 12°C PDM: 9°C

🌡 Solar Array X-: -5°C X+: -6°C

🔴: 3013.42344

Hexadecimal view

Download

```
        0  1  2  3  4  5  6  7  8 012345678
0000 8E FF FF FF FF 0A 06 01 C9 .........
0009 34 84 00 00 00 00 F1 0F 00 4.......
0012 00 68 A5 5C 8A CF 2E 42 52 .h.\...BR
001B 4B 20 4D 57 20 56 45 52 3A K MW VER:
0024 30 35 61 5F 30 31 00 00 00 05a_01...
```

4. Electrical power system

The NORBY electrical power system is designed to supply power to satellite subsystems. The functionality of the EPS includes the distribution of incoming and stored energy between NORBY subsystems according to a given algorithm, as well as monitoring the current status of system parameters. The EPS comprises four function blocks (figure 3):

- the power generation block;
- the power storage block;
- the electricity conversion block;
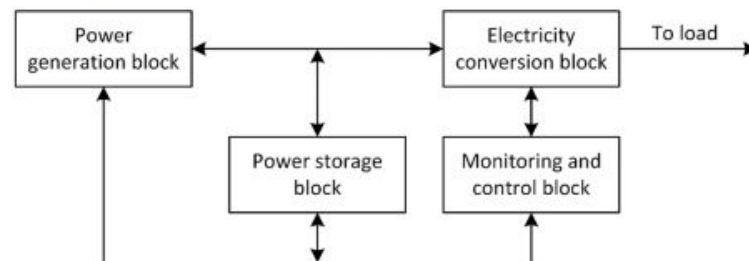- the monitoring and control block.

Figure 3. Functional diagram of the NORBY electrical power system.

The power generation block is a functional unit that converts solar energy into electrical energy and then transfers it to the other EPS blocks.
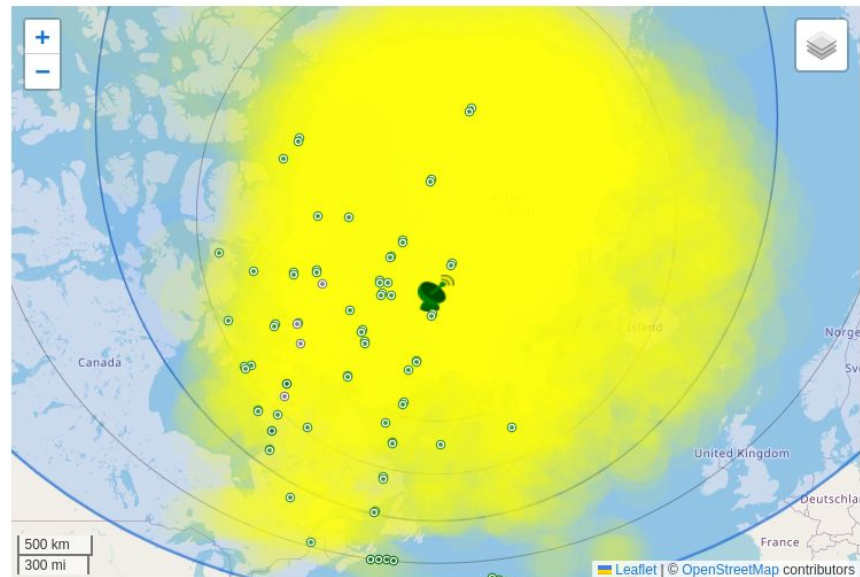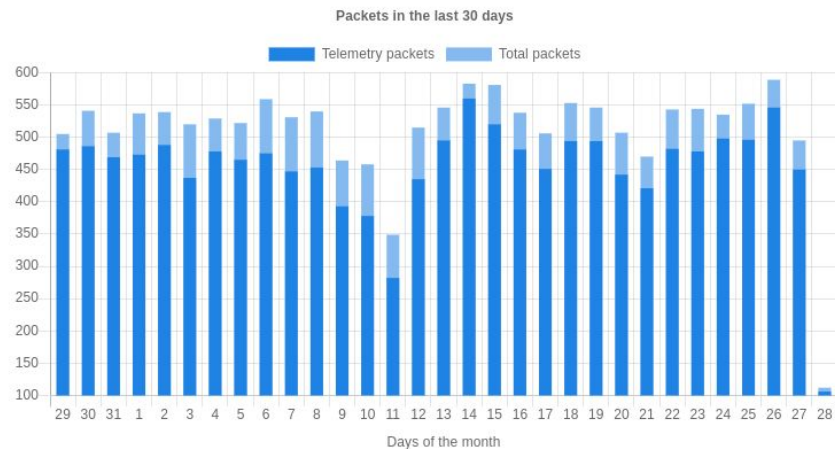
NORBY has six solar panels. Four of them are rigidly fixed to the outer sides of the satellite structure. Two of the panels are fold-out. Between 6 and 12 photovoltaic (PV) cells are located on each solar panel. Solar panels on the sunny side of the orbit generate electricity proportional to the power of incident light, with cell efficiency reaching 28% and a maximum output power of 1.25 W per PV cell. Each PV cell is connected to its own DC/DC converter, which ensures that maximum power is withdrawn from the cell. Each converter is daisy-chained to another of the same converters to produce a total output voltage in the range of 5 V to 8.3 V. At the output of each such pair is a diode to protect the entire solar panel in case one of the panel elements fails. The maximum power of the

Status	Listening	Version	Creation date
● Online	Surv-251	2403241	4 years ago
Last seen	Last Packet	Position (Lat, Long)	QTH Locator
a few seconds ago	18 minutes ago	67.011, -50.73	GP47pa
Elevation	Auto tuning	Test mode	Confirmed packets
37.00 m	433	OFF	305582
Telemetry packets	Type of antenna	Band	Record distance
300334	Eggbeater	401 - 479 MHz	3482.5 Km

Description

Antenna: EB-432 EGGBEATER Preamplifier: SSB Super-Amp SP-70 Receive: LILYGO® TTGO LoRa32 V1.1 433MHZ LoRa ESP-32 OLED 0.96 Inch

Packets in the last 30 days

Telemetry packets   Total packets

Days of the month

500 km
300 mi

Leaflet | © OpenStreetMap contributors

Galileo
@g4lile0.bsky.social

+ Seguir

My Sunday Sudoku is reverse-engineering the new 🛰 Starlink telemetry format. 😅

26 de enero de 2025, 5:54 Todos pueden responder

HOD-HOD-1A

Received on: January 1, 2025 1:19 PM
LoRa 436.25 Mhz SF: 9 CR: 6 BW: 250 kHz
Sat in Sun ☀ Eclipse Depth: -32.68°
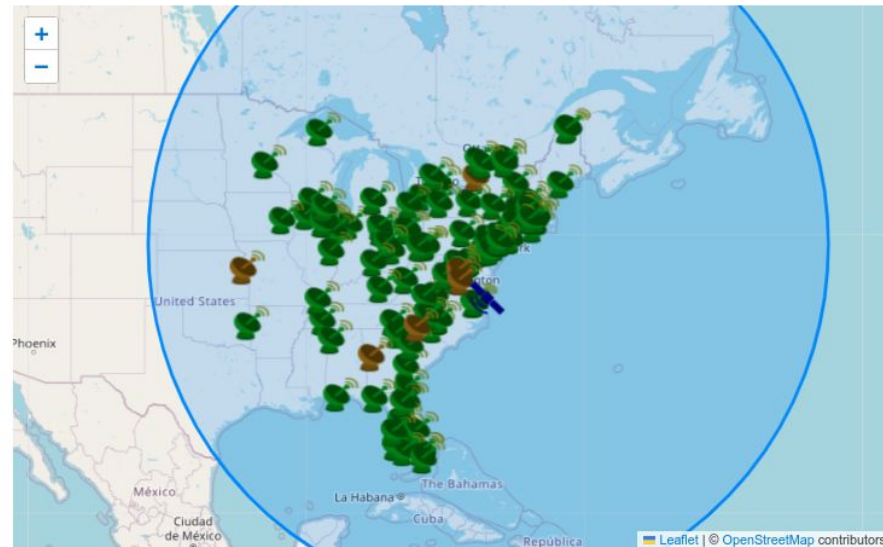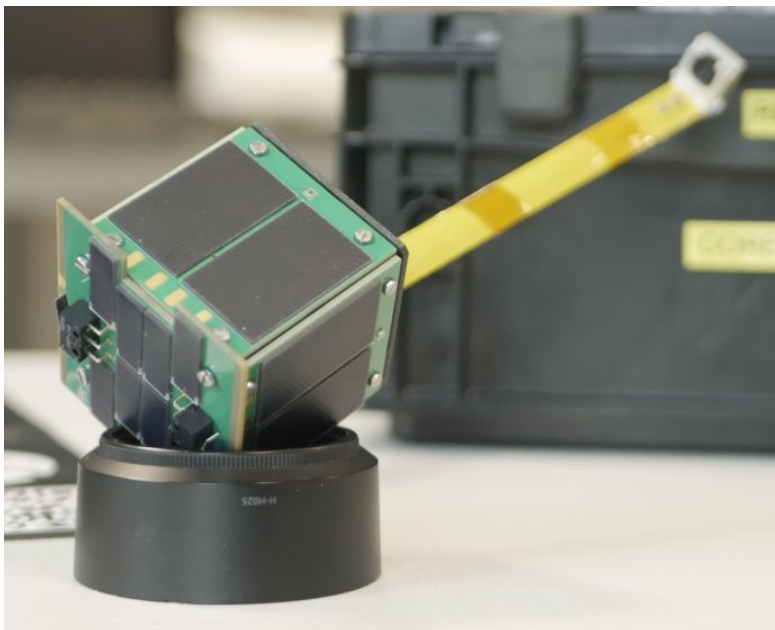Theoretical coverage 4813 km

Hexadecimal view

Download

```
      0  1  2  3  4  5  6  7  8  9  A  B  C  D  E  F 0123456789ABCDEF
0000 54 49 4E 59 47 53 20 4B 34 4B 44 52 20 48 65 6C TINYGS K4KDR Hel
0010 6C 6F 20 66 72 6F 6D 20 46 4D 31 37 21 20        lo from FM17!
```

Raw parsed view

copy

▸ { ··· }

Filip Tomczyk / SQ3TLE

Kubuś
Quick summary about HYPE as for now: the mission began nominally a...

Technical update on that:
We reproduced the issue about 16 hours after the anomaly on the engineering model in our lab, using the last valid telemetry data from TinyGS ❤️. Lab testing showed us that at temperatures below 5°C, the SX1268's PLL failed to lock within the timeframe specified by our software. As a result, the radio entered an invalid state, reported failure to initialize to OBC and rest of the satellite continued working in safe mode.

Thankfully, our "dead man switch" mechanism rebooted the satellite after 24 hours of no valid, cryptographically signed commands from the ground. On the second attempt, 48 hours after the initial failed reboot, the satellite successfully restarted at a higher temperature.

At the moment, we're operating with the awareness that HYPE cannot be rebooted in low temperatures without facing a potential wait of one to few days. However, a software update to fix this issue is now scheduled for upload within the next two weeks.

Fun fact:
During preflight thermal tests, we verified continuous operation from -40°C to +60°C with the pass condition being no restarts, so this bug managed to slip through 😅

👍 4

17:38

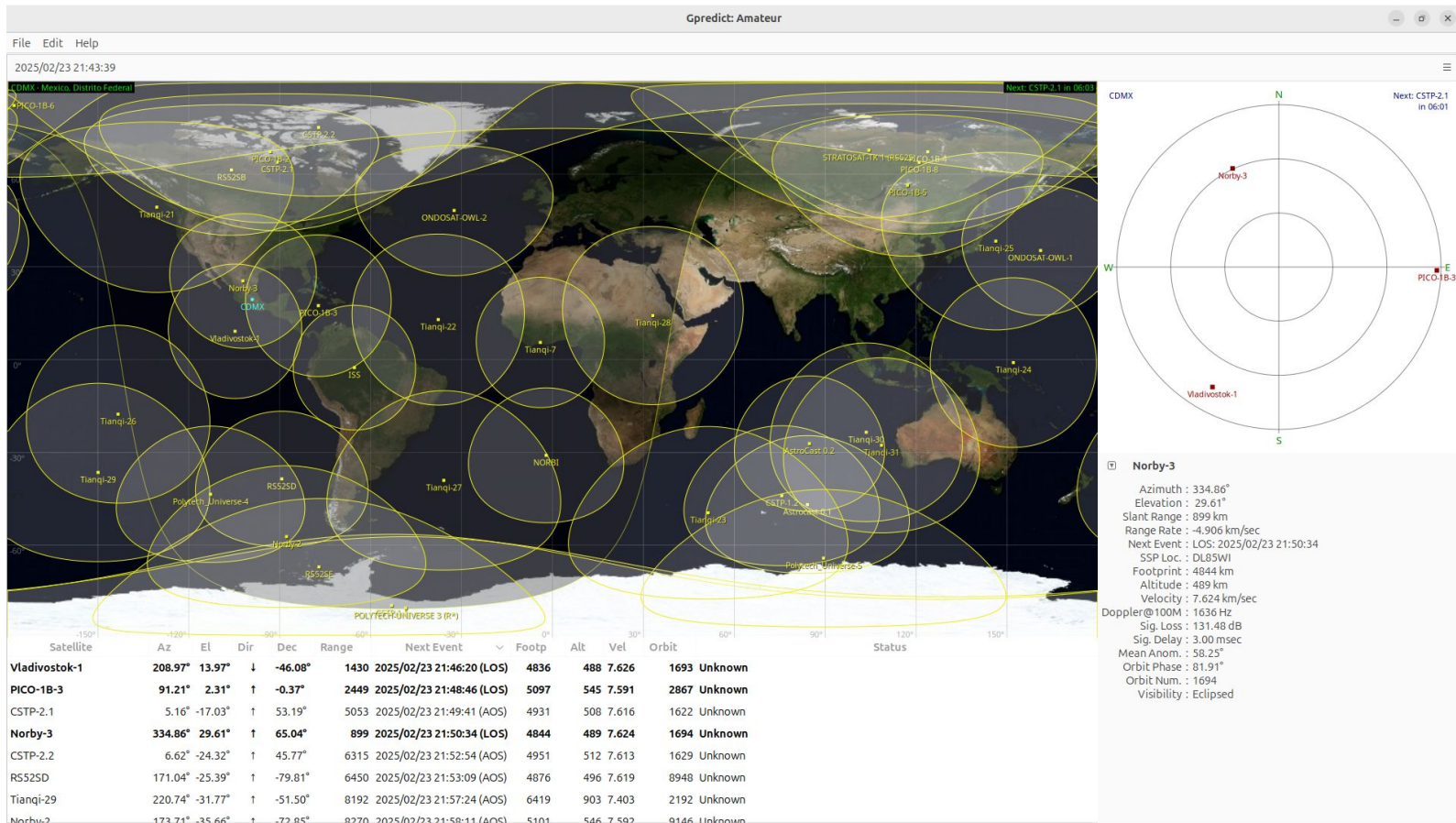**TinyGS**
@tinygs.bsky.social

Found 🛰: HOD-HOD-1A ➡️ fits TLE 2024-199AK. Our @tinygs.bsky.social community of over 1600 ground stations is enhancing Space Situational Awareness by matching TLEs! #ESA #satellite

Predicción de órbitas

Upcoming passes for NORBI ×

AOS	LOS	Duration	Max El	AOS Az	LOS Az
2024/11/20 14:45:51	2024/11/20 14:54:07	00:08:15	8.08°	119.39°	25.42°
2024/11/20 16:17:44	2024/11/20 16:28:43	00:10:59	30.92°	186.17°	334.86°
2024/11/21 03:57:14	2024/11/21 04:08:25	00:11:10	47.83°	19.00°	181.76°
2024/11/21 15:56:42	2024/11/21 16:08:06	00:11:24	70.75°	172.00°	345.75°
2024/11/22 03:36:44	2024/11/22 03:47:12	00:10:28	22.09°	30.45°	167.07°
2024/11/22 05:10:46	2024/11/22 05:19:49	00:09:02	11.22°	340.43°	232.95°
2024/11/22 15:35:57	2024/11/22 15:47:13	00:11:15	49.50°	158.02°	356.27°
2024/11/23 03:16:33	2024/11/23 03:25:33	00:08:59	10.60°	43.87°	150.57°
2024/11/23 04:49:19	2024/11/23 04:59:47	00:10:27	22.82°	352.74°	216.66°
2024/11/23 15:15:30	2024/11/23 15:26:03	00:10:33	23.09°	143.46°	7.15°
2024/11/23 16:49:43	2024/11/23 16:58:50	00:09:06	10.85°	209.06°	316.45°
2024/11/24 04:28:09	2024/11/24 04:39:19	00:11:10	49.26°	3.71°	201.98°
2024/11/24 14:55:26	2024/11/24 15:04:33	00:09:07	11.39°	127.27°	19.41°
2024/11/24 16:28:02	2024/11/24 16:38:36	00:10:34	22.46°	192.68°	329.74°
2024/11/25 04:07:11	2024/11/25 04:18:30	00:11:18	70.08°	14.34°	187.87°
2024/11/25 16:06:44	2024/11/25 16:18:00	00:11:15	48.55°	178.04°	341.14°
2024/11/26 03:46:28	2024/11/26 03:57:20	00:10:52	30.23°	25.41°	173.51°

Print   Save   Close

Pass details for NORBI (orbit 22841) ×

≡ Data   ⊕ Polar   🔳 Az/El

CDMX

N
W
E
S
30°

16:05
16:03
16:01
15:58
15:56

BI

nuth : 177
tion : -57
ange : 113
Rate : -1.1
vent : AO
Loc. : MA
rint : 504
tude : 533
ocity : 7.5
Doppler@ 00M : 371 Hz
Sig. Loss : 153.47 dB
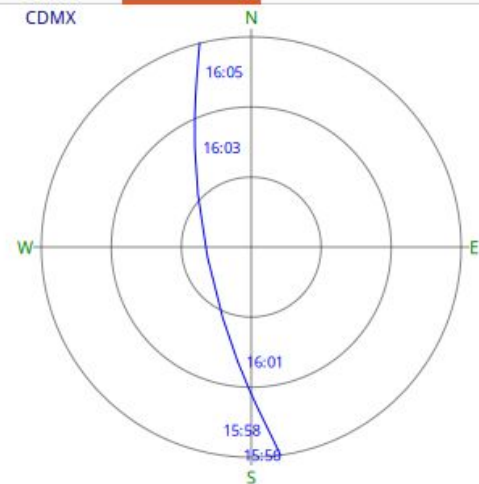
Print   Save   Close

Conectemos

manuel@rabade.net

@manuelrabade