Monitoring the UHF Military Satellites

A How-to-Guide for Listening to the Milsats

Imagine digging through the static and noise in the HF radio spectrum to dig out the signal of a military aircraft reporting its position in some far flung point on the globe. Or how about monitoring the communications from a carrier strike group as they conduct operations off the east or west coast of the United States?

There is a large segment of the radio hobby for whom chasing military communications across the radio spectrum is a full time radio adventure. But, there are even bigger, better and higher things than that to monitor in the radio spectrum. For the military monitor, intercepting communications from an orbiting military satellite ("milsat") is equivalent to finding the Holy Grail.

For some radio hobbyists, the mere mention of monitoring the frequencies transmitted from space by any orbiting satellite evokes a certain level of trepidation. Others regularly enjoy filling their speakers with all sorts of exotic communications and unique communications from quite a number of military satellites. As I have written in past pages in *Monitoring Times* and in our defunct sister publication, *Satellite Times*, "if satellite reception was easy, then everyone would be doing it."

So, this aspect of the radio hobby is not easy or for the faint of heart. It will require some study on your part, the purchase of some good quality receiving equipment, and in some cases, even designing and building your own antennas for the various military satellite bands you want to monitor. Depending on the equipment and antennas you have at hand right now, satellite monitoring can be either a snap, or for some, a "mission impossible."

Milsat Monitoring 101

Unlike conventional scanner monitoring – where all you need to do to receive signals across the entire tuning range of your scanner is to put up a wideband type antenna – satellite monitoring isn't quite as straightforward.

Two factors are in play that have a direct relation on monitoring any satellite signals. First, the satellite *downlink* frequencies (signals transmitted from the satellite back to earth) have weaker transmit powers than their terrestrial counterparts in the VHF/UHF spectrum. This requires some sort of gain antenna and/or pre-amplifier to pull in these weaker signals. If we use a gain antenna, that usually equates to a directional antenna that will have to be aimed properly at the satellite we want to receive in order to hear signals from that platform.

Second, satellites are always on the move as they orbit above the earth's surface. Fortunately, most military satellites we are interested in monitoring are in geostationary orbits (GEO) above the equator. From a ground observer's point of view, these geostationary satellites appear to be stationary at one point in the sky, so aiming our directional antenna at them will be easy. We can use a satellite tracking computer program such as Obitron (see resource guide) to work out the angles to point to any of the known U.S. milsats in geostationary orbit.

If it is a non-geostationary satellite, then things can get a bit more complicated. Usually reception of these birds requires an antenna with a bit higher gain. Higher gain antennas have narrower frequency response and narrower antenna beam widths. So we are going to have to steer the antenna and track the satellite for proper reception. This is especially critical on faster moving, lower earth orbiting satellites. You are going to have to accurately point the antenna array at the satellite as it moves across the sky to get a quality signal to the receiver.

Of course, once we start moving the antenna to follow a non-geo bird, the cost and complexity of our monitoring station goes up. And if we want to monitor different bands, more antennas and preamps for those bands will be required as well.

The bottom line here is that one satellite monitoring setup does not fit all. You will have to have a different antenna and possibly a separate receiver/external amplification setup for each satellite band you want to monitor.

A Relatively Simple Setup

I am a firm believer in the KISS (Keep it Simple Stupid) method of radio listening and I really enjoy a challenge. Yes, I could spent hundreds of dollars and purchase a top of the line shack that could hear anything and everything, but what fun would that be? So let's look at a simple, inexpensive, but effective setup that you might be able to put together.

The first piece of equipment for any milsat monitoring post is the receiver. I highly recommend a multi-mode VHF/UHF receiver such as an Icom R7000/R7100, AOR AR5000, etc. This is one area you don't want to short change. You may be able to hear some signals with a general marketplace scanner, but the best approach is to use a multi-mode tabletop receiver.

The next component purchase for your receiving system should be a low noise preamplifier. I highly recommend you look at products offered from Down East Microwave. This is a very reputable company, and they offer quality products for monitors interested in weak signal VHF/UHF communications.

I recently chatted with one of their technical specialists and he said they can pretty much custom build a low noise amplifier (LNA) for any portion of the spectrum you are interested in. For milsat work they can build you a custom preamp for between $75 to $100 depending on whether you want a standard indoor model or an outdoor mast-mounted weatherproof box (recommended). These preamps have about a .6 dB noise figure and provide 17 dB gain. You will have to provide a dc voltage of 10-13 vdc for the operation of these preamps, but they will greatly improve your reception of milsat signals. You can get more information or order one from DEM using the contact information in our resource guide. Be sure to tell them that *MT* sent you.

Another area where you do not want to scrimp is in the coaxial feedline between the antenna and the receiver. This sort of monitoring does not lend itself to using RG-8X from Radio Shack. Get the best low loss coax you can afford and work with. You will find some interesting background information on coax choices online at the Grove Enterprises website on the *Ask Bob* website pages (see resource guide).

Finally we need an antenna. Yes, you can

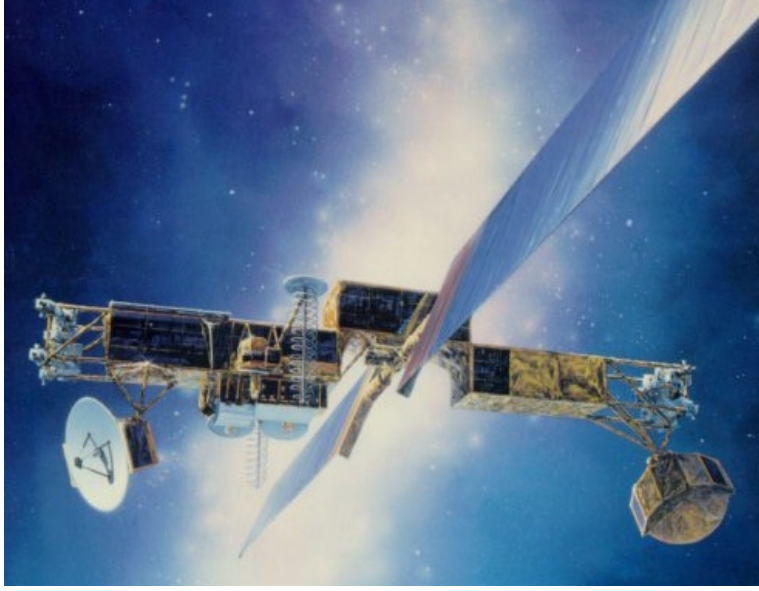
use an omni-directional antenna, such as a ground plane, discone or Scantenna, but you will get a much stronger signal from the birds if you use a directional antenna. I have used several directional antennas over the years and the simplest and best off-the-shelf antenna you can purchase is the Grove Scanner Beam (ANT18). In fact, quite a few of the scanner antennas listed on the Grove Enterprises scanner antenna webpage will work very well also.

If you want to try your hand at rolling your own, check out the plans for a four element Yagi cut for 260 MHz on the German *Satellite World* website (see resource guide for the link).

What's Out There to Hear?

First, let me add a caveat that there is not nearly as much clear voice as there was several years ago. But from time to time, I still run across clear communications on various milsat downlinks.

For instance, as I type this article, the Kennedy Space Center is preparing to launch another space shuttle to the International Space Station. I monitored some of the Eastern Test Range search and rescue units ("Herky 642/643" and the "Wolfden") setting up clear communications on 261.575 MHz using narrowband FM. These transmissions are probably being downlinked by the FLTSATCOM 8/USA-46 located at 15.5 deg west using the Fleetsat Bravo bandplan. This is one of several frequencies in the 225-400 MHz range that have been used over the last few years for this purpose. When not involved with space shuttle launch communications, I have heard other encrypted voice communications on this FLTSATCOM Bravo, channel 6 downlink.



Another FLTSATCOM 8 downlink transponder that has occasional clear comms is 261.450 MHz (Bravo channel 1). Not only have space shuttle launch support comms been monitored on this one, but also clear comms in support of an overseas trip to Europe from the President of the United States (POTUS). Other clear channel comms have been monitored on the following FLTSATCOM - AFSATCOM wideband channels: 260.425 260.475 260.625 261.500 261.525 261.675 261.775 261.850 261.875 261.925 261.950 262.075 MHz.

The Milstar satellites transmit an interesting spread spectrum digital mode nicknamed the "waterdripper." Select the USB mode and dial up 243.785 and 243.825 MHz to hear these unusual transmissions.

There is a lot more to monitor than what I have indicated above. Mixed in with the occasional clear voice communications, you will hear a wide variety of encrypted and data signals transmitting from these orbiting platforms.

TABLE ONE

Military Satellites with known or possible UHF downlinks

GEO Milsats

156.4° West	UFO F3/USA 104 – Bandplan: Quebec orbit inclined 5.7 degrees
150.3° West	MILSTAR 1-F2/USA 115 orbit inclined 6.8 degrees
145.4° West	DSP F14/USA 39 orbit inclined 11 degrees
144.4° West	SDS 3-F3/USA 162 Aquila orbit inclined 2.5 degrees
135.2° West	DSCS 3-F11/USA 148
130.3° West	DSCS 3-F10/USA 135 orbit inclined 2.5 degrees
105.6° West	UFO F6/USA 114 – Banplan: Oscar orbit inclined 4.1 degrees
99.2° West	UFO F5/USA 111 – Bandplan November orbit inclined 4.65 degrees
90.0° West	MILSTAR 2-F6/USA 169
53.1° West	DSCS 3-F14/USA 170 (AOR-W)
49.6° West	DSP F17/USA 105 orbit inclined 9 degrees
39.1° West	MILSTAR 1-F1/USA 99 orbit inclined 5.9 degrees
38.6° West	DSP F16/USA 75 orbit inclined 10.8 degrees
34.1° West	UK Skynet 4F
22.0° West	UFO F7/USA 127 – Bandplan: Papa (AOR-W)
17.7° West	UK Skynet 5C
15.6° West	FltSatCom 8/USA 46 – Bandplan: Bravo (AOR-W) orbit inclined 8.6 degrees
12.9° West	DSCS 3-F12/USA 153 (AOR-E)
10.1° West	SDS 3-F2/USA 155
01.1° West	UK Skynet 5A
06.0° East	UK Skynet 4C (inactive)
09.8° East	DSP F23/USA 197 orbit inclined 3 degrees
11.8° East	Italian SICRAL 1B
16.2° East	Italian SICRAL 1
28.7° East	UFO F2/USA 95 – Bandplan: November (IOR)
29.6° East	MILSTAR 2-F5/USA 164
35.7° East	NATO 4B/USA 98
44.5° East	Russian Raduga 1-5
52.7° East	UK Skynet 5B
53.3° East	UK Skynet 4E
56.6° East	DSCS 3-F8/USA 97 orbit inclined 4.5 degrees
59.8° East	DSCS 3-F13/USA 167 (IOR)
69.3° East	DSP F21/USA 159 orbit inclined 3.6 degrees
70.2° East	Russian Raduga 1M-1
71.1° East	UFO F11/USA 174 – Bandplan: November or Quebec
72.6° East	UFO F10/USA 146 – Bandplan: November or Quebec
75.0° East	SDS 3-F3/USA 162
89.0° East	Advanced Orion 3/USA 171 orbit inclined 3.2 degrees
103.0° East	DSP F22/USA 176 orbit inclined 1.4 degrees
135.0° East	UFO F9/USA 140 Bandplan – Oscar orbit inclined 2.8 degrees

HEO Milsats (Satellite Data System or SDS)

SSC#	Name(s)
25148	SDS 3-F1/USA 137 Capricorn/ NROL 5
28384	SDS 3-F4/USA 179 Nemesis/NROL 1
32378	SDS 3-F5/USA 198 Scorpius/NROL 24 – Bandplan: Delta

Note 1: Skynet 4A (20401), Skynet 4B (19687), Skynet 4D (25134), and NATO 4A (21047) have all been boosted to the geostationary graveyard and are no longer operational.

Note 2: More information is needed on Milstar 4/USA 157 (26715)

TABLE 2

Known Milsats UHF Downlinks and Bandplans

Bernie 3/USA 81 - 258.150 MHz
Italian Sircal - 252.200-252.350 MHz; 258.150-258.300 MHz; 267.100-267.250 MHz
Milstar "Waterdripper" - 243.785 243.825 MHz spread spectrum signal
Milstar - 253.400 253.425 MHz
NATO - 4B 253.950 257.450 MHz 25 kHz bw
Navy NOSS - 250.150 MHz
SDS Bandplan Delta - 243.695-243.760 MHz 12-5 kHz channels
SDS Banplan Echo - 243.855-243.920 MHz 12-5 kHz channels
SDS/DSP - 250.075 250.200 250.225 251.275 251.300 251.325 251.700 252.675 256.375 256.475 257.825 258.775 258.800 260.950 262.675 263.225 263.250 263.375 267.550 267.575 267.800 267.825 268.675 268.700 268.925 268.950 MHz
UK Skynet 4C - 254.200 257.325 MHz
UK Skynet 4E - 254.050 254.150 257.550 257.650 MHz
UK Skynet 5A - 245.800 257.700 261.200 MHz 25 kHz bw
249.480 249.530 249.850 250.130 250.300 10 kHz bw
UK Skynet 5B - 245.200 249.950 253.980 254.8295 257.900 261.100 262.500 MHz 35 kHz bw
249.4395 249.460 249.4995 249.5095 250.1795 MHz 8 kHz bw
UK Skynet 5C - 245.900 249.500 249.550 249.880 249.900 250.100 254.730 256.600 261.100 MHz
Unknown satellites - 248.825 254.950 261.400 261.425 261.975 262.950 267.925 MHz

TABLE 3

FLTSATCOM Bandplan Bravo (downlink/uplink in MHz)

Fleet Broadcast (25-kHz bandwidth)
Channel 1 250.550/SHF

Note: The Fleet Satellite Broadcast Subsystem has 15 subchannels of encrypted message traffic at an input data rate of 75 bps per channel. These subchannels are time-division multiplexed and transmitted in a one-way RF transmission at 1200 bps. The shore-based terminal transmits this data on a direct sequence spread-spectrum SHF signal to the UHF satellites, where the signal is translated to UHF and down-linked to the subscribers. The queued and/or channelized message traffic for Fleet Satellite Broadcast transmission is encrypted and inputted to a time-division multiplexer, where it becomes a 1200-bps data stream and is passed to the transmitter. The structure of the Fleet Satellite Broadcast transmission allows 15 subchannels: eleven 75-bps subchannels for general-service message traffic, two 75-bps subchannels for special-intelligence message traffic, and two 75-bps subchannels for Fleet weather data. A sixteenth subchannel in the Fleet Satellite Broadcast transmission is used for frame synchronization.

Navy Fleet Relay (25-kHz bandwidth)

2	252.050/293.050
3	253.750/294.750
4	255.450/296.450
5	257.050/298.050
6	258.550/299.550
7	265.450/306.450
8	266.950/307.950
9	268.350/309.350
10	269.850/310.850

Air Force AFSATCOM (5-kHz bandwidth)

11	244.045/317.145
12	244.055/317.155
13	244.060/317.160
14	244.065/317.165
15	244.070/317.170
16	244.075/317.175
17	244.080/317.180
18	244.085/317.185
19	244.090/317.190
20	244.095/317.195
21	244.100/317.200
22	244.110/317.210

Note: AFSATCOM 5-kHz channels 11-17 are regenerative, which means that the uplink RF signal at 317-MHz containing 75 bps messages, is converted to baseband; the message bits are amplified, reshaped, and remodulated and transmitted on the downlink at 243 MHz. Processing limits the signal to 75 bps and requires a special radio. AFSATCOM 5-kHz channels 18-22 are non-regenerative as there is no processing done other than the conversion. AFSATCOM is specifically designed for emergency action message (EAM) dissemination, force direction, force report back and Commander-in-Chief (CINC) internetting. The AFSATCOM terminal segment consists of all Air Force airborne and ground communication equipment, required interfaces, and related terminal equipment.

TABLE 4

UFO Bandplans-Frequencies

Fleet Broadcast Service

	November	Oscar	Papa	Quebec
Channel 1	250.350/SHF	250.450/SHF	250.550/SHF	250.650/SHF
Channel 1 Alt	250.400/SHF	250.500/SHF	250.600/SHF	250.700/SHF

Navy Fleet Relay (25 kHz) channels (41 MHz offset)

	November	Oscar	Papa	Quebec
Channel 2	251.850/292.850	251.950/292.950	252.050/293.050	252.150/293.150
Channel 3	253.550/294.550	253.650/294.650	253.750/294.750	253.850/294.850
Channel 4	255.250/296.250	255.350/296.350	255.450/296.450	255.550/296.550
Channel 5	256.850/297.850	256.950/296.950	257.050/298.050	257.150/298.150
Channel 6	258.350/299.350	258.450/299.450	258.550/299.550	258.650/299.650
Channel 7	265.250/306.250	265.350/306.350	265.450/306.450	265.550/306.550
Channel 8	266.750/307.750	266.850/307.850	266.950/307.950	267.050/308.050
Channel 9	268.150/309.150	268.250/309.250	268.350/309.350	268.450/309.450
Channel 10	269.650/310.650	269.750/310.750	269.850/310.850	269.950/310.950
Channel 11	260.375/293.975	260.575/294.175	260.425/294.025	260.625/294.225
Channel 12	260.475/294.075	260.675/294.275	260.525/294.125	260.725/294.325
Channel 13	261.575/295.175	262.075/295.675	261.625/295.225	262.125/295.725
Channel 14	261.675/295.275	262.175/295.775	261.725/295.325	262.225/295.825
Channel 15	261.775/295.375	262.275/295.875	261.825/295.425	262.325/295.925
Channel 16	261.875/295.475	262.375/295.975	261.925/295.525	262.425/296.025
Channel 17	263.575/297.175	263.775/297.375	263.625/297.225	263.825/297.425
Channel 18	263.675/297.275	263.875/297.475	263.725/297.325	263.925/297.525

UFO 5 kHz Non Processed Channels

	November	Oscar	Papa	Quebec
Channel 19	243.915/317.015	243.995/317.095	244.075/317.175	244.155/317.255
Channel 20	243.925/317.025	244.005/317.105	244.085/317.185	244.165/317.265
Channel 21	243.935/317.035	244.015/317.115	244.095/317.195	244.175/317.275
Channel 22	243.945/317.045	244.025/317.125	244.105/317.205	244.185/317.285
Channel 23	243.955/317.055	244.035/317.135	244.115/317.215	244.195/317.295
Channel 24	243.965/317.065	244.045/317.145	244.125/317.225	244.205/317.305
Channel 25	243.975/317.075	244.055/317.155	244.135/317.235	244.215/317.315
Channel 26	243.985/317.085	244.065/317.165	244.145/317.245	244.225/317.325

Note: Non Processed Channel is a satellite transponder in which the received signal is amplified and frequency-translated, but the digital data is not reconstituted before retransmission.

UFO 5 kHz Channels

	November	Oscar	Papa	Quebec
Channel 27	248.845/302.445	248.975/302.575	249.105/302.705	249.235/302.835
Channel 28	248.855/302.455	248.985/302.585	249.115/302.715	249.245/302.845
Channel 29	248.865/302.465	248.995/302.595	249.125/302.725	249.255/302.855
Channel 30	248.875/302.475	249.005/302.605	249.135/302.735	249.265/302.865
Channel 31	248.885/302.485	249.015/302.615	249.145/302.745	249.275/302.875
Channel 32	248.895/302.495	249.025/302.625	249.155/302.755	249.285/302.885
Channel 33	248.905/302.505	249.035.302.635	249.165/302.765	249.295/302.895
Channel 34	248.915/302.515	249.045/302.645	249.175/302.775	249.305/302.905
Channel 35	248.925/302.525	249.055/302.655	249.185/302.785	249.315/302.915
Channel 36	248.935/302.535	249.065.302.665	249.195/302.795	249.325/302.925
Channel 37	248.945/302.545	249.075/302.675	249.205/302.805	249.335/302.935
Channel 38	248.955/302.555	249.085/302.685	249.215/302.815	249.345/302.945
Channel 39	248.965/302.565	249.095/302.695	249.225/302.825	249.355/302.955

500-kHz Wideband Transponder

23*	261.700/295.300

Wideband Channel 23 Breakout*

23-1	261.450/295.050
23-2	261.475/295.075
23-3	261.500/295.100
23-4	261.525/295.125
23-5	261.550/295.150
23-6	261.575/295.175
23-7	261.600/295.200
23-8	261.625/295.225
23-9	261.650/295.250
23-10	261.675/295.275
23-11	261.700/295.300
23-12	261.725/295.325
23-13	261.750/295.350
23-14	261.775/295.375
23-15	261.800/295.400
23-16	261.825/295.425
23-17	261.850/295.450
23-18	261.875/295.475
23-19	261.900/295.500
23-20	261.925/295.525
23-21	261.950/295.550

Note: Two operating modes are used on these UHF channels. The narrowband mode is limited to a 5-kHz bandwidth (a single 5-kHz channel, or a 5-kHz bandwidth on a 25-kHz or 500-kHz channel). The wideband mode is limited to a 25-kHz bandwidth (a single 25-kHz channel, or a 25-kHz bandwidth on a 25-kHz or 500-kHz channel).

Where are all the satellites located?

There are quite a few military satellites in GEO/High Elliptical Orbit (HEO) that have UHF downlinks. Your first task is to locate them so you can accurately point your directional antennas. Our Table 1 lists the latest intelligence on which birds are in orbit/active and where they are located.

One of the easiest ways to verify which FLTSATCOM/UFO (UHF Follow-On) milsat bandplan is visible at your location is to check the fleet broadcast downlink channels that are operational 24/7. I use the following fleet broadcast channels as beacons for antenna and equipment alignment: 250.350 250.450 250.550 250.650 MHz.

You should correlate any of the fleet broadcast frequencies you receive above with the Fleet/UFO bandplans included with this article. This will help you to locate additional frequencies to monitor from your location.

You will find a list of miscellaneous milsat downlinks in Table 2. These downlinks offer you an opportunity to monitor transmissions from a wide variety of orbiting communications platform form the United States, NATO, and other European countries. If you need the current bandplans for the last operational FLTSATCOM and the UFO milsats, check out Tables 3 and 4.

Finally ...

Give milsat listening a try and be sure to drop us a report of what you hear from your location. If you have a multi-mode VHF/UHF receiver, a decent preamp, coax, and antenna system, you may be surprised at some of the satellites and communications coming from them that you can monitor.

There are a lot of military communications audible to the radio hobbyist throughout the HF/VHF/UHF spectrum. By adding the capability to monitor the UHF milsats, you will not only get a deeper appreciation for the sheer amount of military traffic that takes place throughout the entire radio spectrum, but you may also discover you are filling in the gaps in what you hear from the other portions of the radio spectrum.

So, if you like to experiment with other forms of radio listening, consider giving milsat monitoring a try. It can provide you with a truly out-of-this world listening experience.

UHF MilSat

240.000 - 242.875	Volna
243.125 - 243.520	Volna
243.695 - 243.845	SDS, MILSTAR
243.855 - 244.225	FltSatCom, UFO
244.300 - 248.580	Volna
243.625 - 244.975	ComSatBw
245.200 - 245.900	Skynet
247.380	Skynet
248.175 - 248.750	ComSatBw
248.845 - 249.355	UFO
249.375 - 249.850	LES
249.400	ComSatBw
249.450 - 250.225	SDS, Skynet
250.350 - 250.700	UFO
250.900	ComSatBw
251.275 - 251.700	SDS
251.775	ComSatBw
251.850 - 252.150	UFO
252.225 - 252.350	SICRAL
252.400 - 252.650	SICRAL
253.400 - 253.500	MILSTAR
253.430	Skynet
253.550 - 253.850	UFO
253.800 - 254.830	NATO, Skynet
255.250 - 255.550	UFO
254.775 - 255.775	ComSatBw
256.375 - 256.600	SDS, Skynet
256.850 - 257.150	UFO
257.300 - 257.900	NATO, SDS, Skynet
258.175 - 258.275	SICRAL
258.350 - 258.650	UFO
258.775 - 258.800	SDS
259.150 - 259.425	ComSatBw
259.920 - 260.120	Volna
259.975 - 260.175	SICRAL
260.250	Skynet
260.300 - 260.875	FltSatCom, UFO
260.950	SDS
261.050 - 261.250	Volna
261.100 - 261.350	Skynet
261.400 - 262.575	FltSatCom, UFO
262.200 - 262.500	Skynet
262.675 - 263.375	SDS
262.850 - 263.150	Volna
263.500 - 264.075	FltSatCom, UFO
264.250 - 265.150	Volna
265.250 - 265.550	UFO
266.750 - 267.050	UFO
267.125 - 267.225	SICRAL
267.550 - 267.825	SDS
267.875 - 268.100	SICRAL
268.150 - 268.450	UFO
268.675 - 268.950	SDS
269.650 - 269.950	UFO
270.075 - 275.000	Volna
277.300 - 278.500	Meridian
280.000 - 292.805	Volna
311.350 - 316.572	Volna
317.500 - 322.000	Volna

Update: 09.07.11