This article from Greg Roberts ZS1BI was published in the AMSAT-US Journal ORBIT in March 1980. At the end I added some pictures of his station setup and how it evolved over time to become more and more sophisticated. It includes some pictures of the operator and his friends listening to:

Radio Transmissions from Outer Space

Point your antennas skyward and join ZS1BI and the many others who comb the satellite frequencies for their own style of rare DX!

By Gregory Roberts,* ZS1BI

Since the dawn of the Space Age in October 1957, nearly twelve thousand objects have been placed in orbit. A large number of these are fragments (space junk) and are of little interest, and a high percentage have re-entered the earth's atmosphere or have been de-orbited. Despite this, several thousand objects are still up there and some of these are of potential interest.

All launches are performed with a purpose and in virtually all cases, the launch has carried at least one satellite containing a transmitter that might only operate for a few hours, or operate for perhaps many years. This has given rise to the hobby of tracking down and identifying these sometimes weird signals that originate from artificial earth satellites. I started doing this in 1963 and still get a thrill out of identifying an "unknown" transmission. This hobby was also instrumental in my becoming a radio amateur, as I found the OSCAR satellites of interest.

Be a Space Sleuth

In deciding to eavesdrop on satellite transmissions, one must know where to look if a lot of time is to be saved. A good place to start is to find a chart of the radio spectrum allocations and see what has been set aside for space use. Not all the bands are used, but by some careful reading, it is possible to make a good guess as to the best place to start.

Satellite activity in the high frequency part of the spectrum, up to about 30 MHz, is rather limited and now seems to be only used by the amateur satellites and the Soviet Union. The frequency band 19.985 to 20.005 MHz is used mainly by COSMOS satellites and the occasional Chinese one. The COSMOS satellites do not transmit continuously, but only apparently over the Soviet Union or shortly prior to recovery. Manned Soviet flights use frequencies of 15.008 and 20.005 MHz, but transmissions outside the USSR are rare. In the United Kingdom, Geoff Perry and his Kettering Group have produced excellent results from monitoring the Soviet activity. It can be said without fear of any contradiction, that Geoff is the world's leading authority outside the USSR on Soviet satellites. If you live outside of satellite range of the USSR, it probably would not be worthwhile to spend much time near these frequencies.

I do not propose to cover the amateur satellites, as this activity should be well known to all amateurs, other than to say that both the United States' AMSATs and

"I started doing this in 1963 and still get a thrill out of identifying an unknown transmission."

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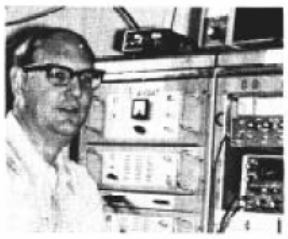


Gregory Roberts, ZS1BI

Table 1

Satellite Status, November, 1979

62 Alpha	Alpha 1	Tiros 5	136.230	and 136.920
62 Beta	Alpha 1	Alouette 1	136.980	
62 Beta	Upsilon 1	Relay 1	136.140	and 136.620
64 03A		Relay 2	136.140	and 136.620
64 83D		Transit 5B-5	136.650	
65 32A		Explorer 27	136.740	intermittent
65 51A		Tiros 10	136.230	
65 98A		Alouette 2	136.980	
66 77B		EGRS 7	136.800	NASA calls it 6677C
66 77C		ERS 15	136.440	NASA calls it 6677B
66 89B		EGRS 8	136.830	
67 40D		ERS 20	136.260	
67 65A		EGRS 9	136.840	
67100A		OSO4	136.710	
69 09A		ISIS 1	136.410	sometimes 136.080/136.590
69 37B		EGRS 13	136.800	
69 46B		OV5-6	136.380	
69 82B		Timation 2	137.380	
69 82E			137.410	
70 09A		Sert 2	136.920	(or 136.230 – seldom)
70 25A		Nimbus 4	136.500	
70 25B		TOPO 1	136.840	
71 24A		ISIS 2	136.410	sometimes 136.080/136.590
71 30A		Tournesol 1	136.630	intermittent
71 71A		Eole 1	136.350	
71 80A		Shinsei	136.694	
71 96A		Explorer 45	136.830	
71110A			136.800	
71110C			137.080	
71110D			136.320	
71110E			137.050	
72 65A		Copernicus	136.260	
72 97A		Nimbus 5	136.500	
73 78A		Explorer 50	137.980	
74101A		Symphonie 1	137.020	
75 04A		Landsat 2	137.860	
75 27A		GEOS 3	136.320	

Soviet Union's RS amateur satellites (OSCARs) operate in the 10-meter band. Soviet satellites have been reported as operating on 29.80 and 30.02 MHz. I have not paid any attention to these frequencies and so cannot really comment on this point. In the early days, Soviet satellites used 40 MHz and may still be doing so. I believe that from time to time United States satellites use frequencies near 6 meters (50 and 54 MHz have been mentioned), but the number is low and probably not worth the effort.

"In the early days, Soviet satellites used 40 MHz..."

The next portion of the band that is used is around 90 MHz and again by the Soviet Union. Unfortunately, this band is impossible to monitor in much of the world as the portion 88 to 108 MHz has been set aside for, and is used by, commercial fm broadcasting.

During the first few years of the Space Age, the United States' satellites used frequencies around 108 MHz. All these satellites have long since stopped transmitting. The frequency of 121.5 MHz is popular for Soviet manned flights. The chances of activity over most of the world, however, are rather remote.

Is That All There Is?

Having got this far, one might well think, "Is there any band worth monitoring?". Fortunately, the answer is "yes" and the next band of any note is 136 to 138 MHz. This band has been set aside by international agreement for the use of scientific satellites. Although it is principally used by the United States, satellites of other nations may be found here from time to time. The popularity of this band has declined somewhat in recent years with the tendency to move satellite communications higher up the spectrum. Closing down most of the

75 33A	Aryabhata	137.440	
75 49B	SRET 2	137.530	
75 52A	Nimbus 6	136.500	
75 72A	COS B	136.950	
75 77A	Symphonie 2	136.800	
75100A	GOES 1	136.380	
75107A	Explorer 55	137.230	
77 80A	Sirio	136.140	
77117A	Meteor	137.300	APT
78 12A	IUE	136.860	
78 26A	Landsat 3	137.860	
78 41A	HCMM	136.170	
78 44A	OTS 2	137.050	
78 71A	ESA GEOS	137.200	
78 87A	Jikiken	136.695	
78 96A	TIROS N	137.620	(APT) 137.770
78 99C	Magion	137.150	
79 14A	Corsa-B	136.725	
79 21A	Meteor 2	137.300	APT
79 47B	Ariel 6	137.560	APT
79 51A	Bhaskar	137.230	
79 57A	NOAA 6	137.500	(APT) 136.770

Please note that in some cases the satellites also transmit on other frequency bands.

67 34A	Transit 15	149.988	
67 48A	Transit 16	149.988	
67 92A	Transit 17	149.988	
70 67A	NNSS 0-19	149.988	
76122A	Cosmos 883	149.990	SOVNAV
77 13A	Cosmos 894	150.020	SOVNAV
77 62A	Cosmos 926	149.990	SOVNAV
78 22A	Cosmos 991	149.900	SOVNAV
78 34A	Cosmos 1000	149.990	SOVNAV
79 26A	Cosmos 1089	149.900	SOVNAV
79 30A	Cosmos 1092	149.990	SOVNAV

Please note that not all SOVNAV satellites will be operating on any one day.

STADAN system has further contributed.

A Move to Higher Frequencies

One of the reasons for moving higher is the need for greater bandwidths for high-speed data transmissions not possible in the vhf spectrum. Some satellites are designed to operate for a limited time. But, if something goes wrong, the satellite may continue transmitting, even if the data is meaningless or no longer required. The oldest satellite still transmitting was launched in 1962. It is still occupying a frequency that could be used by another satellite. All in all, some seventy-odd frequencies are used in this band, and a large variety of signals may be found. Some of the transmissions are frequency modulated, whilst others are merely beacons. All types of orbits are found, ranging from circular low orbits, to highly elliptical orbits with periods up to several days. Of course, one also finds rapidly decaying satellite orbits. Several satellites with unspecified missions also transmit in this band, and it might be an interesting challenge to find out just what is being sent. One disadvantage is that the satellite may go silent before your setup is fully operational. There are several satellites that transmit weather pictures. Both the Soviet Union and the United States have low-altitude satellites sending APT (Automatic Picture Transmissions). It is fairly easy to build equipment to receive and utilize these pictures.

"The oldest satellite still transmitting was launched in 1962."

Getting to Know the Birds

When I first started monitoring this band, 90 percent of the signals were unknown. Over the years, however, using Doppler and other techniques, I have been able to

identify at least 95 percent of the transmissions. New satellites appear from time to time, and to complicate matters, satellites previously silent may resume transmitting. Some satellites only transmit in sunlight or after having been in sunlight for a minimum time. Others may be commanded on and off.

Table 1, which is based on my observations over the years, shows the satellites transmitting in the 136—138 MHz band and is the most complete listing to the best of my knowledge. All these satellites were heard to be transmitting at the end of October, 1979, and the vast majority will still be transmitting a year from now. Obviously, some of the geostationary satellites may not be heard in other parts of the world. It is also certain that you will find transmissions that I have not identified, as some of those geostationary satellites are below my horizon. Other than these cases, it should be possible to identify transmissions from low-orbit satellites or highly elliptical orbits. The receiving equipment need not include large antennas. A good converter feeding into a good communications receiver will make it possible to identify satellites on the basis of the frequency heard.

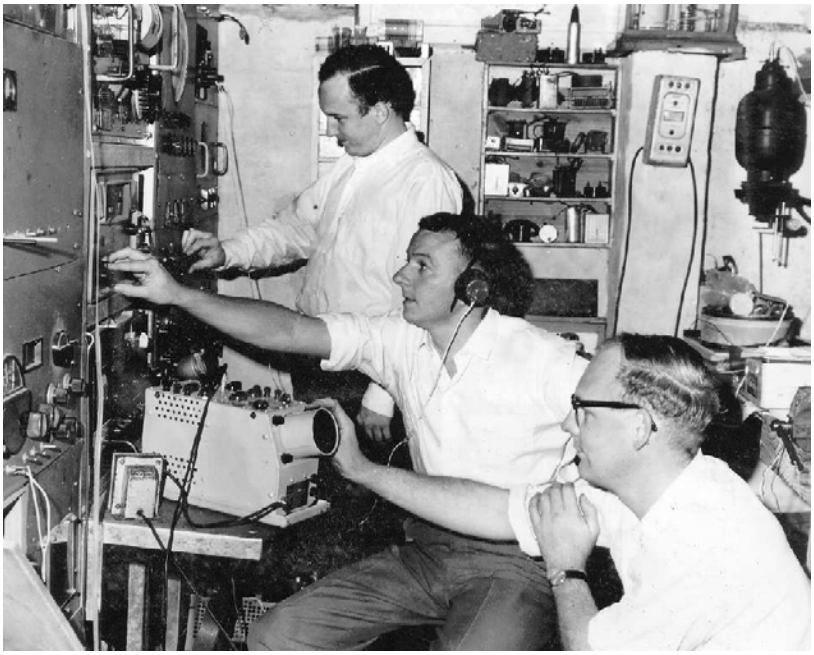
"The receiving equipment need not include large antennas."

On Top of 2 Meters

The final band I will deal with in this article is the band from 149.850 to about 150.05 MHz. It is used for navigation satellites launched by both the Soviet Union and the United States. The Soviet navigation satellites, or SOVNAVS as I call them, transmit useful telemetry, and it's very easy to hear the "second" time pips and use this to set your shack clock. The United States TRANSIT satellites provide a pulse every even minute on the minute. The TRANSIT satellite system is gradually being phased out, as this band is no longer used for the latest navigational satellites. The indications are that the SOVNAV system will be used for quite a while yet, as new satellites are continually being added. It will be worthwhile pointing out that the Soviet satellites may be switched off from time to time (always some left operating), so all may not be heard. The Kettering Group have decoded virtually the entire SOVNAV transmissions and this is another example of what can be done by amateurs who have the interest and dedication.

The first picture shows Greg Roberts ZS1BI very simple radio tracking setup around about 1964, which was in his apartment. This picture shows Art Arnold ZS5SU (sitting in the front) and Greg Roberts ZS1BI (standing in the back) shortly after they met first time and became friends.

The second picture shows the radio tracking setup around about 1967. This was called the Durban Satellite Tracking Station and was situated at the home of Art Arnold, where Art and Greg also had several telescopes set up for visual tracking. The people are from left to right: Art Arnold ZS5SU, Walter Scott who assisted them from time to time and Greg Roberts ZS1BI.



The next pictures show the excellent receiver setup as well as his impressive antenna system which he used around 1975-1978.