DESKTOP TRANSCEIVERS TO WORK HAM SATELLITES

" If I have to emphasize one experience in my ham live it is each time I listen to myself in the ham satellites downlink"

I am sure you have several unforgettable experiences, the most of my own radio experience could be resumed in the before paragraph, although I could add others such as: I have spoken with three different ISS crews, I have been able to swap several photos in SSTV with Japan and to make contact in PSK31 with the West coast of USA through the AO40 satellite, although I am also very fond of having had some long conversations in LEO satellites with an HT and hand held antennas with some friends.

The **International Space Station (ISS)** is a common project of many nations in **Europe** as well as **Canada, Russia, Japan and the USA.** When fully constructed the ISS will consist of about 70 major components and hundreds of smaller ones that are to be launched into space by the year 2010. Some of the major components are:

- **Zarya**, also called Functional Cargo Block (FGB–acronym from the Russian term) – includes the energy block, contingency fuel storage, propulsion and multiple docking points.
- **Zvezda**, also called Russian Service Module – provides life support and utilities, thrusters and habitation functions (toilets and hygiene facilities).
- **Canadian Mobile Servicing System** – includes a 55-foot robot arm with 125-ton payload capability as well as a mobile transporter that can be positioned along the truss for robotic assembly and maintenance operations.
- **US, European and Japanese Laboratories** – together provide 33 International Standard Payload Racks with additional science space available in the two Russian Research Modules.
- **The Amateur Radio station** – which is frequently used to allow ISS crews and visitors to talk with school children and fellow amateurs around the world.

To: EA4CYQ

From	Day	Month	Year	UTC	MHz
☒ NA1SS ☐ RSØISS KC5ACR	14	01	2006	1840	437.550

Mode: ☒ Voice ☐ Packet ☐ SSTV ☐ APRS ☐ Repeater ☐ SWL

QSL confirming QSO with the ISS crew

In this occasion, the topic I would like to set out is to extend the last article published in the Unión de Radioaficionados Españoles monthly magazine in July 2006 about circular polarization and different circular polarized antennas to work VHF and UHF bands. So in the same way, I will try to analyze in depth what kind of transceivers we can have in our shack to work ham satellites.

We will assume that we have just installed a set of circular polarized antennas with azimuth-elevation rotor system or fixed antennas designed to work ham satellites such as Loops, Moxson, Eggbeater or Eggbeater II with preamplifier. In both cases the transceivers are the same and we will concentrate on the VHF and UHF bands because the 90% of satellite activity is in these bands.

Before starting we must make clear some concepts in relation to the Doppler effect and the FM LEO satellites:

- An FM LEO satellite, speaking in a simply way, is a FM repeater which usually receives in VHF and transmit in UHF.
- The Doppler effect is +/-2.5 KHz in the VHF band. How the commercial FM transceivers has a wideband of up to 5 KHz, we will not consider this effect in this band.

- The Doppler effect is +/-10 KHz in the UHF band, it means that in the worst case we must change manually the frequency of our receiver into this margin around the satellite transmit central frequency or our PC will do it.

We must make clear too some concepts in relation to the Doppler effect and the SSB LEO satellites:

- Nowadays there are satellites working in V/U and U/V mode if we fit to the pattern of uplink/downlink frequencies.
- These kind of satellites have an inverted linear transponder between 40 KHz and 100 KHz, the uplink is always in LSB and the downlink in USB independently of the band.
- These satellites let keep several QSOs simultaneously, to set a figure at least 10 without problems.
- As a result of the Doppler effect, we must be changing the uplink or downlink or both of them continuously to make a QSO. We must constantly retune the transceiver manually or our PC will do it for us.

With all these things clear and to understand better our transceivers and what tasks can carry out, we will see what kind of help a PC and the proper software can do for us. I will try to explain the SATPC32 possibilities in a superficial way.

This software is designed by DK1TB and the benefits of its registration are completely donated to AMSAT, you can download it at http://www.dk1tb.de/indexeng.htm. In DEMO mode is 100% full featured, we must only introduce our QTH decimal coordinates each time we start the programme. If you are AMSAT member must pay 40$ to register the DEMO version and 45$ if you are not AMSAT member. This amount of money will be donated to investigate into ham satellites and to lunch them.

This software will let us:

- To control 14 different rotor interfaces, nearly the 100% of the commercial devices.
- To control all the Yaesu, Kenwood and Icom transceivers equipped with CAT, you can build or purchase an external interface if it is needed.
- To control whatever transceiver or rotor by means of exchange of dates in DDE client format.
- With some transceivers it can work in transparent VFO mode by means of which we do not need to touch the computer. We will tune a station by means of the tune knob of our transceiver in the downlink, the PC will read the frequency and will calculate the right uplink frequency, taking into consideration the Doppler effect, and the PC will send it to the transceiver.
- Others transceivers let work in transparent VFO mode but we must tune the station with the "↑" and "↓" PC keys and the program will calculate the right uplink frequency, taking into consideration the Doppler effect, and the PC will send it to the transceiver.
- We will be able to work in transparent VFO mode with two different transceivers, one of them receiving and the other transmitting simultaneously.

Well, I have managed to work ham satellites from my shack or I have spoken with hams who have been working with one of the following configurations:

1.- With only one transceiver dual band, all mode and full duplex.
2.- With two one band all mode transceivers of different bands.
3.- With only one transceiver dual band, all mode and no full duplex.
4.- With an all mode receiver and an all mode one band transceiver.

I am not going to discuss the necessity of RF amplifiers because if we have antennas with enough gain, the majority of transceivers have enough power out to work ham satellites comfortably.

SSTV images received from the AO40 satellite

1.- <u>WITH ONLY ONE TRANSCEIVER DUAL BAND, ALL MODE AND FULL DUPLEX</u>

This is the most expensive option, and it is not have to be the most effective. Into this frame we can find the following transceivers:

- FT-726R
- FT-736R
- FT-847
- IC-820H

- IC-821H
- IC-910H
- TS-790E/A
- TS-2000

All the transceivers of this group have internal RF filters which let us work in full duplex mode without interfering a band with the other at full power out. This feature usually makes these transceivers voluminous up to the point they seem HF transceivers.

All of them have only one knob to tune both bands so we must choose before tuning which band we want. They let change the frequency while we are transmitting, this feature is essential to look for our downlink while we are transmitting in the uplink frequency of the ham satellite linear transponders.

The FT-726 does not have CAT port. The FT-736R has CAT port, but it only communicates from the PC to the transceiver, it does not have communication from the transceiver to the PC. So we are forced to tune the transceiver by means of "↑" and "↓" PC keys if we have the intention of working in transparent VFO mode. The others transceivers have bi-directional communication and they work in full transparent VFO, so we only have to turn the knob to tune the downlink and the PC will do the hard work.

All of them let choose the TX subtone from the PC, which is necessary with some ham satellites.

The TS-2000 transceiver has a "birdie" in 436.800 MHz which makes impossible to receive in this frequency, unfortunately the ham satellites SO-50 and AO-27 have their downlink in this frequency and we can not work them with this transceiver, It is pity!. A "birdie" is an unwanted noise generated by internal oscillators or an heterodyne product of several internal oscillators.

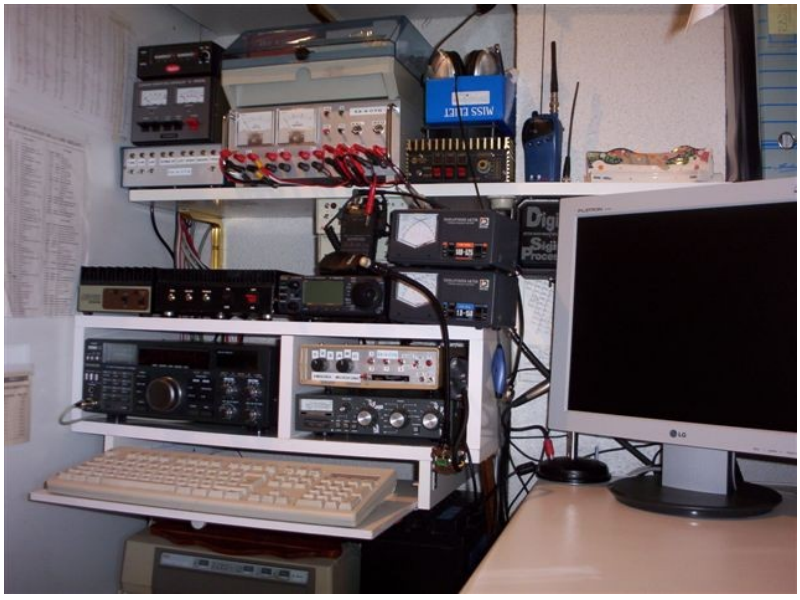

Photo nº1.- Only one transceiver dual band, all mode and full duplex.

2.- <u>WITH TWO ONE BAND ALL MODE TRANSCEIVERS OF DIFFERENT BANDS</u>

Many hams use this option and I have been using this method successfully for years. We can find the following advantages.

- We have two knobs, one per band. It makes the operation more comfortable without switching between main-band and sub-band as happens with the transceivers of the above section.

-This option is usually cheaper, because we just have an one band transceiver in our shack and we can find other transceiver of the other band, and many times a second hand one.

- This option is more flexible because we have the option to leave one of them in the shack and to carry the other on holidays, to install in the car or to go on a trip.

This kind of transceivers are generally a bit old because nowadays the manufacturers usually build them dual band and some of them full duplex. So the one band transceivers do not usually have CAT port and we are forced to tune them manually. But do not let yourself be taken in, this way of working is full effective, specially if you are beginner because it helps us to understand how the linear transponders and the Doppler effect work and we have the opportunity to interact with the transceivers, so we will learn very interesting skills.

As you can imagine there are a lot of combinations but perhaps the most beautiful are that pairs of the same manufacturer of different bands:

- TM-255E/A and TM-455E/A
- TS-711 and TS-811
- IC-271E/A and IC-471E/A
- FT-480R and FT-780R
- TR-751E/A and TR-851E/A

Apart form these one band all mode transceivers, we can find in the market for VHF: TR-751, TR-7000, IC-290H and IC-275.

We have another option into this group, the most of us just have in our shack one of these HF-VHF-UHF bands all mode no full duplex transceivers, such as the IC-706MKIIG, IC-7000, FT-817, FT-857 or FT-897. If we add whatever one band all mode transceiver I have described before we will have a complete satellite station.

I have been working with an IC-706MKIIG and a TM-255E for years (Photo nº2), and the outcome does not have to envy my present station with a TS-790E (Photo nº1).

Photo nº2: An IC706MKIIG for the UHF band and an TM-255E for the VHF band.

3.- WITH ONLY ONE TRANSCEIVER DUAL BAND, ALL MODE AND NO FULL DUPLEX

We must work in split mode, because we do not have full duplex possibility. This is the only option in which we can not enjoy our self voice in the downlink while we are transmitting in the uplink, so we will not know how the satellite is receiving us, if our modulation is right and what signal our downlink is.

But we are not blind at all, our PC, which knows the satellite we are working, with the proper software will calculate the uplink frequency and it will send it to the transceiver. SATPC32 has this ability.

Now capable transceivers of changing the frequencies of the main VFO and sub VFO while we are transmitting or tuning the frequency must exist. Yaesu has achieve this feature with the FT-817, FT-857 and FT-897. Unfortunately the IC-706MKIIG although can be full controlled by its CAT port, it is not capable of carrying out this task properly.

As curiosity I will tell that the elliptical orbit satellites such as the AO40 which is up to 40.000 Km far away, the signal can suffer for a delay up to 300 msg, some hams have listened to its own signal when they have pushed off the PTT. Using this trick they have confirmed that they were in the right frequency.

Photo nº3: A couple of IC-706MKIIG transceivers, one for UHF and the other for VHF, both of them computer controlled by of the CAT port and the software, working the satellite.

4.- WITH AN ALL MODE RECEIVER AND AN ALL MODE ONE BAND TRANSCEIVER

This is an option similar to the nº2 combination. As we never transmit simultaneously in two bands, one of the transceivers can be a receiver and the other whatever of the one band transceivers we have seen before.

Nowadays we can find a lot of all mode VHF/UHF receivers and scanners, many of them are HT such as the IC-R10, IC-R20 or the TH-F6. All these equipments can be controlled by computer and they can work in transparent VFO mode by means of the "↑" y "↓" PC keys. Pedro EB4DKA and I have tested all these HT with the exception of the IC-R20 and the others are suitable to work satellites. Of course the audio quality in the SSB mode is not as good as the desktop transceivers because of the filters.

There is a receiver which stands out due to its performance and it can be fully controlled by PC, this is the IC-PCR1000. In this case we must use the SATPC32 DDE client option to communicate the receiver with the PC.

It is possible to work in VFO transparent mode tuning the receiver with the "↑" and "↓" PC keys by means of the DDE client option and we will communicate the PC with the transmitter by means of the CAT port. SATPC32 lets do it flawlessly.

If we use a transceiver one band all mode no full duplex capable, we will manage to work both modes V/UHF and U/VHF. I have worked receiving with the IC-PCR1000 and transmitting with the IC-706MKIIG, although we can also use the IC-7000, FT-817, FT-857 and the FT-897.

I am sure you were happier at the beginning of reading this article and perhaps you now have a headache. Do not worry it is my fault, because I am sure I have not explained properly all kind of combinations because they are unnatural in the majority of our shacks. But if you are interested in ham satellites I am sure you try to read it again, and perhaps we could "make the contact".

As I have explain much things about satellites, from now on all the things will be more complex, you should start with easy things and listening is usually the best option.

I do not want to say good bye without claiming the ham satellite frequencies, which are 145.000-146.000 MHz in the VHF band and 435.000-438.000 MHz in the UHF band exclusively for this use. If some hams around the world use these frequencies for another activity they are interfering with ham satellites, making our work more difficult than it is.

I am grateful to my family who lets my share its time with this hobby, and all of you who do the same reading this article. We can find very interesting information about ham satellites at EB4DKA Web, http://www.eb4dka.tk, where you should entry because Pedro are making a hard work updating it with Podcasts and video recorders which I am sure they help you to understand in an easy way and without effort this amazing branch of the amateur radio activity, after all "a picture is worth a thousands

words". We can get in touch at ea4cyq@amsat.org If I can help you or I can learn from you.

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