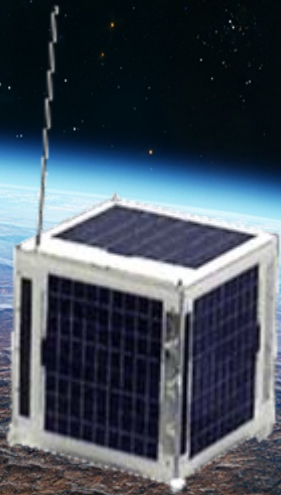


FM Satellite Communication with Equipment you may already own.



by Scott, KA7FVV

What do we need to make Satellite contacts?

We will be making portable FM satellite contacts. “Easysats”

There are several SSB/CW satellites in orbit but this takes more expensive equipment to communicate through them.

You need to be able to transmit on VHF FM amateur radio frequencies of 145.850, and 144.490 and receive on 436.795. ISS transmit and receive on a VHF only with a wide split. More on that later.

You also need to know when the satellite is going to be above the horizon for your QTH using satellite tracking software.

What equipment is needed for FM Satellite contacts?

What ever radios you use for satellites usually it will be half duplex. Full duplex is not real practical in handheld applications. I have tried this with my W32A and only get static on the UHF receive.

Dualband Handheld – Some handhelds work better than others

Separate VHF/UHF Handhelds

VHF Handheld and UHF receiver/scanner

Gain Antenna – Arrow or Elk are standard types

Satellite Tracking Software

Radio equipment

There are a couple of handhelds that lend themselves very well to amateur satellite communications.

Icom W32A: It has dual VFO's and the ability to mute the sub band upon transmitting.

Yesu FT-60: This radio allows for programming the VHF/UHF split into the same memory channel.

Baofeng UV-3R (Plus) and UV-5R: These work great for satellite communications since the UHF receive and VHF transmit can be programmed into the same memory.

2 watts with the UV-3R or Plus is plenty to talk through the satellites.



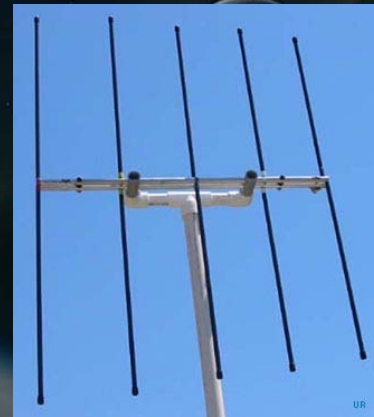
Antennas

You will need some gain to hear the satellites that are at a minimum of 250 miles away and could be up to 3000 miles.

Satellites transmit at low power so a gain antenna is a must.

I have successfully used an extended rubber duck antenna to make contacts on UO-14, SO-35 and AO-51. This is rare.

A beam antenna works best and you maybe able to use just a VHF beam since that is the transmit band and it should also receive the UHF frequencies even not tuned for UHF.



Satellite Tracking

Now that you have decided on your equipment you need to know when the satellite will be in range. The FM satellite are in low earth orbit (LEO). Passes over your QTH will be from 5 to 15 minutes in duration.

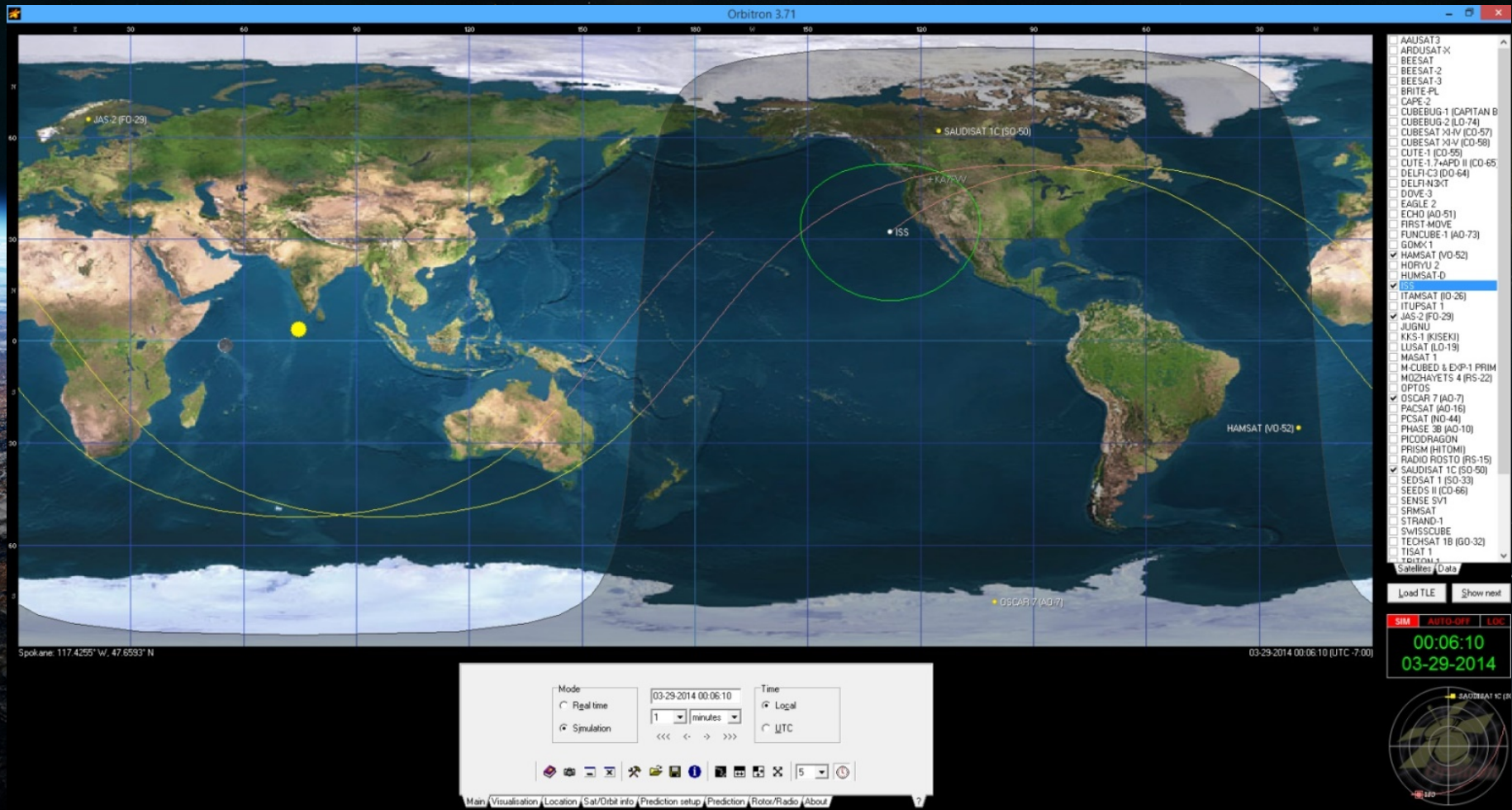
You need some sort of satellite tracking software.

Multiple programs are available for the Windows PC, MAC, Linux, iPhone, iPad, and Android devices.

Tracking programs use keplerian elements to give accurate location of the satellite you are tracking. These elements must be updated on a weekly basis or less. Updating the tracking elements is built into the tracking programs and can be setup to happen automatically.

Satellite Tracking Programs

One of the best for the Windows PC is Orbitron. It is free and very easy to use.



Satellite Tracking Programs

I will demo programs on the Windows PC, iPhone, iPad, Android and PPC. iPhone, and Android programs are shown here.



Satellite Tracking Terms

Start or AOS (Acquisition of Signal)

Middle or TCA (Time of Closest Approach)

End or LOS (Loss of Signal)

You also need to know where to point your antenna to talk with the satellite. Notice there is Azimuth and Elevation indicated in the example. This relates to where the satellite is in the sky relative to your QTH. Tracking programs also show a radar view that will assist in visualizing the satellites path in the sky.

Time - LOC	Satellite	Azm	Elv	Mag	Range	S.Azm	S.El
03-31-2014 01:39:18	ISS	267.5	0.0	ecl	2402	14.3	-37.2
03-31-2014 01:44:48	ISS	349.3	45.3	ecl	570	16.0	-37.0
03-31-2014 01:50:20	ISS	71.6	0.0	ecl	2412	17.6	-36.7
03-31-2014 03:16:21	ISS	287.9	0.0	ecl	2406	41.8	-29.5
03-31-2014 03:21:52	ISS	10.1	44.4	ecl	580	43.2	-28.8
03-31-2014 03:27:33	ISS	81.5	0.0	ecl	2411	44.6	-28.2



Satellite Tracking Terms continued...

Azimuth (Az) is measured in degrees around your QTH. Picture a 360 degree circle with 0 degrees being due north, 270 west, 180 south and 90 east.

Elevation (El) is measured in degrees above the horizon a satellite is from your QTH. 0 degrees would be at the horizon and 90 is directly overhead.

Tracking programs will give a constant Az/El reading as the satellite passes or in a prediction printout the Az/El at AOS/TCA/LOS or Start/Mid/End.

With the information provided and a little practice with the programs, output you will know if the satellite is moving south to north, north to south, west to east, northwest to southeast, etc. The path of the satellite depends on the satellite orbit, your QTH and where the satellite is at the time of the pass.

What satellites are we looking for?

We are looking for the FM Amateur Radio Satellites known as “Easysats”.

The current active FM satellite is SaudiSat 1C (SO-50).

Fox-1 is scheduled for a summer 2015 launch and will replace the failed AO-51.

SO-50 was launched in December 2002 and is still operational.

LituanicaSAT-1 is a Lithuanian satellite launched from ISS on February 28, 2014 and reentered on July 28, 2014

AO-27 launched September 1993 and went silent due to battery or hardware failure fall of 2012.

AO-51 launched June 2004 and went silent due to battery failure December 2011.

International Space Station (ISS) is FM as well. Voice contacts are rare. APRS Packet is active most of the time except during docking and undocking operations.

What Frequencies do we use?



SO-50 (67.0 tone)

Uplink (Tx) – 145.850
Downlink (Rx) – 436.795
74.4 tone to turn on.



ISS Voice

Uplink (Tx) – 144.490
Downlink (Rx) – 145.800
APRS (Tx/Rx) – 145.825

Current FM satellites are a mode called V/u – VHF Uplink/UHF Downlink
Since the satellites are moving at a speed on the average of 17000 mph and you are standing still we must adjust for Doppler shift. Only needed for UHF.

Satellite Frequency Reference

SO-50 FM	V/u	Transmit with a 74.4 hz tone to turn on the 10 minute timer if the satellite is off, then use the 67.0 hz tone.							
Doppler Adjust	Downlink	436.815	436.810	436.805	436.800	436.795	436.790	436.785	436.780
Tone: 67.0	Uplink					145.850			
		AOS				MID			LOS
ISS Voice				APRS					
	Downlink	145.800		Downlink	145.825				
-1.31	Uplink	144.490		Uplink	145.825				

Program your memories with some kind of designator so you know what memory you are using such as SO50AOS, SO50AOS1, SO50MID, etc.

Your First Satellite Contact, things to remember:

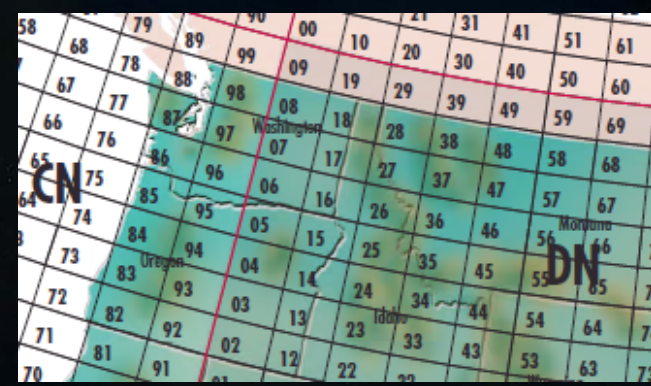
- Passes are short. 5 to 15 minutes at the most.
- Rag chewing is discouraged.
- Like terrestrial FM repeaters only one person can talk at a time.
- Satellite is passing in and out range of other stations who want to make contacts.
- Review the upcoming pass or passes you wish to work.
- Passes of 20 degrees of elevation or more work best when working portable.
- Have the pass information either printed or on your phone.
- Tune the radio to the AOS UHF receive frequency and have the squelch open.
- Point the beam at the AOS location on the horizon, wait and listen.
- When the satellite is above the horizon you should start to hear signals and the noise floor of the receiver will diminish.
- Continue to monitor and follow the satellite as it rises above the horizon.
- Be sure to change the UHF receive frequency adjusting for Doppler for the best signal. Signals can be garbled on one frequency and the next 5 khz step be crystal clear.
- Unless you have mic fright it is time to try your first FM satellite contact.



Your First Satellite Contact

What do I say?

- Satellite Cardinal Rule: **DO NOT transmit unless you hear the downlink.** The satellite will always hear you even with 2 watts. There are exceptions.
- You may want to listen to the contacts for a pass or two just to get a feel for how a contact goes and make sure you can hear with your equipment.
- CQ is not usually called on satellites but it is heard. QRZ is usually used.
- Contacts are quick and short. Listen to the contacts. Wait for a pause.
- Give your call sign and grid square phonetically and wait for a return or respond to a specific station you have heard giving your call sign and grid square (DN17).
- Contacting station will return with their call sign and grid square.
- You can keep track of grid squares you contact. There are awards for getting a certain number of grid squares via satellite.
- The satellite community is fairly small so you will most likely hear and talk with the same stations.
- FM satellites are a fun and challenging part of the Amateur Radio hobby.



ISS Contacts

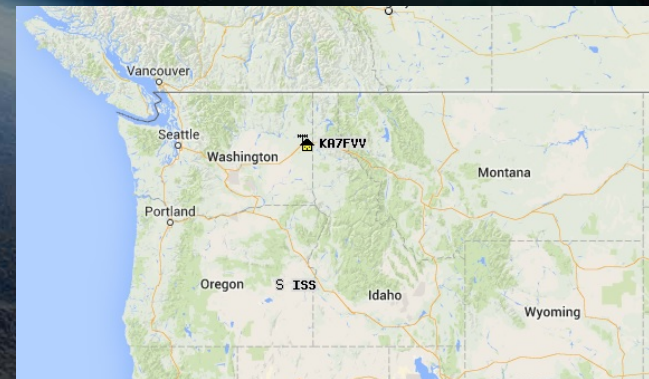
ISS is only active on VHF. Most of the time what is heard is APRS Packet. This is active most of the time. With the correct packet setup you can make contact with ISS and your station can be seen on the ISS heard map on the ARISS web site. Voice contacts is rare. ISS has scheduled school contacts and occasionally the hams on board will have some free time to make contacts. You can not only track the ISS for radio communications but for visual sightings as well. ISS is the brightest man made object in the sky. It is quite a thrill to see ISS and hear it at the same time.

ISS Voice -1.31 offset

Uplink (Tx) – 144.490

Downlink (Rx) – 145.800

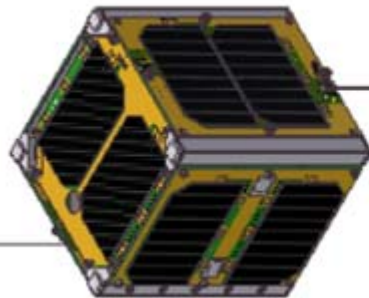
APRS (Tx/Rx) – 145.825



Satellite Tracking Software Demo/Questions/Live Demo

Demo of satellite tracking software:

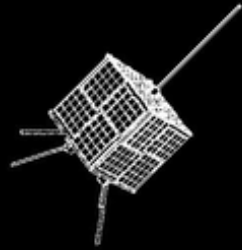
Orbitron, and WxTrack for the Windows PC,
GoSatWatch, HamSat, ProSat for the iPhone/iPod/iPad,
Amsat Droid Free and ISS Detector for the Nexus tablet (Android).
Pocket Sat Tracker, SatCE and Traksat for the Pocket PC



Upcoming FM Satellite
Fox-1C to be launched in 2015

And of course answer any questions.





**KEEP
CALM
AND
TRACK
SATELLITES**

