

# Transmitting on QO100



(Picture from DH2PA)

# Disclaimer

Hello, My Name is Hans From Austria.

Today we'll go through the Steps that must be taken to Transmit over the Geostationary QO100 Transponder. Please keep in Mind that there are several ways to do so. We'll discuss different Setups and i'll explain how i did it with my Setup. Well also talk a bit about operation Practice since some Things youll see on the Transponder are not the best Practices...

When i mention Hardware in this Guide its because i have it either here or i bought it for the Pourpouse. I dont get Money or Hardware for mentioning certain Products here. (Unfor- tunatly... X))

I am not responsible for any Damage that might occur on Hardware or your Health by follo- wing this Guide! Please use your common Sense when working with Tools and clim- bing on Roofs...



# Considerations to be made:

I assume you have already setup your Station so that you can Receive the Satellite. So you should have setup and adjusted your Dish already.

There are 3 Ways to transmit to the Satellite:

- You can either use your existing Dish that you use to receive the Satellite and add some kind of Feed. A feed is a small Antenna that emits RF to the Satellitedish where the RF gets reflected in the Direction of the Satellite. There are different kind of Feeds like the Dual Patchfeed from Mike Willis and UHF-Satcom. You can also use Helix Antennas or other Feeds.



- You can also use a second Dish where you mount a normal Feed.
- The third method is that you use a normal high Gain Antenna like a long Helix Antenna or a wifi Antenna. (Keep in mind that you loose 3db Gain when using a non polarised Antenna) This Method can be usefull when you dont want to mount a second Dish that is only dedicated to QO100 or you manage to mount the QO-100 LNB on your normal SatelliteTV Setup like DH2PA did (Pictures below.).



# What Radio will you use?

This one is interesting and should be thought about carefully. Most of HAMS nowadays have some kind of SDR Radio at Home. My station for now consists of a HackRF for TX and and Airspy for RX. Later id like to setup my Station so that i can work over the Satellite without the need of a PC, so i want to use a Stationradio... (C'MON ICOM RELEASE THE IC-9700 ALREADY!!!!)

- Using an SDR: SDR Radios are getting cheaper and powerfull. There are different Radios out there that can TX on the 13cm band without the need of an Upconverter. Most of them already have a Connector for a Frequency Reference that will be wanted and needed. You can use the HackRF, the ADLAM Pluto, the LimeSDR, and many many more... For todays Guide we will use the HackRF.



- You can however also use your Stationradio. The Radio must be capable of Transmitting on the 2m or 70cm Band (depends on the Input Frequency of your Upconverter). The preferred Voice Mode on QO100 is USB, you could technically also use LSB... Your Radio should either have a very accurate TCXO or a Connector or Mod for an External Frequency Reference. When using your Stationradio you will need an Upconverter wich we will describe later...



# Talking Upconverters...

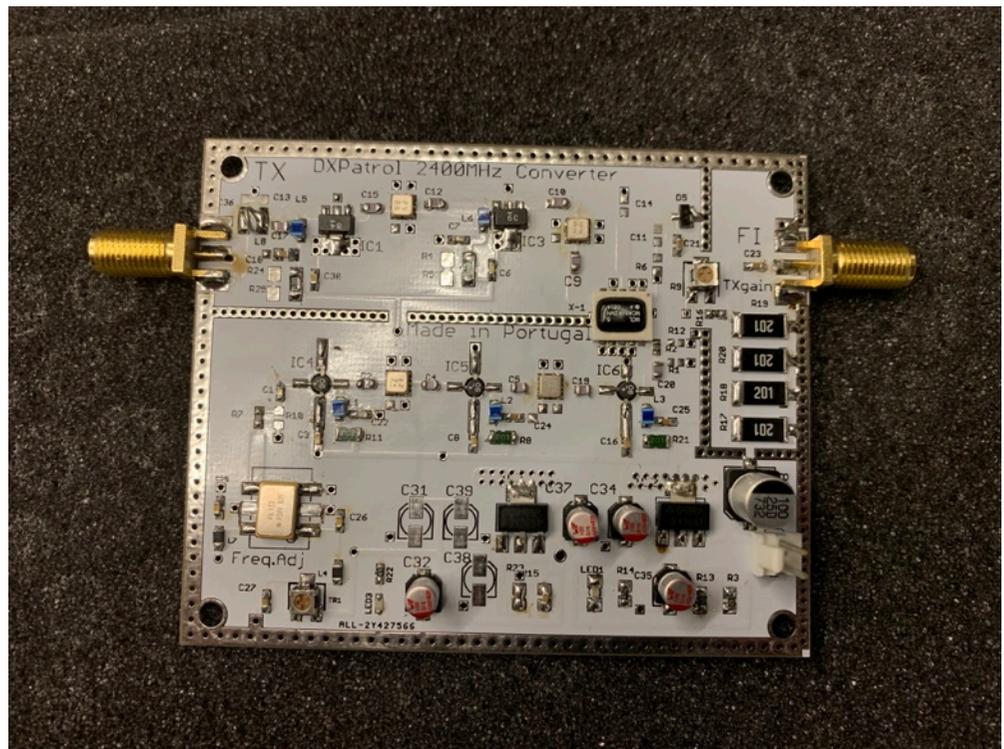
If you want to use a Radio that cannot TX on the 13cm Band on its own you can use an Upconverter. The Upconverter takes the Input Frequency from your Radio and „adds“ the Frequency from the LocalOscillator (LO Frequency) of the Upconverter. The Result is the higher Frequency that comes out of the Upconverter. So lets say the Upconverters LO Frequency is 1970Mhz and you send a Signal on 430.2Mhz the Output Signal after the Upconverter will be at 2400.2Mhz. The Upconverter is normally designed for a specific Band. It has Filters build in to interrupt unwanted Frequencies.

There are different Upconverters usable with QO100. Id suggest you use the Transverter from SG-Labs sice i have heard good Reports. But there is also the Bu500 that can be bought on EBay and the Upconverter from DXPatrol. (There are many more, but these are the ones i know a bit about.)

Please notice that the Upconverter also needs a stable LocalOscillator, the best Solution is to get one where you can connect an external Reference...

You also have to check the maximum Inputpower the Upconverter can handle... If your Radios minimal Outputpower is higher than the Upconverters maximum Inputpower you want to get some Attenuators between them...

The LO Frequency of these Upconverters can normally be set. either over a USB connection, Jumpers or Trimmers.



# „This TCXO drifts like a Motherf%&\$r“

Quote from @0x47DF on Twitter

When working with rather high Frequencies we want our Oscillator to be as Accurate as Possible. The „Unit“ of the Oscillators Error is given in ppm (PartsPerMillion). When you have an Oscillator with an Accuracy of 50ppm at a Frequency of 25Mhz your Frequency can vary 1250Hz Those Frequencies are often multiplied and so does the Error.

Better Oscillators are TCXOs (TemperatureControlledOscillator) and OCXOs (OvenControlledOscillators)

Most of the Equipment have not the best Oscillators installed. Since we work in the 13cm Band wich is Quite High and we also often use 2 Radios for RX and TX we want to get our Frequency as stable as Possible.

The most common Method today is getting a GPSDO (GPSDisciplinedOscillator) wich is a Frequencysource that uses the Signals send from GPS Satellites. They got quite cheap and can be programmed for different Outputfrequencies and Powers. The most common used GPSDO (as far as i can tell) are the ones from LeoBodnar...

Another Method is getting yourself a Rubidium Frequency Standard wich is basically an Atomic Clock. There have been used Standards (wich can be programmed between 0,5 and 25Mhz) sold over ebay some time ago... They work very well for our uses and they increase the Uberhaxxor-31337Value of your Shack at least 42%... =)

Id recommend the GPSDO when you want something that just works...

You want to connect the Reference to everything that has an internal Oscillator, The LNB, the RX-Radio, the TX-Radio, the Upconverter. With such a setup you should be able to get a very stable Signal and you wont have to retune...



# Power the more the better?

How much Power do you need to make a QSO over QO100? Surprisingly little!

When your Antenna is alligned accurately, has a reasonable Size and your Powersource (Radio) is near the Feed you can make CW QSOs wick a few 10s of mw. You can make good SSB QSOs wick 2-3Watts easily.

Make sure you use a high Quality Feedcable with low Signalloss. Aircell7 loses over 30db on 100m, Airbourne10 uses „only“ 20db on 100m. Get your cables short.

You can also put your Gear near to the Feed but that needs a good watherproove housing...

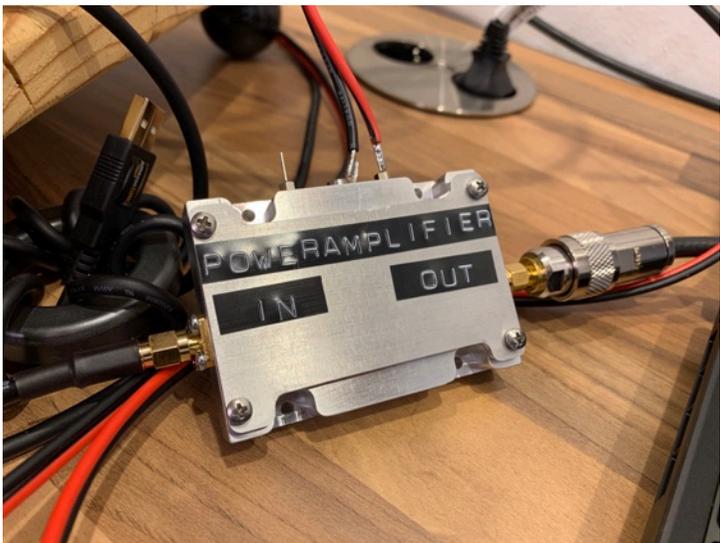
If you need one or more PowerAmplifiers depends on your setup. If you have a short good Feedcable and your Upconverter puts out 3W of RFpower you might go with that.

If your HackRF puts out 8mw and you have 22m feedline you wont be done with just one Poweramplifier.

Good Results have been made with a small Preamplifier like the LNA4all and an 8W Wifi-booster (that puts out about 2W of RF... go figure...).

My current Setup consists of the HackRFs 8mw that goes into a LNA4all that puts out 22mw that goes into the WifiAmplifier that puts out 500mw that goes into the SG-Labs Amplifier that puts out 20W. At full power the feed will be supplied with 8W. Offcourse you should adjust your Power at a suitable Level... I hope i get a Preamp soon that is is capable of putting out the 500mw for the SG-Labs PA so i can get rid of the PA-Centipete...

Take a look at the Specs of your Gear and see if you need a PA and if so what PA is suitable for you. A good PA in my Eyes is the SG-Labs PA. (I dont get paid to say that, Im just a Fan...)



# OK Lets do this...

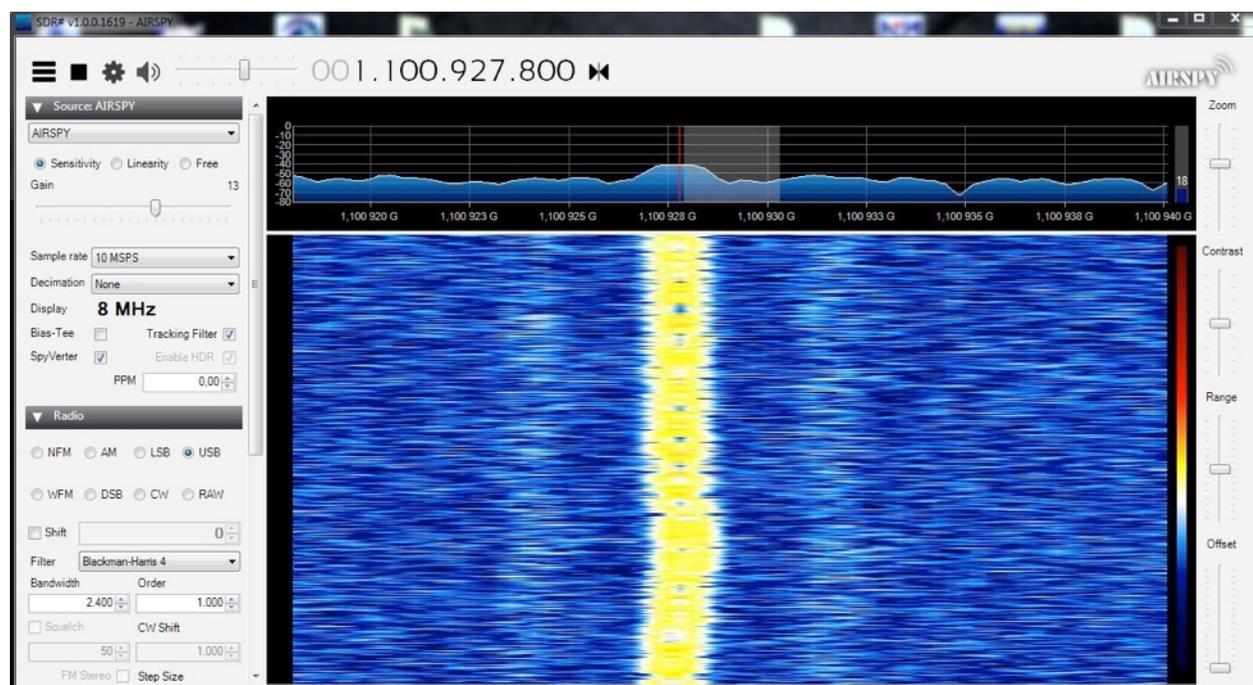
We will now go through the Steps to Transmit Signals to QO100. I assume that your Transmitting Antenna is Setup and pointed to the Satellite. If you use a DualPatchfeed as i use you just need to mount it on the Dish. When you use another Antenna you need a Compass and a Anglemeter... You should have a Feedcable in your Shack, you should have all Software installed and enough power on the Feed to get the Signal to the Satellite. You should also have your Reference Frequency connected to your Radios and if needed Up-converter and LNB...

**I highly encourage you that you try to send on the supposed Frequencies with low Power and low gain Antennas between Radios inside your Shack. We dont want to be a bad Example for other Users.**

Switch everything on and let it Run for a few Minutes to get on Temperature. Especially if your LNB is not connected to the Frequency Reference you want to do this. If your LNB drifts badly you can wrap it with some Bubblewrap some Cloth and a last Layer of Aluminiumfoil. You also want to Weatherproove your Feed...

Make sure everything has Power. The BiasT for the LNB the Poweramplifiers and the Radios. We dont want to search an Error for just to notice that the Power to the Amplifier was not plugged in. Make sure that the GPSDO or the Rubidium Frequency Standard is locked.

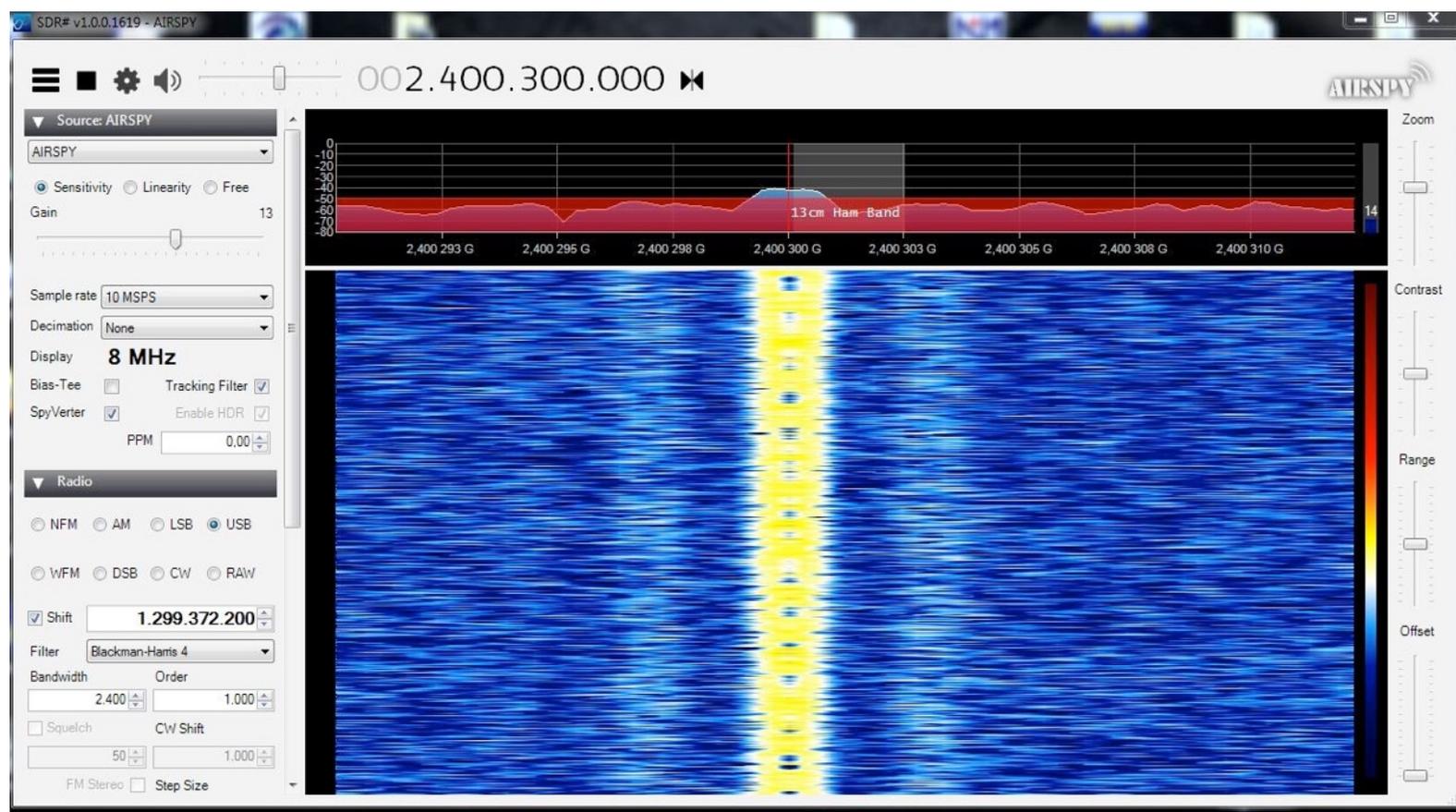
Fire up your RX Software, SDR# in my Case. Before we start with the TX we want to make sure that we 100% know where we are on the Band... Search for the Upper Beacon of QO-100 and Zoom in. Set the Demodulator for USB and adjust the Frequency that the Beginning of our set Frequency is in the Middle of the Upper Beacon of QO-100. Note That Frequency.



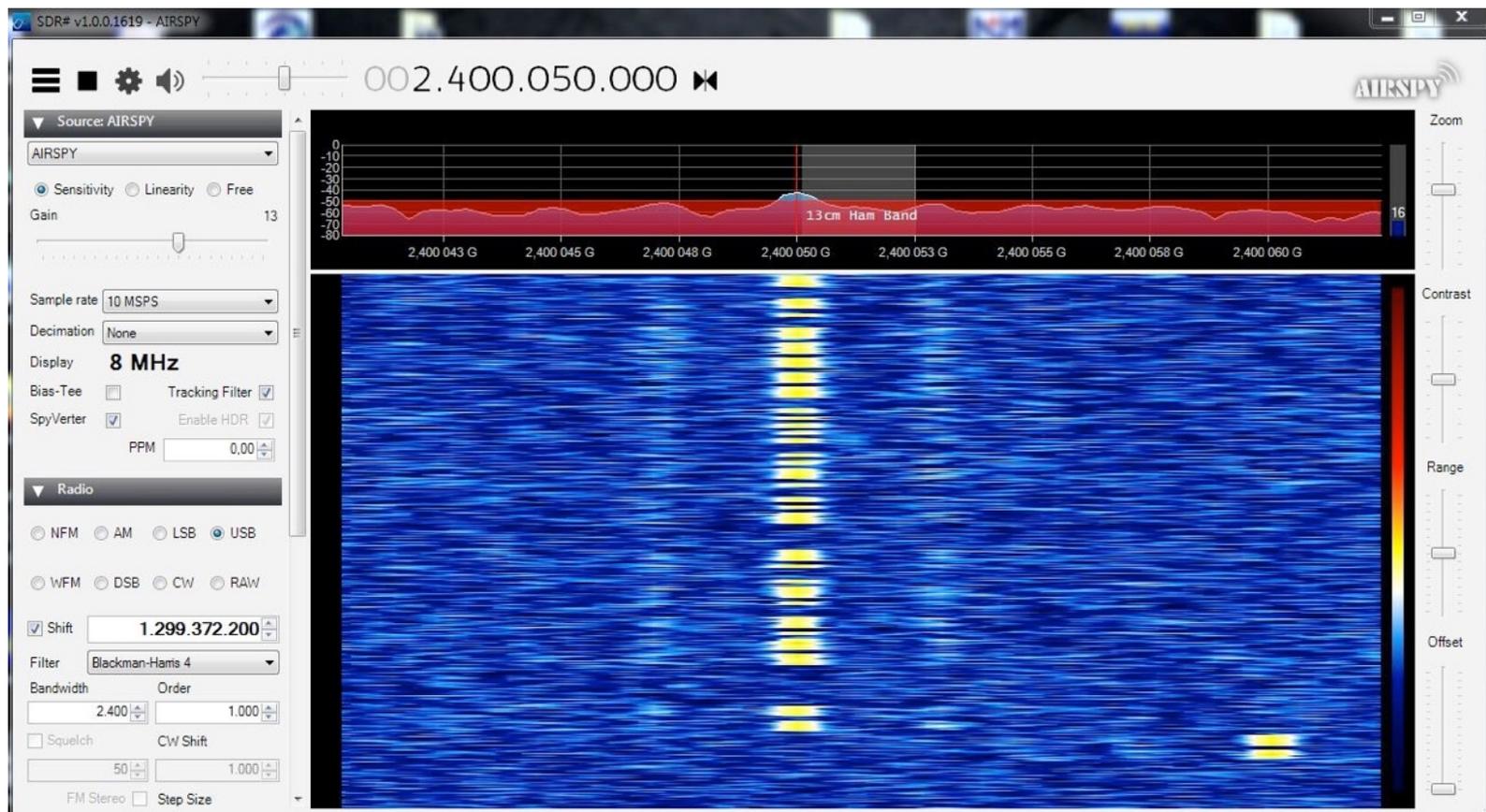
Its a good Practice that you have your RX and TX Frequency adjusted so it DISPLAY the same Frequency in your SDR Software. In reality the upper Beacon would be at 10.489800 GHZ. When we would THEORETICALLY want to send on the Beacons Frequency we would have to set our TX Frequency at 2.400300GHZ. I'd suggest you send your RX Frequency in your SDR Software so it matches the actual TX Frequency. It makes Things much easier...

Take the Readout of the Center of the Upper Beacon. In my Case thats 1.100927800GHZ. We want to set an Offset that the displayed Frequency is 2.400300GHZ so we have to set our Shift (in GQRX its called LO Frequency in the Setup Menu) to 1.29972200GHZ ( $2400300000 - 1100927800 = 129972200$ )

Now the RX Frequency Readout should show 2.400300Ghz.



You can doublecheck your Offset by centering your RX Frequency at the lower CW Beacon. The Readout should be 2.400050GHZ

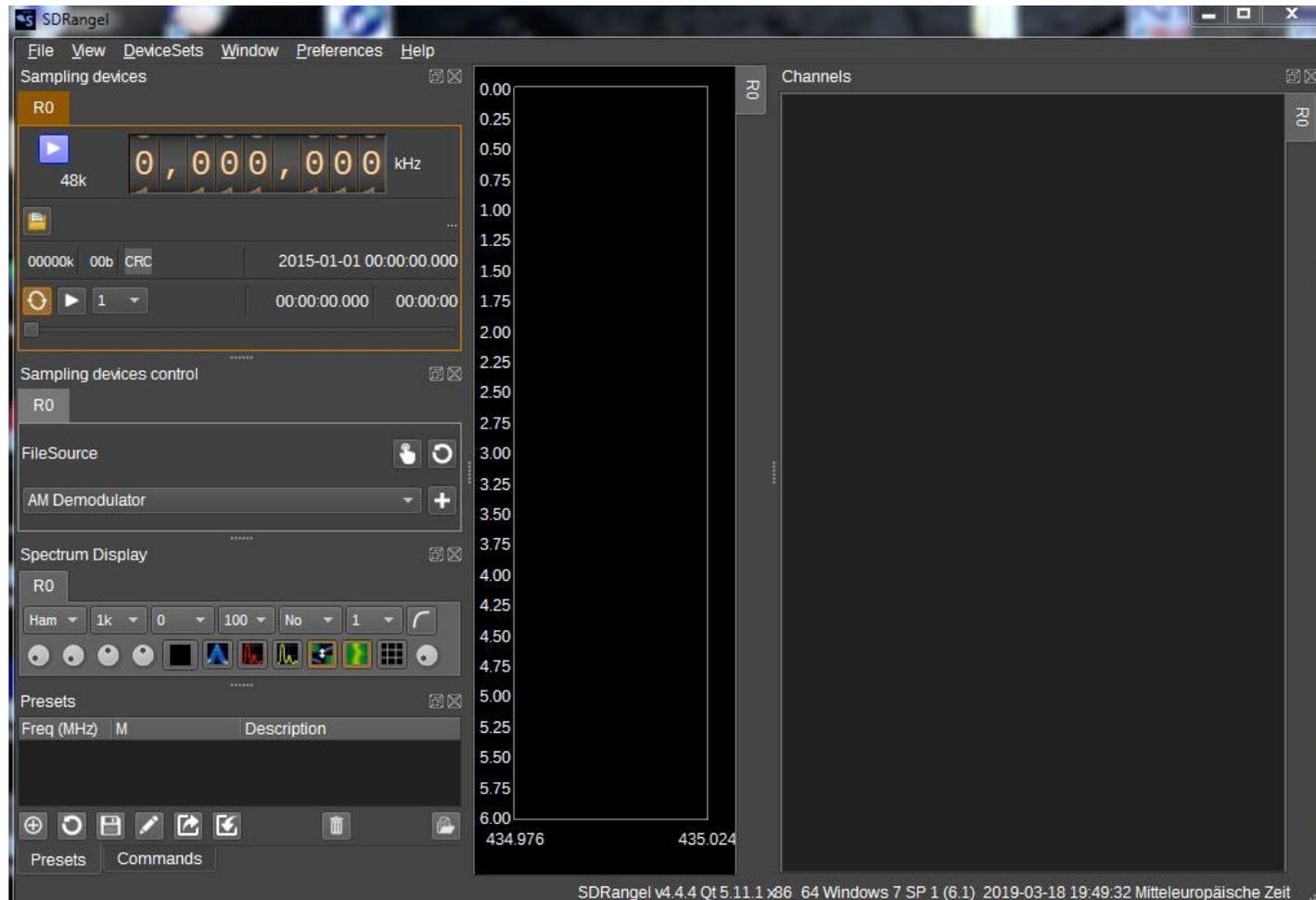


Please be advised that the Offset might value when our LNB or Receiver is Drifting. Its a good Practice when you check if your Offset is correct from time to time...

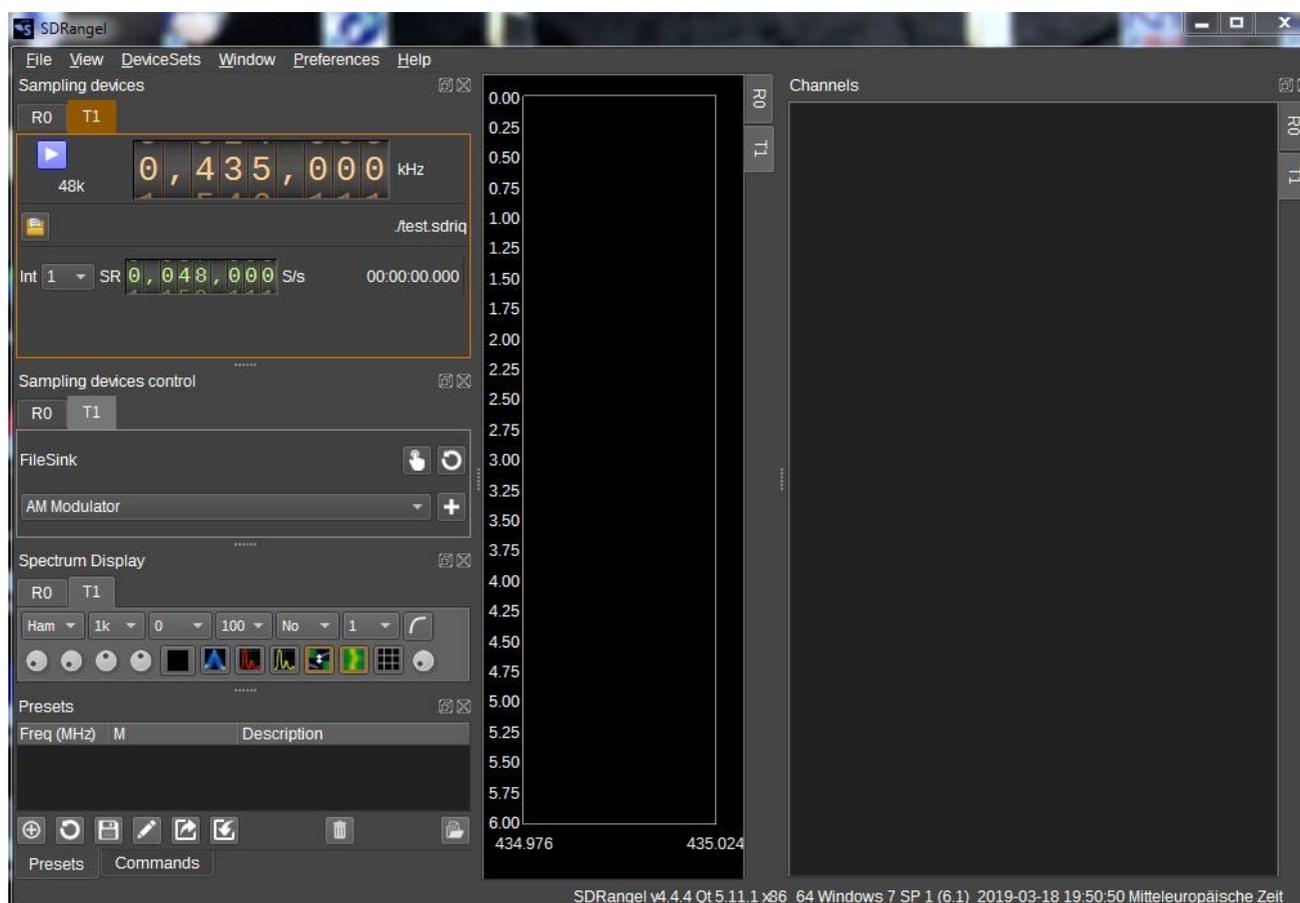
I lead you now Step by Step to make your first Transmission.

I'll use my HackRF and SDRAngel to do this but you might use your Radio and Software of Choice.

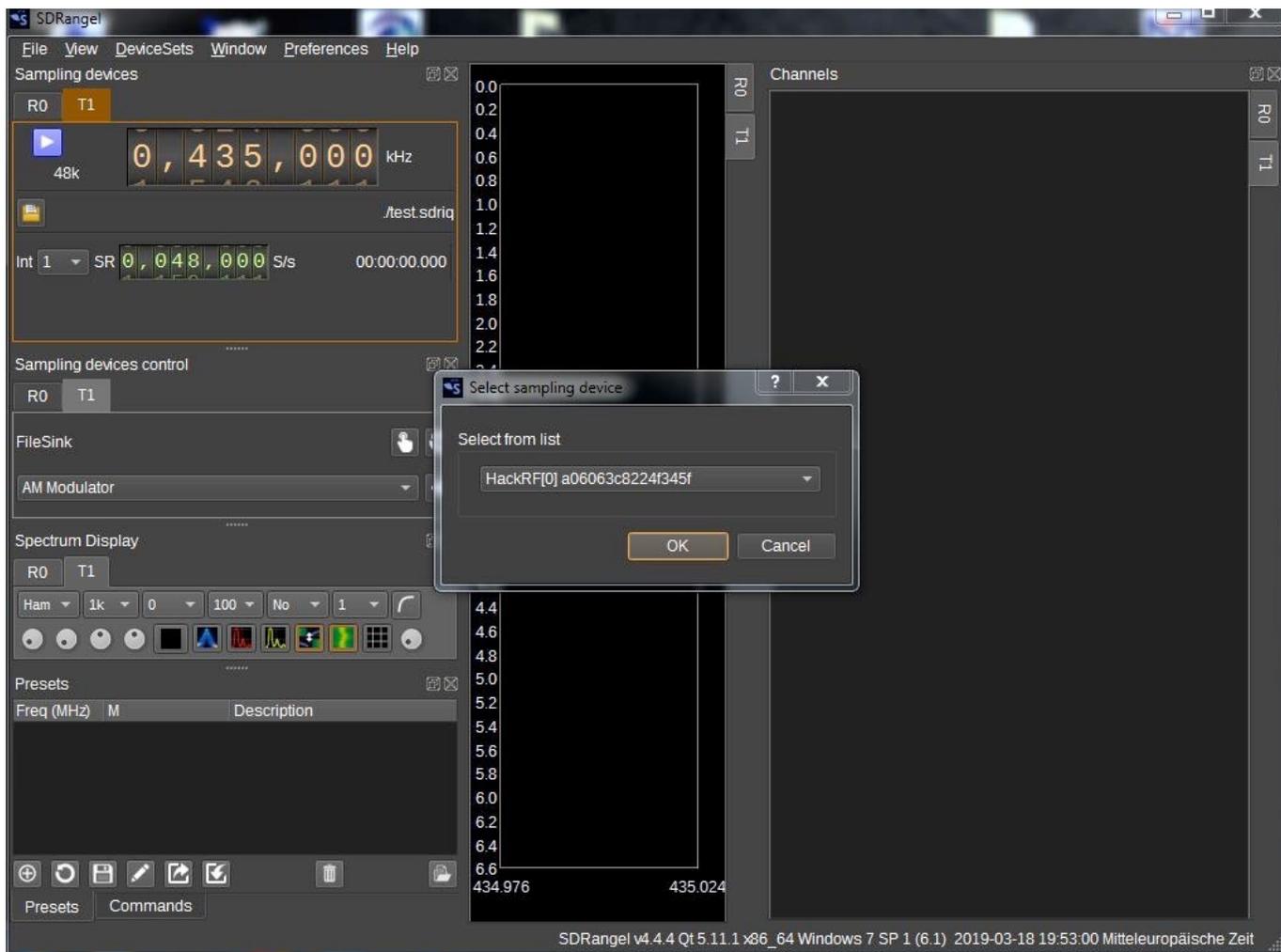
Connect your HackRF and start SDRAngel.



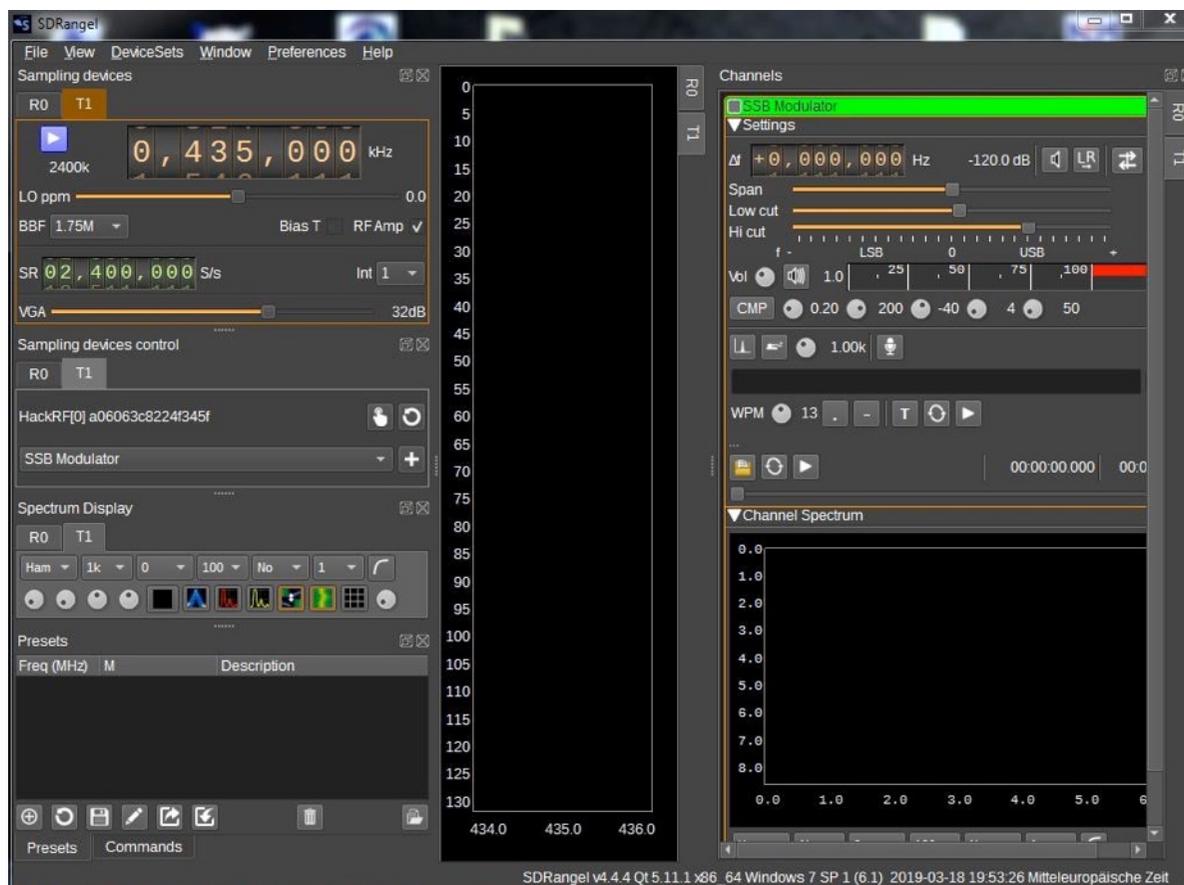
Click on „DeviceSets“ on the upper Menu and select „Add Sink Device“.



Now click on the „Refresh“ icon in the middle of the left Area. Select your Radio and Press „OK“.

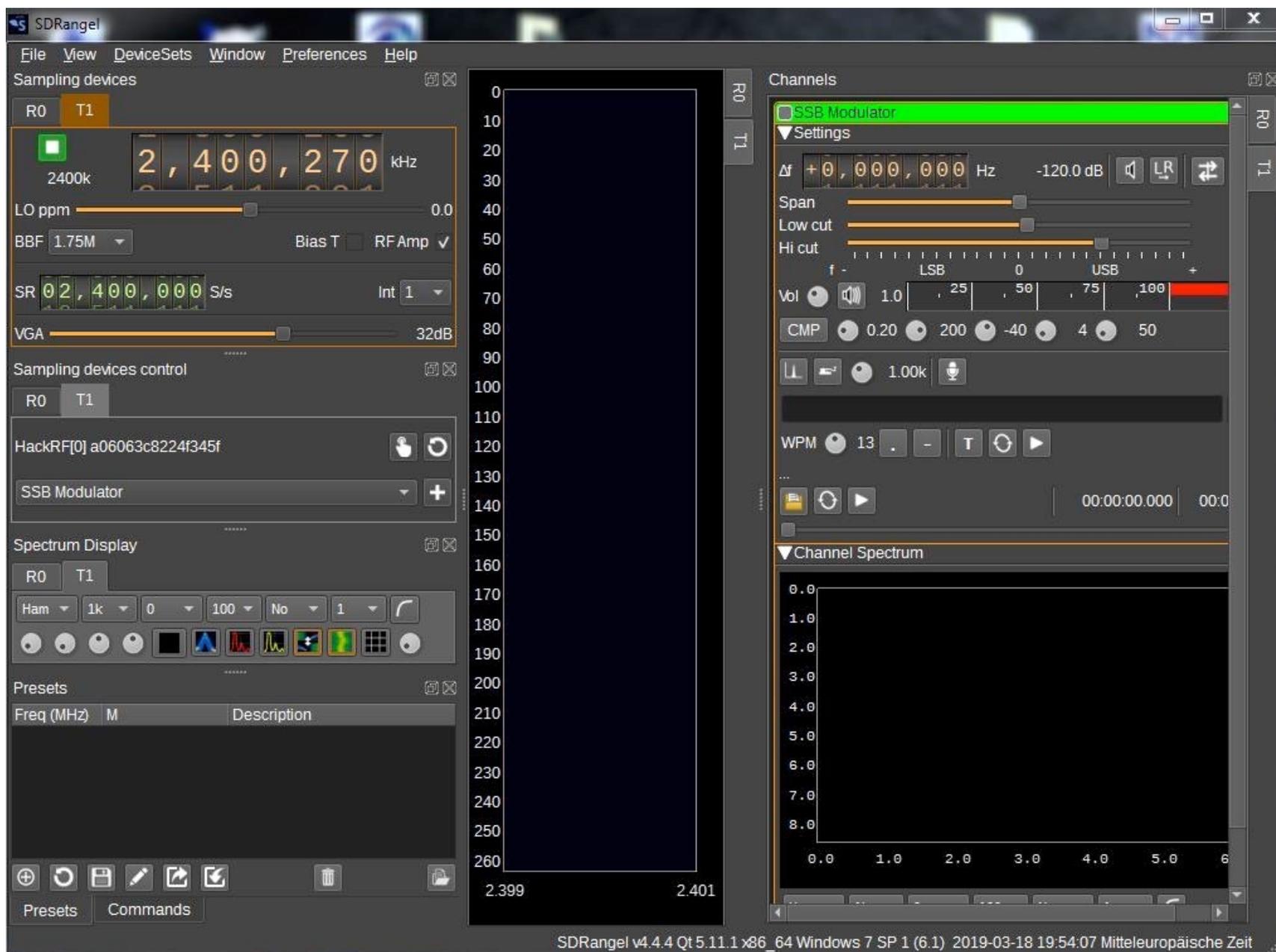


Select „SSB Modulator“ in the DropdownMenu and press „+“ on the Right Side of the DropdownMenu. Make sure „RF Amp“ is checked and that „VGA“ is not too high. (The HackRF puts out about 9mw on full Power but it depends what Amplifiers you have after your Radio...)



Take a Look at your RX Software and look for a free Frequency in the SSB Area of the Transponder (2.400190 - 2.400295 GHZ).

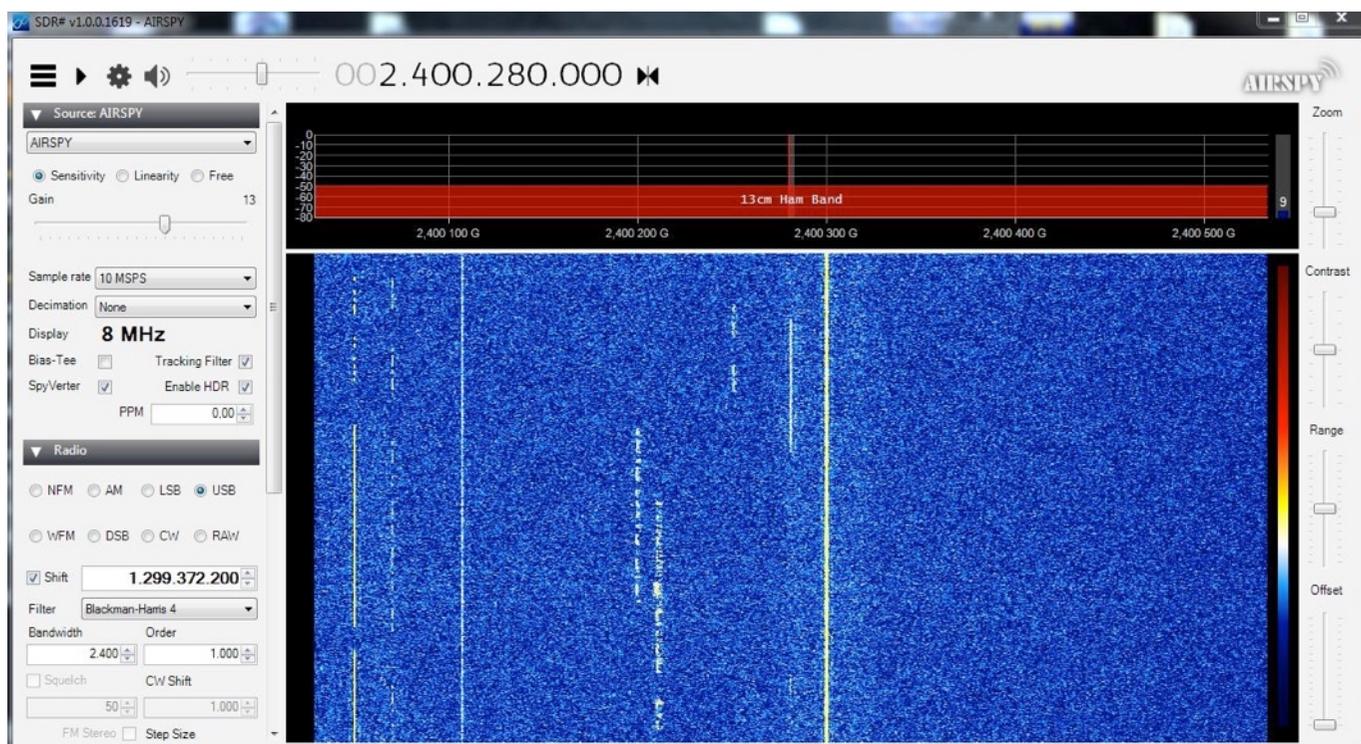
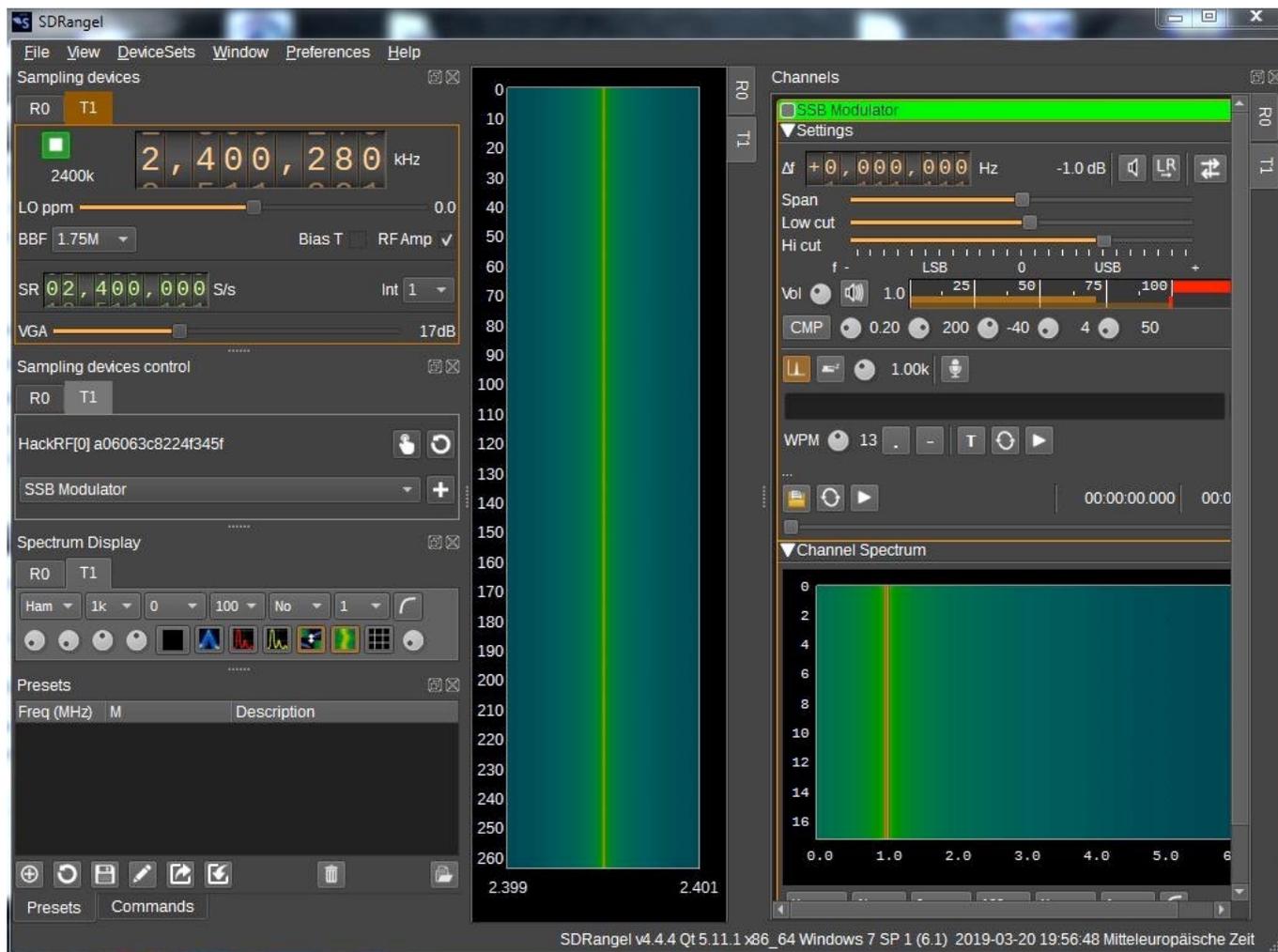
Set the TX Frequency to the free Frequency on the left side of the Programm and klick on the „>“ Button. You are not transmitting yet...



On the Right side of the Window there is in the a Button showing a „Amplitude“ on a Graph. If you press this Button the SDR will send a Carrier Signal.

Open your RX Software and observe the Area. Click on the „Amplitude“ Button and let it go for a Second or so. Click on it again to stop the Transmission and observe if you can see your Signal in the RX Software.

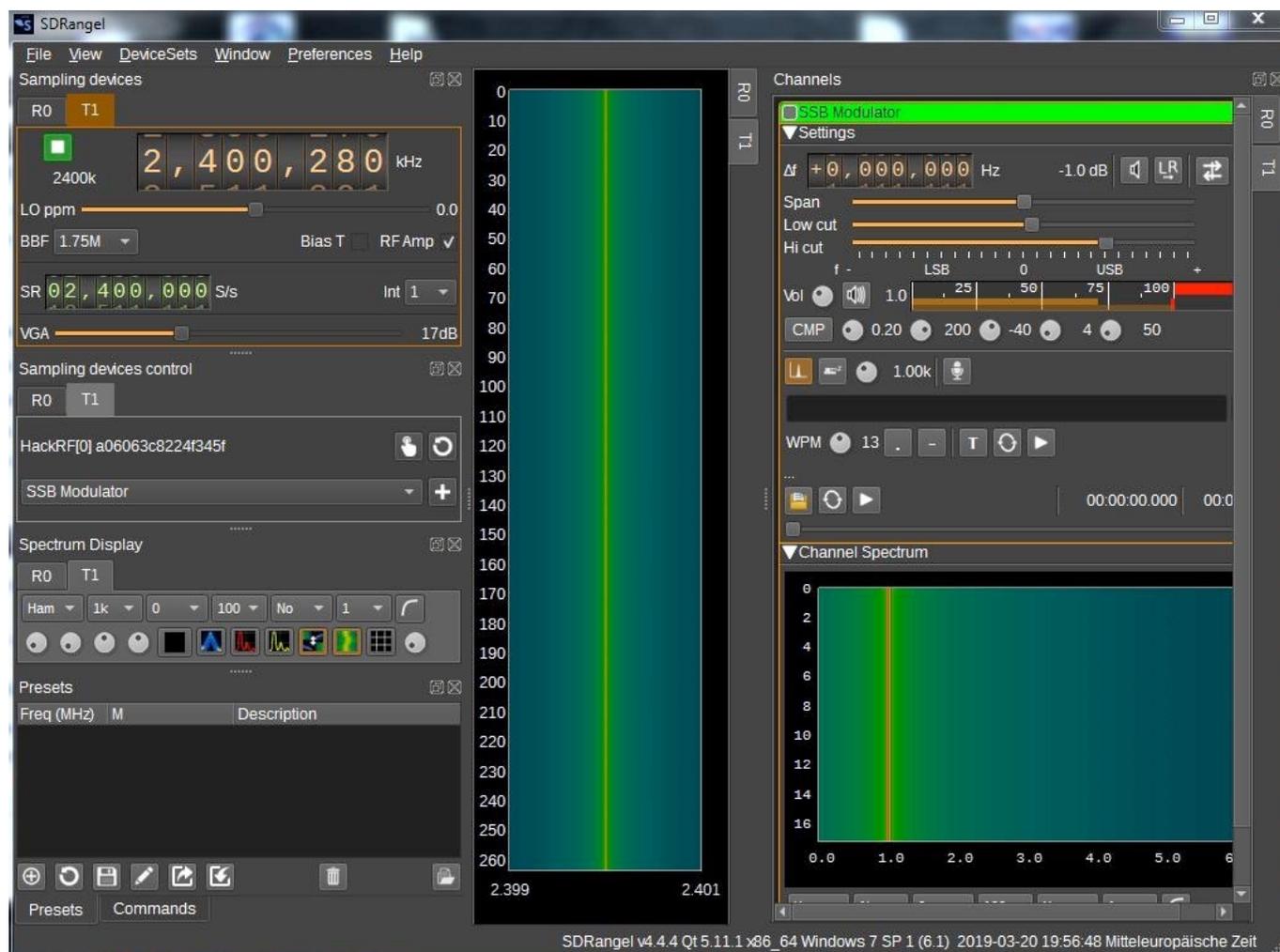
If there is no Signal seen you can increase the TX Power by move up the „VGA“ Slider on the left Side of the TX Window.



As mentioned before, I highly recommend you to test everything with low Power and low Gain Antennas in your Shack before transmitting to the Satellite. Make sure everything works good and your Frequency settings are correct...

If you want to make a SSB QSO connect your Headset or Mic to the Computer and make it the „Default Source“. Got to SDRangel Select your Audio Input Device in the „Preference“ Menu. Adjust the Volume and if needed the Compressor.

By clicking on the „Microphone“ Icon you switch your SDR into TX Mode and you send your Audio...



Since the Readout Frequencies from our RX and TX Radios are the same you can listen for an CQ Call and Dial in the Frequency in your TX Software and make your QSO easily.

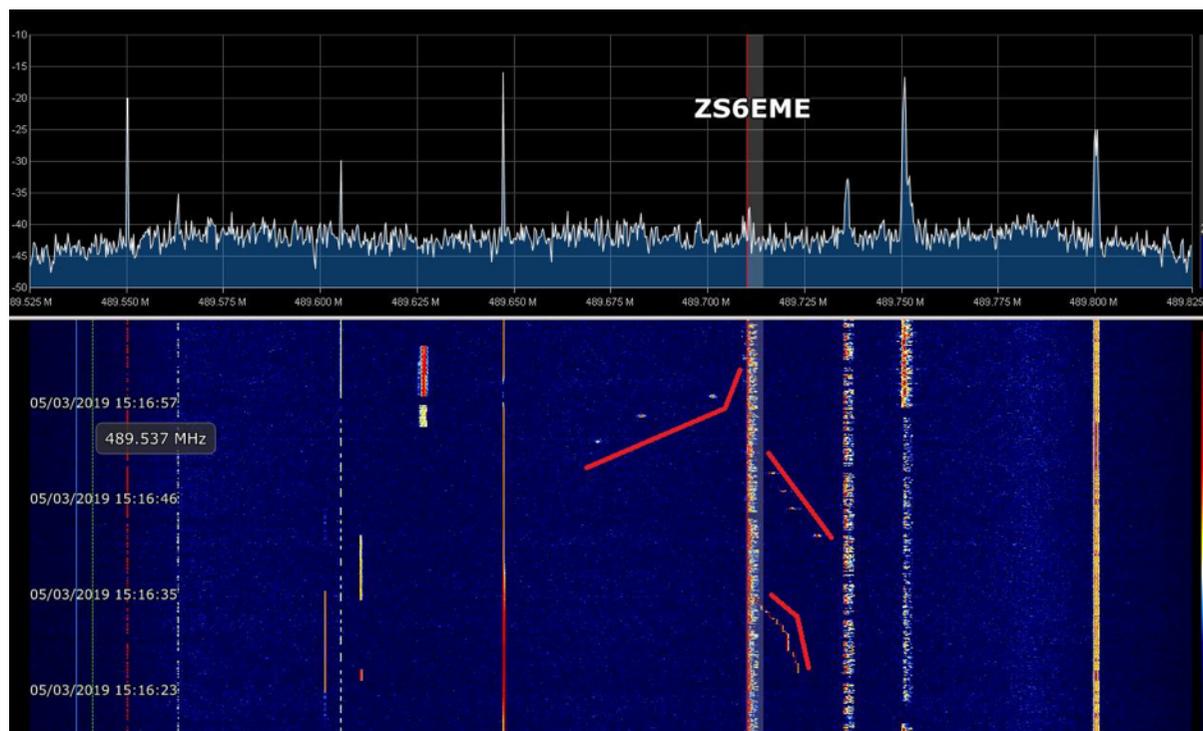
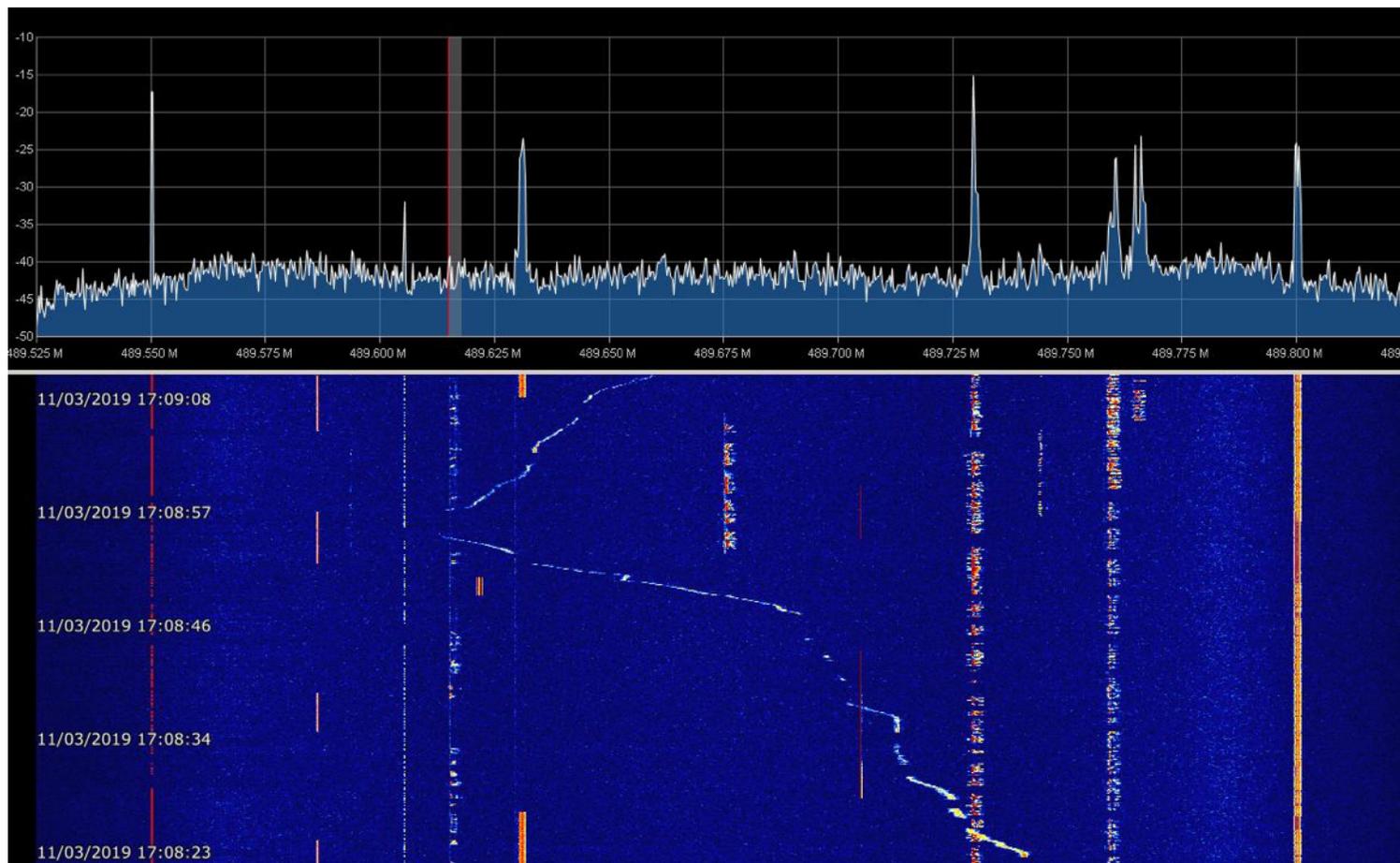
Keep in Mind that you will probably have to increase your Outputpower for a SSB Transmission to be heard well.

Congratulations... You made your first Transmission to QO100. Now reward yourself with something you like, like a beer or something else... I dont Judge... ;)

# Operation Practice 101:

There are quite a few People on QO100 that have a „special“ Way to Operate to put it mildly. You can often see Carriers that are sweeping around the Transponder at full Power getting near to a SSB Signal and then engaging a QSO.

That Kind of Operation is disturbing other Users and does not make yourself liked in the Community.



So why do People operate this Way and what can we do to do better?

If you have your displayed RX Frequency set to the LNBs Outputfrequency (for example 730.xy MHz) its hard to know where your TX will go when set to the REAL TX Frequency (for example 2400.280 MHz) Nobody can do this in their Head and when you add some LNB Drift this can be a real Problem.

Nowerdays since SDR Radios are getting cheap and you cannot only hear Signals but you can also see them you can just send a Carrier swipec around on the Band until you SEE that you are there where you want to be.

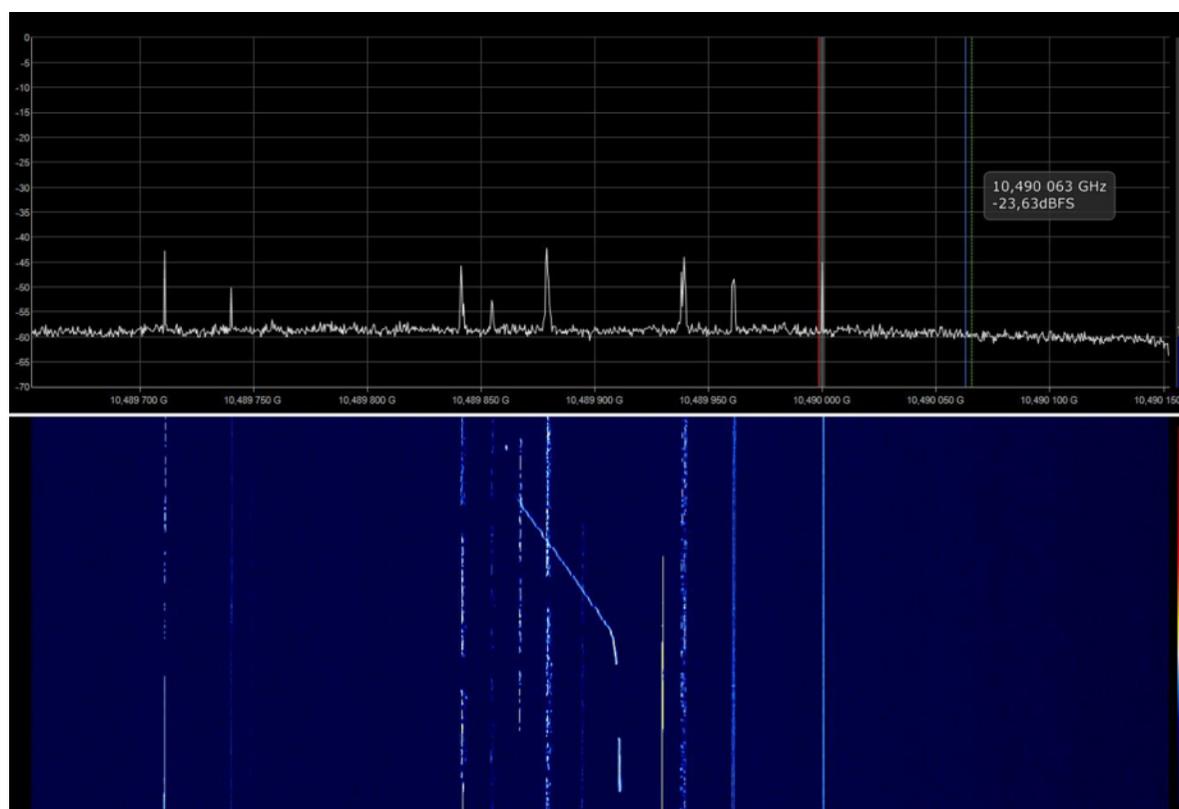
The Solution to this Dilemma is easy, in fact we already did it... When you set your RX Readoutfrequency to the matching TX Frequency (by synchronising to the Beacon where we know the exact Frequency...) you know all the Time what you should dial in your Software.

Go to the desired Frequency in the RX Software. Dial the ReadoutFrequency into the TX Software and you are good to go.

Check if you had some Drift from time to time by confirming that the Beacons are at the Right Frequencies and adjust the Offset if needed.

People on QO-100 are all really nice, but i can understand that someone gets upset when someone is disrupting their QSO every other Minute...

Dont get me wrong. I dont judge and i fully understand that this all can be very overwhelming for a Newcomer but try to do your best on the Satellite. People will be Thankfull...



So that was my Guide. I hope you enjoyed reading it and i also hope you learned something.

If you have some Feedback send me a mail to [oe8hsr@oe8hsr.at](mailto:oe8hsr@oe8hsr.at) or write me a Message on Twitter to @MeltdownCore.

I have added a Linklist on the next Side that might be usefull to get you on the Air.

Hear you soon on QO100

Hans



A big Thanks is needed for the People that send me the Pictures from their Stations and allowed me to use their Pictures: DH2PA, DF2ET, PA1SDB, @Manawyrm, DL0CRE, PE1O-FO, @uhf\_satcom (uhf-satcom.com)

QO-100 BandPlan:

<https://amsat-dl.org/p4-a-nb-transponder-bandplan-and-operating-guidelines/>

Guide to Receiving QO100:

<http://www.oe8hsr.at/blog/wp-content/uploads/Manuals/QO100RX.pdf>

Guide to Build the Plates for the Dual Patchfeed:

<http://www.oe8hsr.at/blog/wp-content/uploads/Manuals/BuildingThePlates.pdf>

Guide to assemble the Dual Patchfeed:

<http://www.oe8hsr.at/blog/wp-content/uploads/Manuals/PatchFeedAssembly.pdf>

Description of the Dual Patchfeed:

[https://uhf-satcom.com/blog/patch\\_antenna](https://uhf-satcom.com/blog/patch_antenna)

3D printable Helical Feed:

<https://www.thingiverse.com/thing:3447513>

LeoBodnar GPSDO:

[http://www.leobodnar.com/shop/index.php?main\\_page=product\\_info&products\\_id=301](http://www.leobodnar.com/shop/index.php?main_page=product_info&products_id=301)

Rubidium Frequency Standard:

<http://www.sprut.de/electronic/referenz/frequenz/rubidium/rubidium.html>