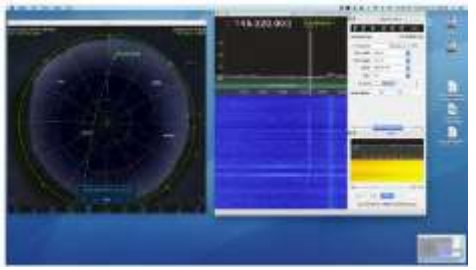
A Web-Based, Open-Access Satellite Receiving Station

- Interim Report

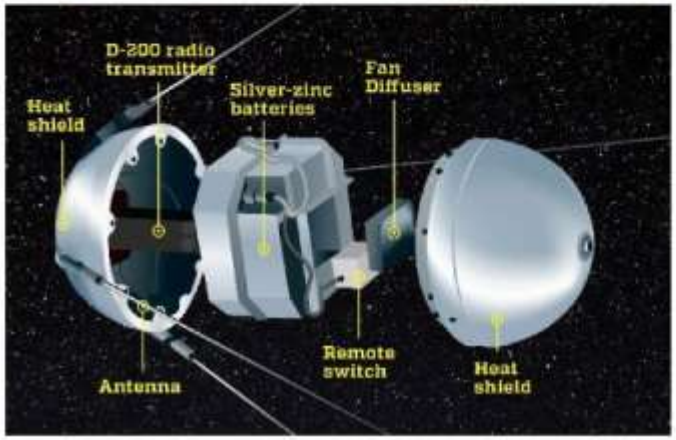
A 21st century project of engagement and inspiration

Joseph DiVerdi, PhD, MBA
Fort Collins, CO USA
15 October 2022



Early Satellites – National & Amateur

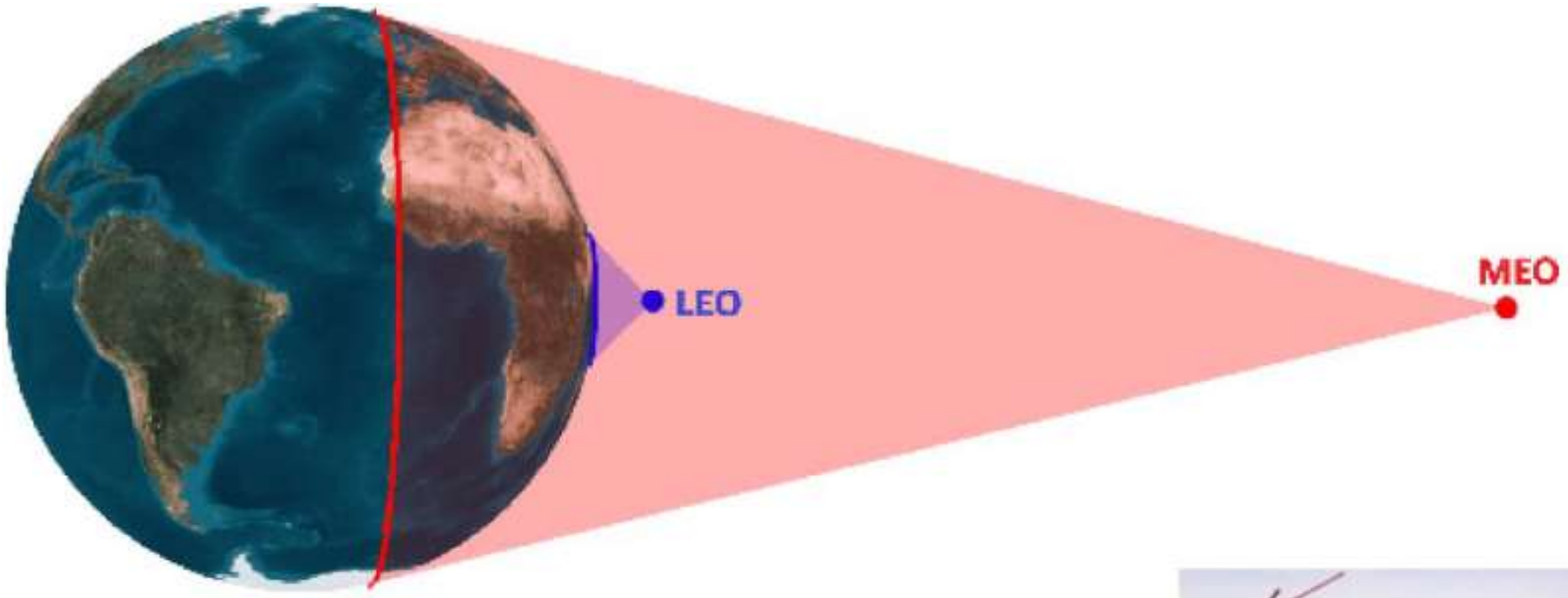
Sputnik 1



Explorer 1

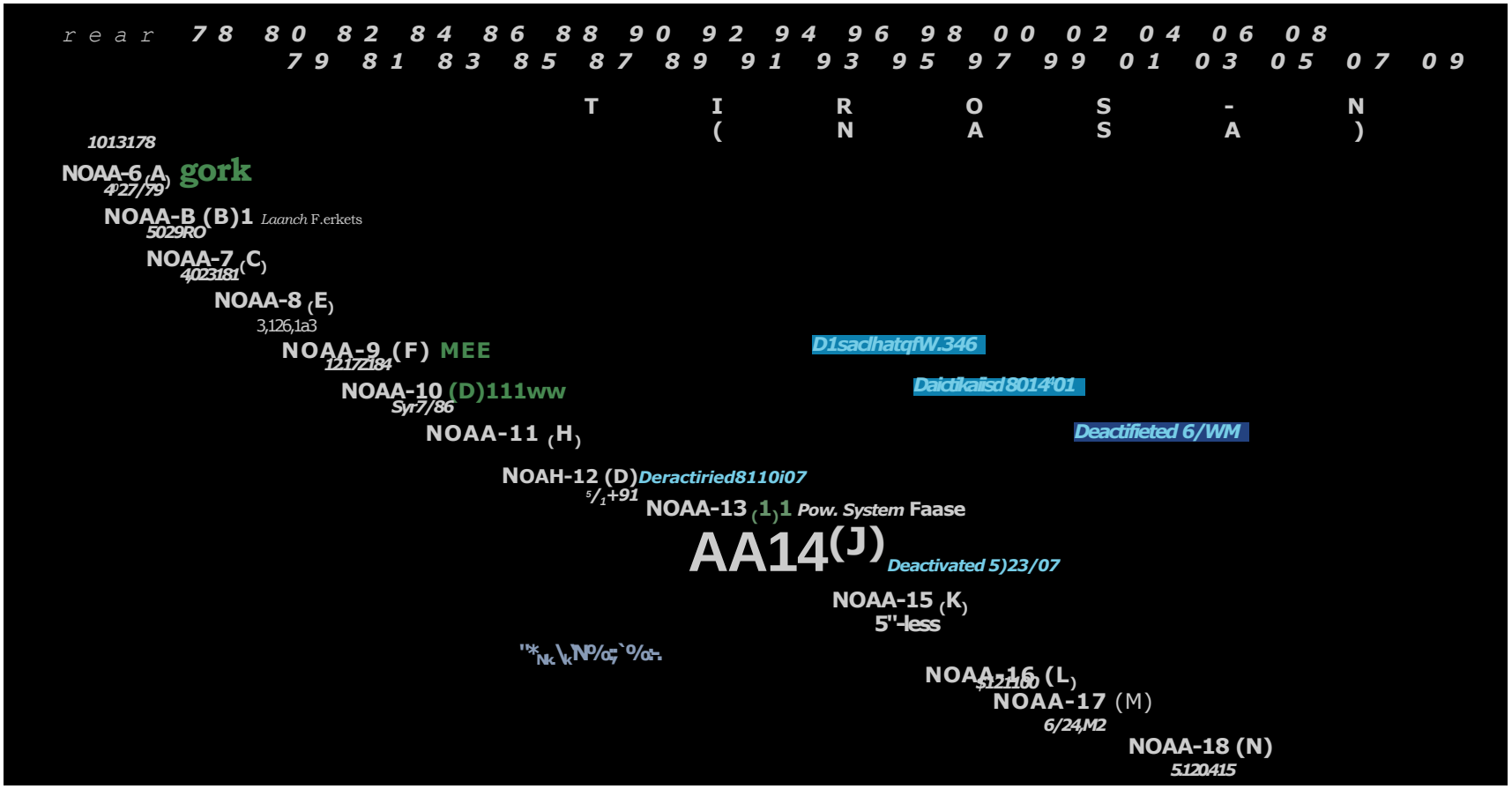
Oscar 1

In Frequent Use by Amateurs



Used to extend VHF & UHF range.
“Extreme Antenna Elevation”

Interesting session at ARRL Hamfest,
Held at Archer, WY on 7 Oct 2022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T I R O S - N
(N A S A)
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NOAA-7 (C)
4,023181
NOAA-8 (E)
3,126,1a3
NOAA-9 (F) MEE
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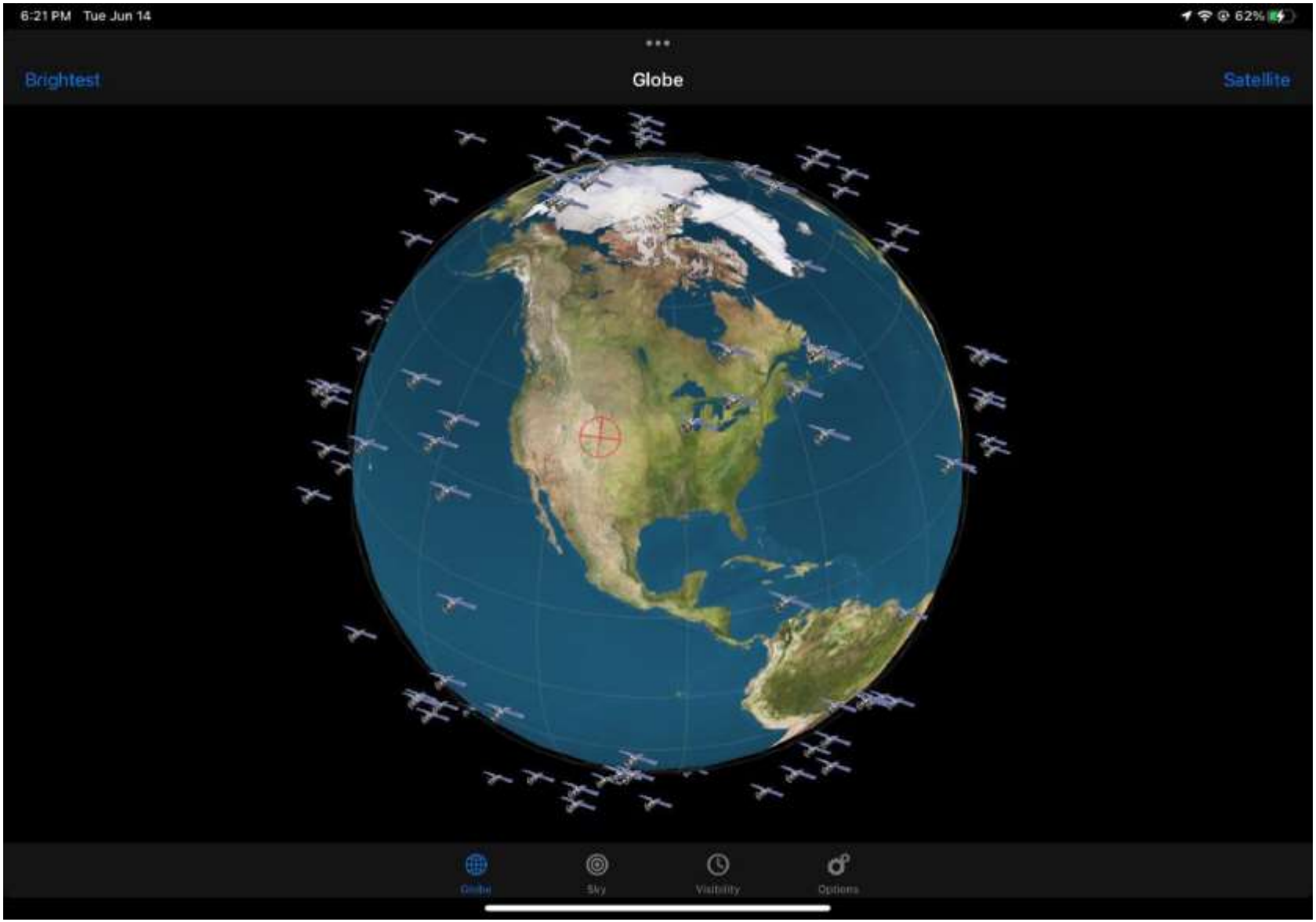
D1sadhatqfW.346
NOAA-10 (D)111ww
Syr7/86
Daidikaiisd8014'01
NOAA-11 (H)
Deactifieted 6/WM
NOAH-12 (D)Deractiried8110i07
5/1+91
NOAA-13 (1)1 Pow. System Faase
AA14(J)
Deactivated 5)23/07
NOAA-15 (K)
5"-less
NOAA-16 (L)
NOAA-17 (M)
6/24,M2
NOAA-18 (N)
5.120415

Remarkable Number of Satellites Present

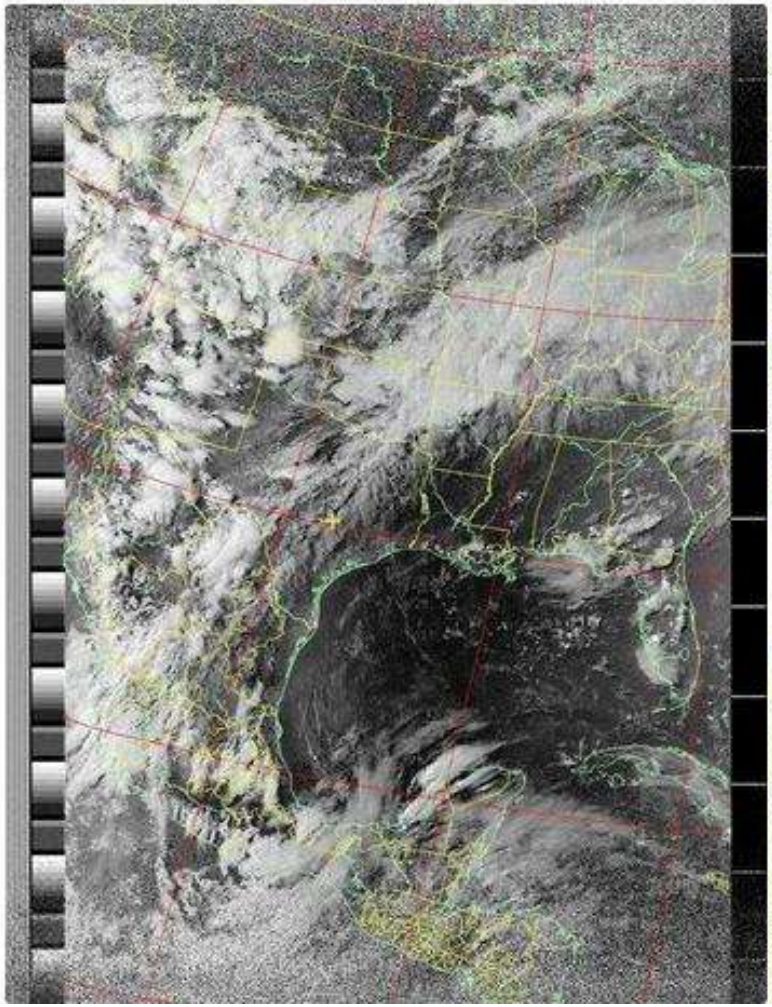


Receiving Satellite Signals is Possible

NOAA Satellite Signals With a PVC QFH Antenna and Laptop

By spacemanlabs in Workshop > Science 204,790 840 86 Featured

Download

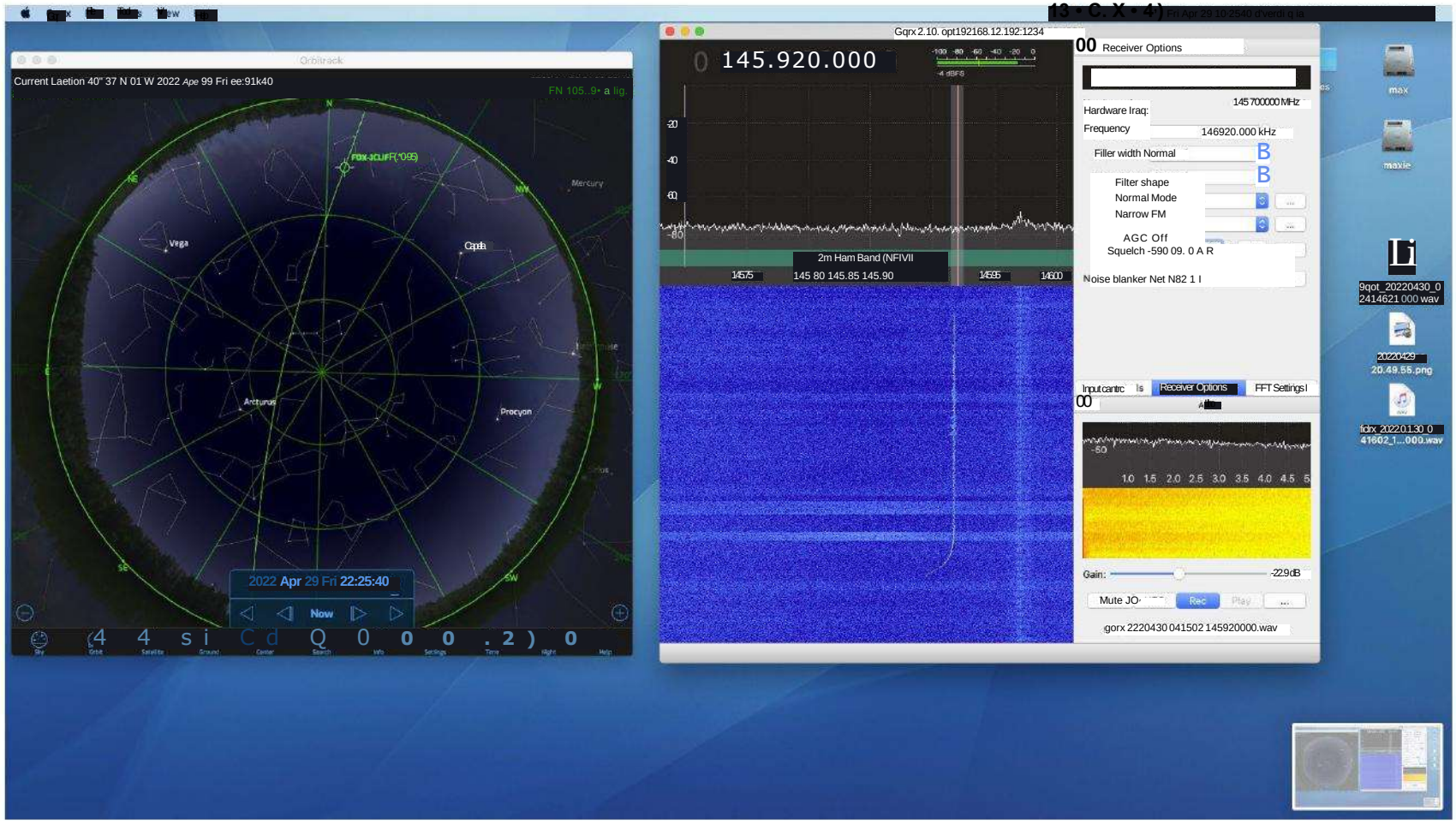


1st Prototype - Antenna **June 2022 Fort Collins, CO**

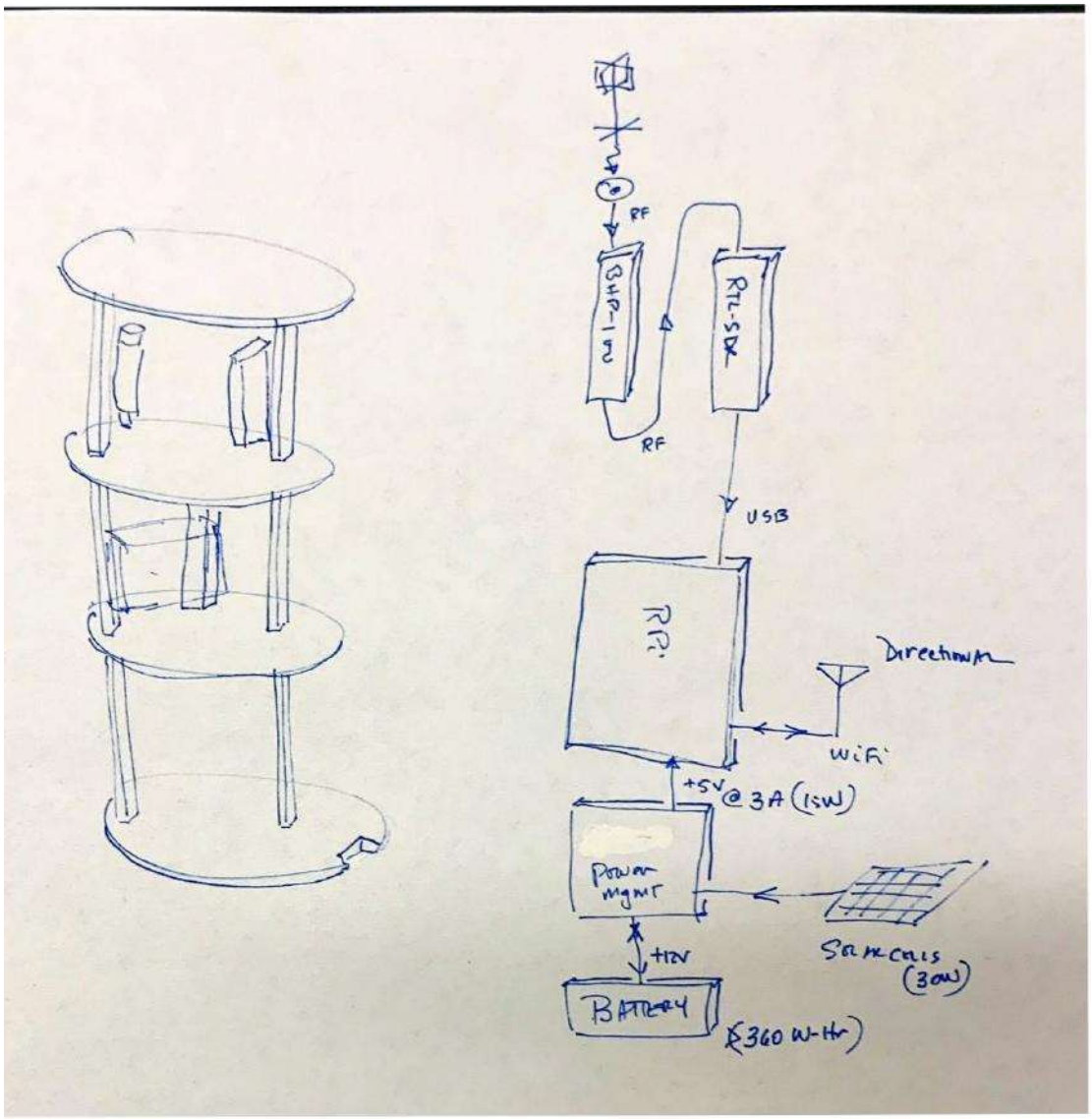
Version 1 – SDR **June 2022 Fort Collins, CO**

First Light - Fox-1 Cliff

NoCO Amateur Radio Club
June 2022 Fort Collins, CO



Version 2 June 2022 Fort Collins, CO



2nd Prototype – Installed June 2022 Fort Collins, CO

NoCO Amateur Radio Club

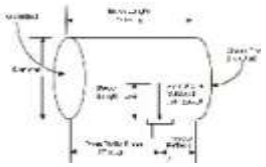
Need to Connect to QTH WiFi **June 2022 Fort Collins, CO**

Cantenna Waveguide http://www.wikarekare.org/Antenna/WaveguideCan.html

Building the Cylinder (Can) Waveguide

We chose to build the antenna for 2.442GHz, or channel 7, as this is close to the center of the 13 channels available to us (US designs use channel 6 (2.437Ghz), as they have 11 channels). I have included a key lengths calculator in the form below. **Nb.**Rectangular waveguides use a different formulae (see Rectangular Waveguide).

Frequency	2.442	GHz
	b/g Chnl 7	
Diameter Measurement	82	mm (Inside Measurement)
		Wide / Side
		Compute
Free Space Wavelength	122.7	mm
Waveguide Wavelength Max	256.2	mm
Frequency Min	2.611	GHz
Frequency Cut Off	2.284	GHz
Frequency	2.144	GHz
Probe Length	30.7	mm
Open End to Probe	28.1	mm (Open End to probe center)
Probe to Reflector	64.1	mm (Probe center to Reflector)
Inside Length	192.2	mm (Reflector to Opening)



The final product only needs to be accurate to about 1mm as this will only shift the frequency within the range of the 802.11 spectrum. A smaller cavity length will shift the frequency response to that slot to a higher channel. A longer slot cavity length will shift it down.

Methods and madness

I measured to .1mm using vernier callipers, on the assumption that errors in cutting might bring that closer to the 1mm error mark. There are only one to make, and you can't go too wrong, i.e. the probe (N-Socket) position.

Misc Notes

The probe is a 2mm diameter copper wire soldered into an N-Socket and cut to 31 mm (1/4 free space wavelength, including the protruding bit of the N-Socket).

The N-Socket is held down with nylon screws. If you use metal screws, use stainless steal ones and keep them short so they don't protrude into the cavity.

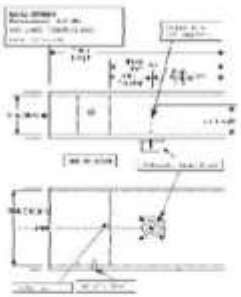
Water in the antenna, or spider and insects will be a problem. One suggestion is to seal around the edges of the reflector with silicone and cover the open end with a piece of plastic (microwave friendly and thin).

Rectangular Waveguide http://www.wikarekare.org/Antenna/Waveguide.html

Building the Rectangular Waveguide

We used 100mm x 50mm rectangular hollow box section aluminium with 3mm thick walls (off cuts from the 8+8 antenna). This gives us an internal size of 94mm x 44mm. We chose to build the antenna for 2.442GHz, or channel 7, as this is close to the center of the 13 channels available to us (US designs use channel 6 (2.437Ghz), as they have 11 channels). I followed Rob Clark's design. I have included a key lengths calculator in the form below. **Nb.**Circular waveguides (cans) use a different formulae (see Can Waveguide).

Frequency	2.442	GHz
	b/g Chnl 7	
94		Measurement)
Short Side	44	mm (Inside Measurement)
		Compute
Free Space Wavelength	122.7	
Waveguide Wavelength Max		mm
Frequency Min	268	GHz
Frequency Cut Off	189	GHz
Frequency	154	GHz
Probe Length	30.7	mm
Open End to Probe	8	mm (Open End to probe center)
Probe to Reflector	45	mm (Probe center to Reflector)
Inside Length	125	mm (Reflector to Opening)
Outside Length	2	mm (Length including Mount)

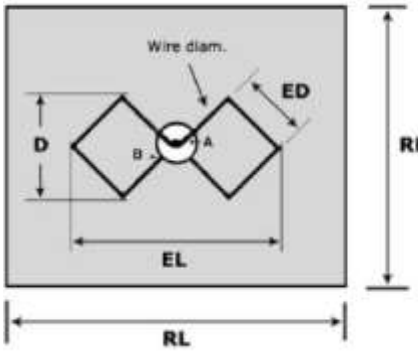


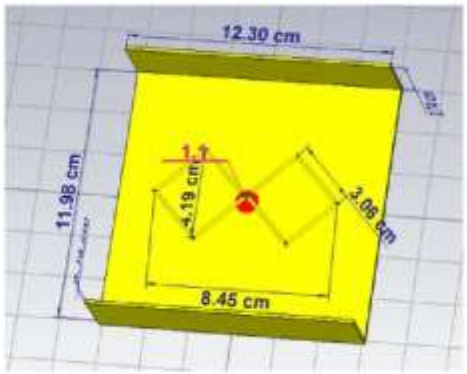
The final product only needs to be accurate to about 1mm as this will only shift the frequency within the range of the 802.11 spectrum. A smaller cavity length will shift the frequency response to that slot to a higher channel. A longer slot cavity length will shift it down.

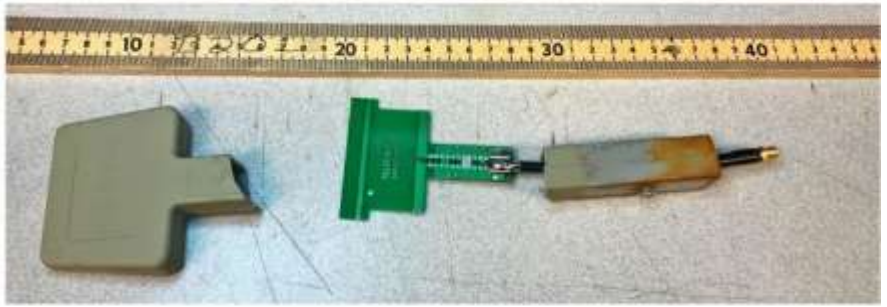
Methods and madness

I measured to .1mm using vernier callipers, on the assumption that errors in cutting might bring that closer to the 1mm error mark. There are only two to make, and you can't go too wrong, the probe (N-Socket) position and the placement of the reflector (end plate).

Misc Notes

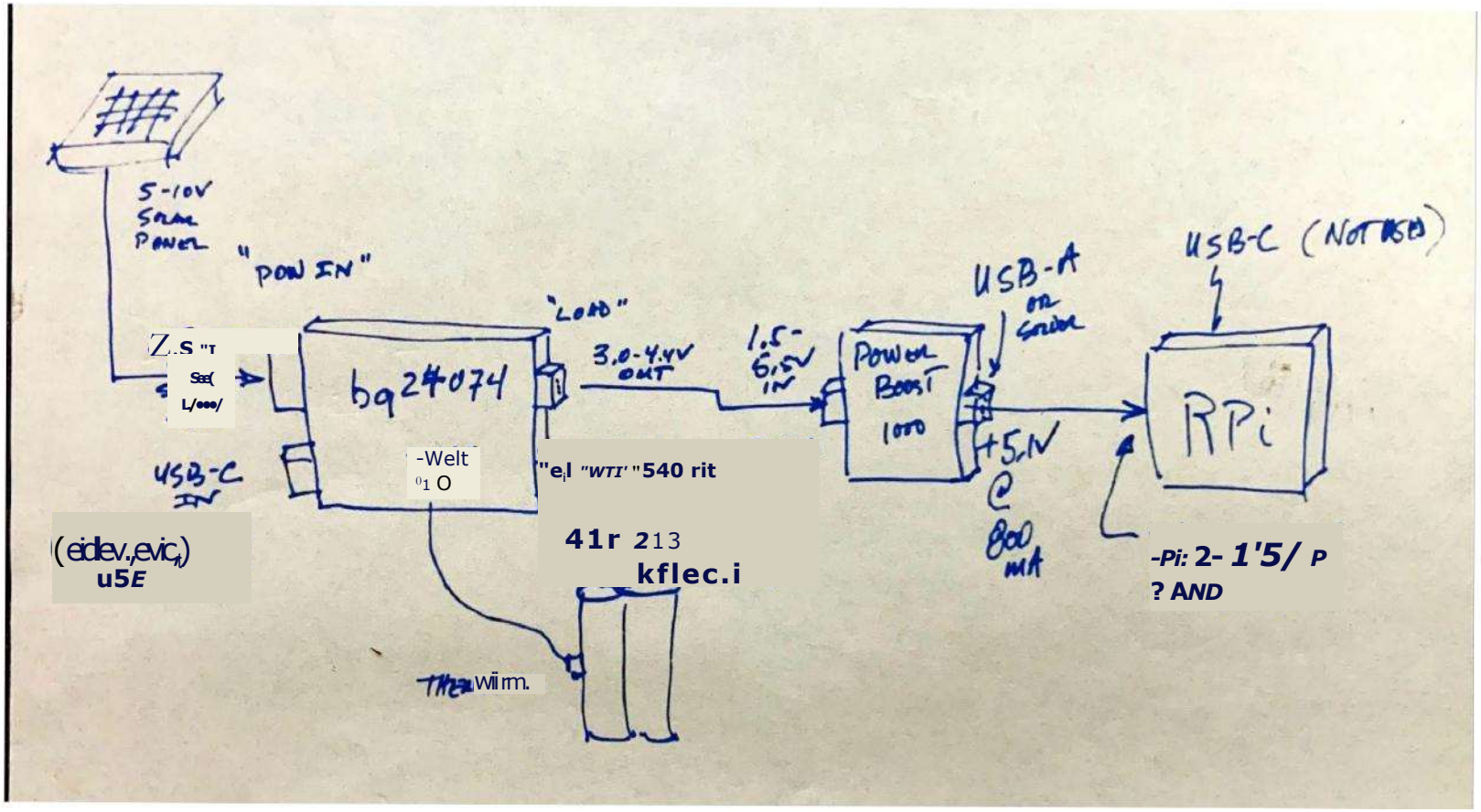






Bi-Quad Antenna for 2.4 GHz June 2022 Fort Collins, CO

Power Management Subsystem



Power Management Components

NoCO Amateur Radio Club
June 2022 Fort Collins, CO

Adafruit Universal USB I DC / Solar Lithium Ion/Polymer charger - bq24074

Created by Bryan Siepert

https://learn.adafruit.com/wdafruit-bc 24074-u niversa I-usb-dc-solar-charger-breakout

Last updated on 2021-11-1S 08:09:16 **PM EST**

0 INSTRUMENTS 71·5131030, TP561031, 71·581032

SLLIS.G-SEPTEMBER2002SED Waal 2015

TPS6103x 96% Efficient Synchronous Boost Converter With 4A Switch

Features

- sex Efficient Synchronous Boast convener With 1000-mA Output Current From 1.84 Input
- Device Clubssoant Current 20-PA (Typ)
- Input Voltage Range: 1.8.4. 5.5.V
- Fixed and Adjustable Output Voltage Options Up to 5.54
- Power Save Mode for Improved Efficiency at Low Output vower
- Low Battery Comparator
- Low EMI-Converter (Integrated Antiringing Switch)
- Load Disconnect During Shutdown
- Over-Tomporature Protection
- Available in a Small 4 mm x4 mm OFN-10 or in a TSSOP-16 Package

Applications

All Single Cell Li or Dual Cell Battery Operated Products as MP-3 Player, PDAs, a. Offier Portable Equipment

3 Description

The TPS6103x devices provide a power supply solution for products powered by either a one-coll Li-lon or Li-polymer, or a hvo to three-cell alkaline, NiCd outputH ba.ry. conve. generates extern p voltage that is et adjusted by an I resistor divider or fix. internally on the chip. It provides high efficient caat paa bs eveoupPto currents uve rtsoio 1 Aa ant 5 Veoydvo.gegown is to 1.8 V. The implemented boost converter is based on fixed frequency, pulse-width- modulation (PWM) controller using a ous rectifier to obtain maximum offidency. cure.. convertor enters Power Save intain a high officio, over a wide load range. Tho Power Save mode can be disaffied, forcing the convertor to operate at a fixed .tching frequency. It can also operate synchronized to an external clock signal that is applied

S'IMT1 itn:rit'e:Ino'axtnalr:or4a:Orrn"A". "" Tho converter can be disabled to minimize battery drain. D.ng shutdown, the load is completely disconnect. from the battery. A low-EMI mode is

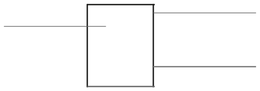
=nared ctrT.r:d g'r:lictg'onrgyaZh'enntrierec' 'Tr'ter entors . discontinuous conduction mode.

Device Information

PART HUMMER	1.1:14.411E wewswerwsu	
TP561030		
TP961031	TSSOP (16/	
TP981032		
TP951030		
TP981031		
TP981032		

" '

4 Simplified Schematic



* I MEstr:Hr20°Zrqsro=21

BQ2407x Standalone 1.40111.54 Linear Battery Chargers with Power Path

1 Features

- ·Fully compliant USB charger
  - Seloctable 10 50 0.mA and 0mA maximum input current
  - 100-mA Maximum current limit ensures compliance. USB-1F standard
  - Input-based dynamic power management (Vie-OPM) for pmtection against poor USS sources
- ·Functional Safety-Capable (B024074)
  - Docume.tion available to aid functional safety system design
- ·28-V Input rating with overvoltage protection
- ·Integrated dynamic power path management (DPPM)function simultaneously and independently Rowans the system and re Me battery
- ·Supports up to 1.5-A charge current wi. currant monilming ougmt(ISET)
- ·Programm.fe input current limit up to 1.5 A for wall adaptors
- ·SyStern Output tracks laa.ry voltage (B024072)
- ·Programmable termination current (6024074)
- ·Battery disconnoct.nction with SYSOFF input (13024075,1302407g)
- ·Programmable pro-charge and fast-charge safety timers
- ·Reverse current, short-circuit and thermal protection
- ·NTG thermistor input
- ·Proprietary start-up sequence lirnits inrush current
- ·Status indication -.arging|done, power go.
- ·Safoty-Rolated Certification:
  - 1EC 62308-1 Certification (BCI24072)

2 Applications

- ·TWS Charging case and headphones
- ·Gaming accessory
- ·Video doorbells, IP ne,vork cameras
- ·Asset tracking and float management
- ·Portable medical devices

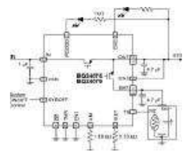
3 Description

T. B024070 solos of devices aro integrated Li-on linear chargers and system power path management devices Mrgeted at space-limited po.blo applications. The devi.s operate from eiMer a USB port or an AC adapter and support charge currents up to 1.5 A. The input vo.ge range with input oveivollage protection supports unregulated adapters. The USB input current lirnit accuracy and start up sequence aloes the 1302407x . meet USB-IF inrush current specification& Additionally, the input drmmic Power management (Var-DPM) prove. the .argor from crashing incorrectly configured USS sources.

The SQ2407x .sourer dynamic power path management (OPPM) that pow. the system whle simult8neously and independently charging dm battery The °PPM circurt reduces the charge current when the input current limit causes the system output to .11 to tho OPPM threshold, thus, supplying the system I.d at all times while monitoung the charge current separately. This feature reduces tho number of charge and discharge cycles on the battery, allows for proper charge termination a. enables tho system to run with a defective or absent battery pack.

Device Information

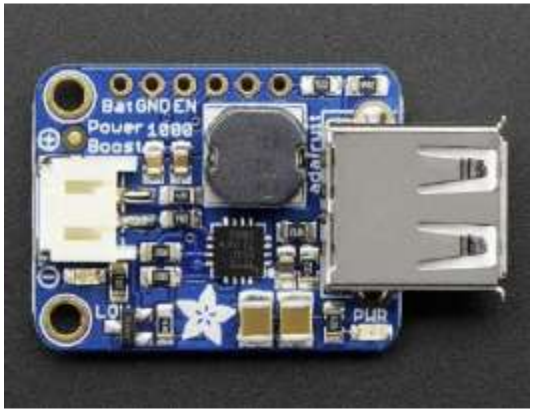
=HO		
80.2•07) V0,141:.• 80.075 130.0711		



Typical Application Circuit

Adafruit Powerboost 1000 Basic

Created by lady ads



http.7/learn.adafruitcornfadafruit-powerboost-1000-basic

Last updated on 2021-11.15 06:16:13 PM EST

So Many Resources Available

NoCO Amateur Radio Club
June 2022 Fort Collins, CO

http://wb5rmg.somenet.net/ksoe/Eggbeater_2.htm

***Jerry*, KSOE: Home Brew Amateur Antennas**

***Eggbeater II* Omni LEO Antennas**

Presented here is a high•performance, circularly polarized omni-directional antenna that is easy to build, easy to tune, ins* arid will work all the mode J Low Earth Orbit (LEO} satellites. I have built several of the traditional 'eggbeaters' from plans around on the Internet, but was never satisfied with the overall performance. This design is the MACOMB of my invesligatio methods of irrurrovino the performance of the 'orioinal" soobeater without obviation the simple construction.

Inclination 97.600400" unto TASMAN, DATA

Uplink 436.250 MHz
Downlink 105960 MHz Beacon 105960 MHz Mode Pr CIISS 7.01-12/ OM, 01.1V
Status active

Remo smousene DATA

uptink 435 36011267.300 MHz
Downlink 145820 MHz
Beacon 145.920 MHz
Mode Fla STC55 62.0Hz: 200bpsDLIV
Status active

Inclination S2370500'
RADIOFrenuemy DATA

upunv 435.350/1267.250 MHz
Downlink '46.880 M.
Beacon 145.800 MW
Mode FM Mr5567.0.1 200bps OUV
Status active

DATA

35130405150 vilz
4.970-145.9501,1Hz
15.336 MHz
110bps BP51, M e e

FOX-113 (RADFXSAT AO-91)

FOX-1B (RADFXSAT 40-91) is a Satellite appearing the constellation Sextans. It orbits the Earth every! minutes at altitudes from 626 to 602 km. It was launcoed in 2017, and NORAD assigned it tracking number 42017. It is a amateur radio satellite.

FOX-SCUFF (AO-95)

FOX-ICEFF (110-95) is a Sat.ite appearing in the constellation Vela. It orbits the Farto eye, 96 minute at altitudes from 579 to 590 km. It was launched in 2018, and NORAD assigned it tracking nun· bur 43770 It Is a amateur radio satellite.

FOX-1D (AO-92)

FOX-10 (40-92) is a Satellite appearing in the mnstellation Hydra. It Wilts the Earth every 94 inutes at altitudes from 481 to 487 km. It was launched in 2018, and NORAD assigned It tracking number 43137. It Is a amateur radio satellite.

39444 - FUNCUBE-1 (AO-73)

FUNcube 1 is a 1U CubeSet built by a teem of volunteer radio amateurs and other specialists.

Funlcube 3. is designed to carry a single oiv linear transponder with a beacon carrying telemetry and data

National Oceanic and Atmospheric Administration

User's Guide for Building and Operating Environmental Satellite Receiving Stations

Updated February 2009

U.S. DEPARTMENT OF COMMERCE

National Oceanic and Atmospheric Administration

National Environmental Satellite, Data, and Information Service

Getting Started on the Amateur Radio Satellites (Part III)

by Keith Baker, KB1SFNASKSF, kb1s1@amsat.org

(The bulk of this article was previously published as "Working Your First Amateur Radio Satellite (Part tor in the May 2010 issue *of Mwtirorikg iNes,* Eliasatourn, NC 2002)

!trust by now a number of you are up and running on our FM birds and are having fun collecting new grid squares or working DX widi. this (for you) new found pan of our wonderful hobby. However, my hunch is that your arm is probably getting tired while working these satellites using just a small, portable, handheld radio atria handheld Yagi of some son_

In anticipation of springtime's warmer weather (in the Northern Hemisphere at kart') my guess is that you'd like to now begin investigating a more permanent antenna array for your satellite station. For beginners on ahudgeLlsuggenyouconsider some form of omnidirectional antenna.

OmEgglasater is a good arnnidIrectlenalbase elation ntenna. Esse. for arodung Me LEO beds. (Courtesy, FIT Antennas)

That's because their use tremendously simplifies building your satellite station, as no rotors, cross booms, or rotor interfaces are needed. Use of omnidirectional antennas also greatly simplifies tlx satellite racking part of this activity as it will allow you to fully concentrate on trying to hear, find (andior track) your own downlink signals while working the bird as it rapidly moves across the sky_

But,unfortunarely, and as we ha discussed, not all omnidirectional antennas are suitable for satellite work. So, in this edition of our beginner'scomen FIonce againoffer same tips en help you optimize your base station antennas for the satellites.

More Satellite Antann• Considerations

Corrary to whatyoundgMhave heard(from well meaning veteran satellite cps) ran only crosslalarized set of multi-element Yagi antennas rnoanted on a non-metallic cross banal will do, Iknow from my own personal experiences that arch talk is largely bunkunt That is, just as with *intst* other pursuits in Amateur Radio, while the ·uhimate"artellite base station antenna array may span one or more circularly polarized Yagi antennas all naounted on a fiberglass cross boom and turned by an (expensive!) commercial alt-azimuth rotator, you can usually still get excellent results on the LEO birds fora whole *lot less* time, money and effort

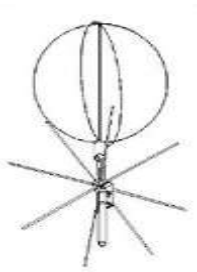
If you already have a VHF and iiHF bare station set lip far scanning or for use on the amateur bands, you probably also have an external VHF or UHF antenna of some sort oannected en it. Unfortunately, the gain of mast of thexe terrestrial antennas occurs at the point in a satellite's orbit where it is farthest away from you tat *the* horizon) and its downlink signal is at its weakest. What's more, as the satellite rises above your horizon_ it will gradually move outside the beam width of most terrestrially optimized antennas to- the paint that, when it is at its closest approach to you (directly overhead) you may not hear the satellite ... and it may *no* hear you ___ at *WV*

Remember,too, that Amateur Radiosarellites are hark tumbling and spinning in space.As we discussed in previous columns, cross-polarizing linear antennas results in *a huge* lass of gain. This means that if the antenna on the satellite is horizontally polarized and your antenna on the Earth is vertically polarized (or vice versa), you may not receive much of anything on the ground, no matter how much power is being transmitted to or from the satellite.

To help minimize these problems, satellite builders usually incorporate what are called circularly polarized antennas into their satellites. Building circularly polarized antennas into a sarel lite helps nunanize the effects of antenna cross.polanzation losses ontheground Lathe satellite moves through space.That's because the difference between right-hand circular pararizatton and left-hand circular polarization is only about 3 dB. Thankfully, there area couple of relatively simple, omnidirectional antennas that are also specifically designed to achieve this high angle, circular signal polarization pattern withom *a/so* coning yam a fortune ... or making your home look like a NASA racking station!

Scrambled Eggs, Anyone?

One relatively inexpensive omnidirectional base station antenna that is useful for LEO satellite work is called an Eggbeater. The Eggbeater antenna looks a lot like its narnesake ___ an ordinary kitchen eggbeater_ It's composed of Iwo full-wave loops of wire (or some other rigid metal material) fed 90 degrees out of phase with each ether. Some designs even sport parasitic reflector elements underneath the array to give the antenna more elevated gain_ At the horizon, the eggbeater exhibits a horizontally polarized linear pattern, which also makes s useful for weak signal VHF or UHF terrestrial work. However, al higher elevations, the antenna exhibits an *ever* more right-hand circular radiation pattern, which makes it idealfor satellite work

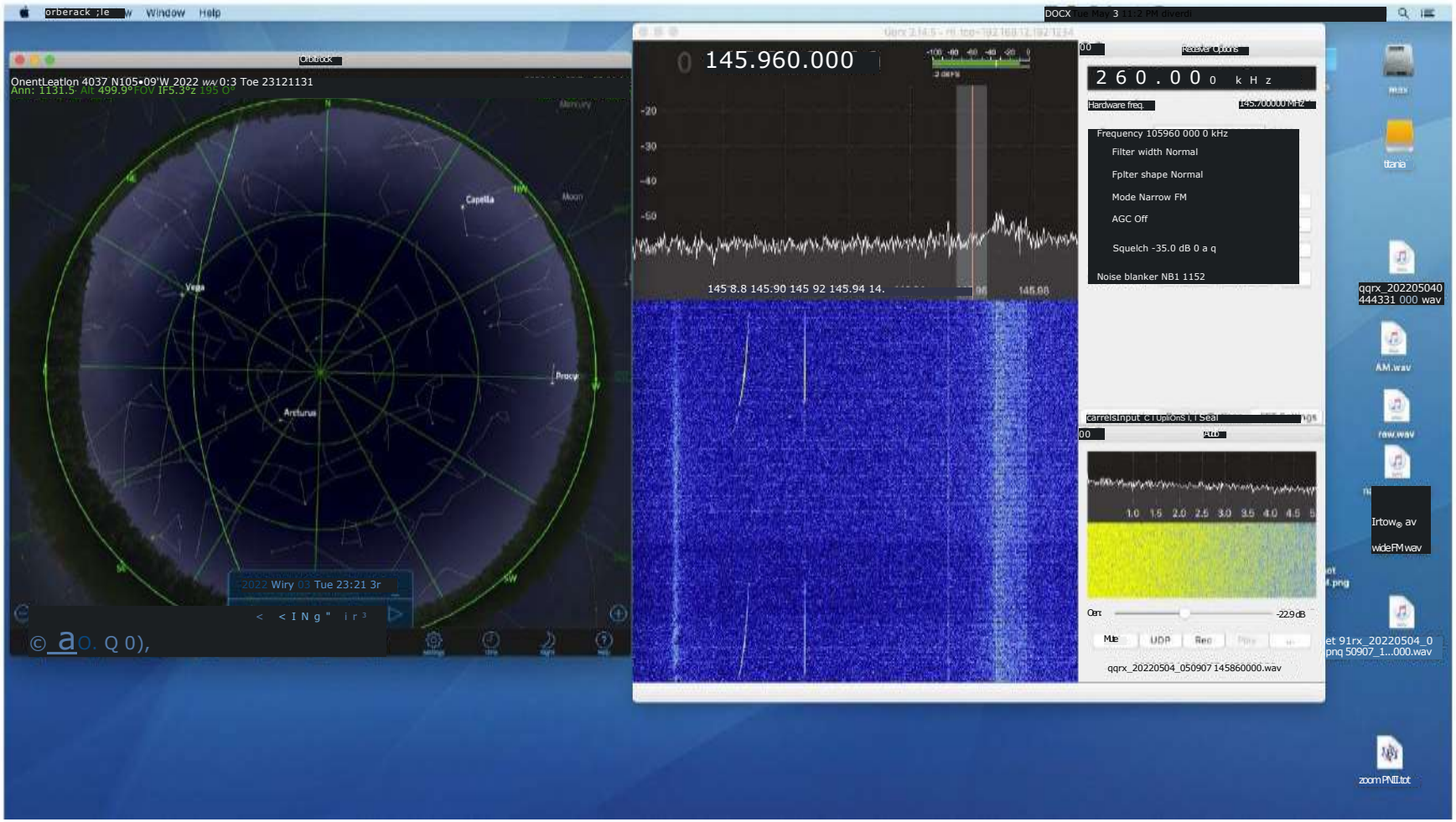


Adding ground prune elements under the Egg. increases gm overall Hyman! gain of the* enigma. (Courlasy,f1Antennes)

Gerald Brown, KSOE, has published en excellent Web anic le on how le home brew satellite-optimized eggbeater antennas

Observational Skills Development

Colorado State University
Fort Collins, CO



GNU-Radio – a Computational Resource

Colorado State University
Fort Collins, CO

a **0 8** hnbal 1.gnmadlo. Index.phrall Oriels

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Edit Newsmr, Search GNU Ream

Tutorials

P102213 leave tuto000-reland feedback (either Mr an individual tutonal or overall organization) in the Ds m cussn page of this arlde (tab at the top), we are always looking M ways to improve.

Wild Heine
GNU Wettslto
FAO

Ouldes

Installing SHUR.°
Contrl.ng

Wild Took
Recent changes
Random page
Help

Tools
Wha lin. here
Related changes
Special pages
Prlrdeble version
Permanent link
Page informelion

Beginner Mortals

Introducing GNU Radio

1.what ts GNU Radio,
2.00.1102 GNU Radio
3.Your First Flowgraph

Flagg raph Fundamentals 1.
Python Vanables GRC .
Variables in Flowgraphs 3.
Runtime updating Variables
O. Signal Date Types
5. Converting Data Types
Packing Bits
S. Streams and Vectors
8. Hier Blocks and Parameters

Creating end modifying PyMon Blocks

1.Creating Your First Block
2.Python Block WOO Vectors
3.PyMon Block Message Passing

O. PythonBlOCk Tags

OSP Blocks

. Low Pass FilMr Example
. Designing Filter Taps 3.
Sample Rate Change

Intermediate/Advanced Modals

Core GNU Rm. Mechanics

1.Stream Tags
2.Poyrniaphic Types (P080)

3.Message Passing

Modulation and Demodulation

4.Narrowband FM
5.Sing. Sideband (SSB)
6.QPSK Mod and Demon-
. BPSK Demodulation
S. Frequency WI Keying (FSK)
5. OFDIA Basics
X. Packet Communications

Custom Blocks and ON of Tree (000) Modules

1.Creating an OOT (Python block example)
2.Creating an 00T (C++ block example)
3.Binting the VAML file fora *No.* (GIA 3.8+)

Miscellaneous

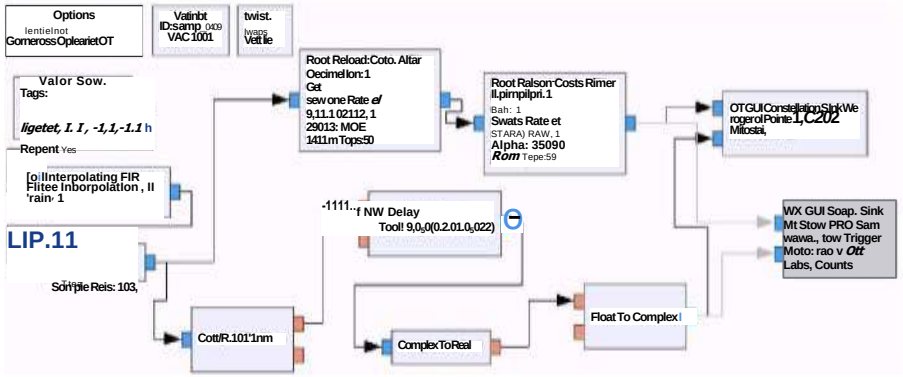
1. understanding a Flowgraphis Python Code
. Using GNU Radio With SORB
3. 10 and Complex Signals
O. understanding Sample Rate
5. understanding ELM Blocks
5. Bancllirnited Threshold and Detection Demo Application

Developer FlAnource.

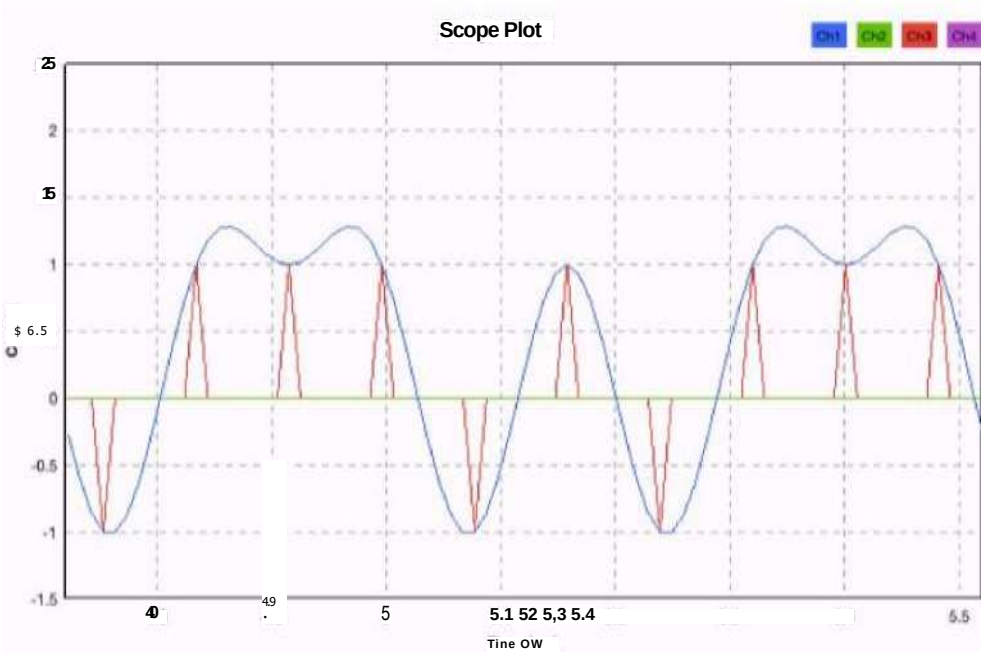
1.Porting Enating Rowgrabh5 to ₅ower 000500
2.Porting Ensting 00Ts horn 3.9 to 3.10
3.Porting EMsfing 0000 horn KB to 3.9
0. Porting EMsfing 00Ts horn K7 to 3.8
5. VOLK: What it does, why n rocks, how to write new kernels
O. W00Nng WRIALSA and Pulse Audio
X. Using Visual Studio Code for Source level debugging of 0000
3. Using Eclipse for Building and Source level debugging C++ 00Ts
. Using COcle,1310Clo IDE for GNU Radio Development
10.OH and GNU Radio
1.How to use Octave or Matlab with GNU Radio
2.The GNU Radio Sche02010
3.Using Custom Buffers for Hardware Accelerated Blocks 10. Remote Control and AutornMlon of FlOvigrephs 0401 XMLRPC

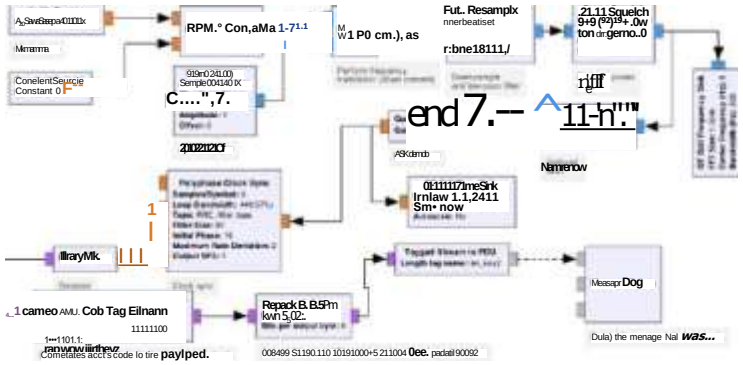
Download file: BPSK_modulatorB.grc.

Flow Graph.

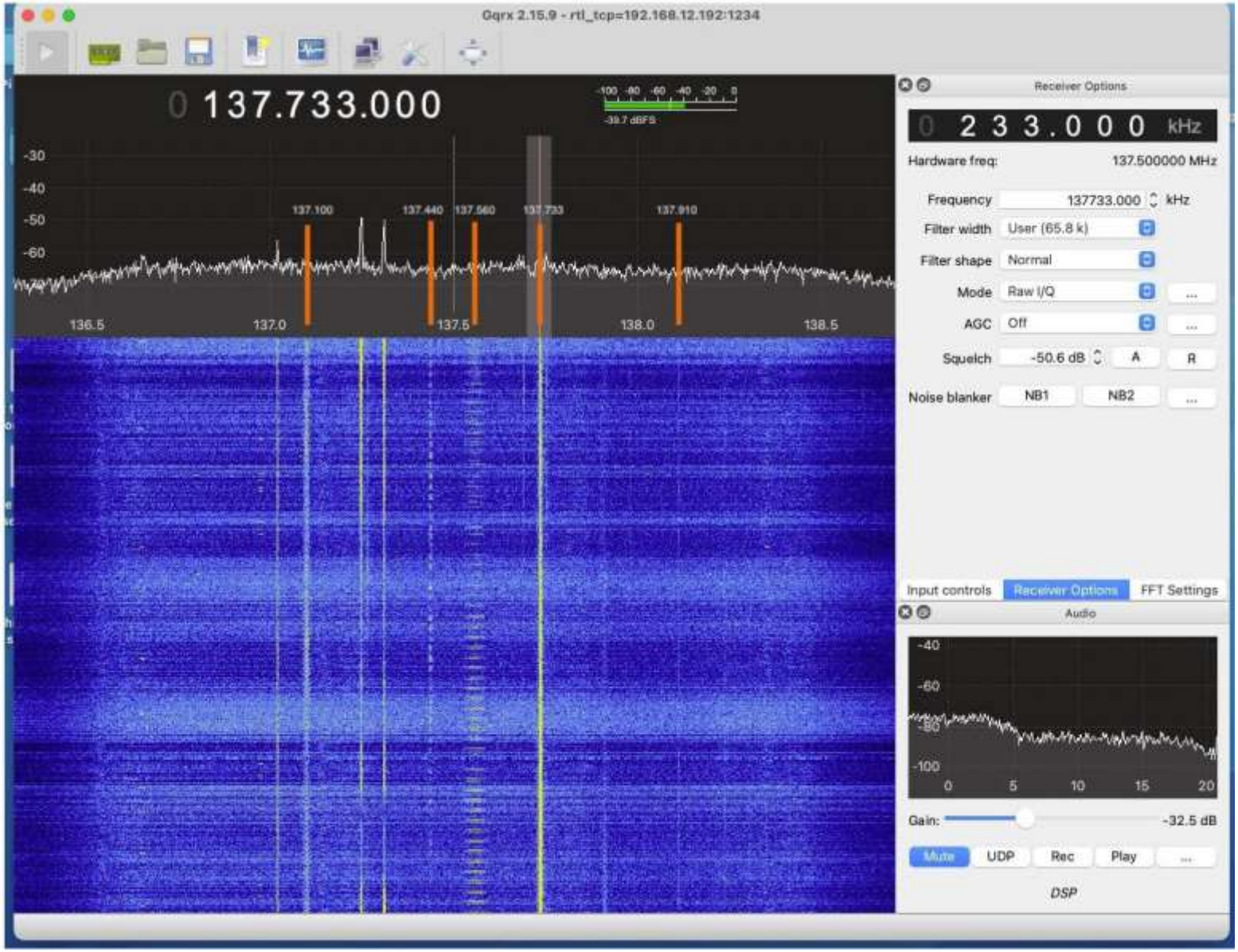


Output:



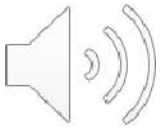


There's a Lot of Stuff on the Air Fort Collins, CO



Colorado State University

Fox-1 Cliff Audio Beacon **Fort Collins, CO**



2022.04.20 09:43:02 UTC

145.920 MHz