



**AMSAT-UK**

**Spectrum Forum Meeting – Saturday 20<sup>th</sup> November 2010**

**Spectrum Report – Amateur Satellite Service**

### **Satellite Projects**

During the year AMSAT-UK members have travelled extensively to give presentations on Amateur Satellites and run stands at rallies. Currently AMSAT-UK is involved in a number of satellite projects:

#### **FUNcube**

This is a 10cm cube satellite that has the primary goal of enthusing and educating young people about radio, space, physics and electronics. It will carry a low power 20 kHz bandwidth, 435 to 144 MHz linear transponder for weak signal CW and SSB working.

FUNcube will support the educational Science, Technology, Engineering and Maths (STEM) initiatives and provide an additional resource for the **GB4FUN** Mobile Communications Centre.

It is planned that FUNcube will operate in "educational" mode during daylight hours and in "amateur mode" at night and during weekends.

The project received major initial funding from the Radio Communications Foundation (RCF).

For further information on FUNcube, see

<http://www.FUNcube.org.uk/>

#### **FUNcube SDR Dongle**

This is a 64 to 1700 MHz Software Defined Radio designed to support the FUNcube project. It is the size of a memory stick and plugs into the USB socket of a laptop.

A presentation on the FUNcube SDR Dongle was given to the Martlesham Microwave Round Table, Nov 13-14.

Further details at

<http://www.FUNcubeDongle.com/>

## **UKube1**

The United Kingdom Space Agency website now includes some more details of the UKube-1 3U (10 \* 10 \* 30cm) CubeSat project. See

<http://www.ukspaceagency.bis.gov.uk/20084.aspx>

The baseline design for this satellite includes a set of FUNcube boards to provide the educational outreach for the project. AMSAT-UK is presently discussing the precise details of this arrangement with the UKube-1 project team. This development will enable a much higher level service to be provided for the Science, Technology, Engineering and Mathematics (STEM) outreach to schools than would be possible with just a single spacecraft.

In the information pack provided by the UK Space Agency at

<http://www.ukspaceagency.bis.gov.uk/assets/ZIP/CubesatAOPayload.zip>

they reference two International Amateur Radio Union (IARU) documents regarding the Amateur Satellite Service:

[AD-05] IARU Amateur Satellite Frequency Coordination Request (IARU-ASFCR) (Rev. 2009-03)

[AD-06] IARU Amateur Radio Satellite (IARU-ARS) guidelines (Rev. 2006-10)

BBC report on UKube-1 at

<http://www.bbc.co.uk/blogs/thereporters/jonathanamos/2010/11/uk-takes-open-source-route-int.shtml>

## **European Student Earth Orbiter (ESEO)**

The European Student Earth Orbiter (ESEO) is a micro-satellite mission to Low Earth Orbit. It is planned to be developed, integrated and tested by European university students as part of the ESA Education Office projects. ESEO will carry an Amateur Radio payload developed by AMSAT-UK along with a number of experiments developed by the students.

ESEO Mission

[http://www.esa.int/esaMI/Education/SEM4DLPR4CF\\_0.html](http://www.esa.int/esaMI/Education/SEM4DLPR4CF_0.html)

## **GENSO**

The aim of this ESA project is to automatically collect Digital Telemetry Data from Amateur Radio and Educational satellites and AMSAT-UK have been actively involved in it from the outset. This project is a major long-term software and hardware development.

AMSAT-UK and European Space Agency (ESA) co-operation on GENSO

[http://www.southgatearc.org/news/november2007/amsat\\_esa\\_genso\\_cooperation.htm](http://www.southgatearc.org/news/november2007/amsat_esa_genso_cooperation.htm)

GENSO - Team F - Hardware Definition and Device Drivers

[http://www.genso.org/index.php?option=com\\_content&task=view&id=26&Itemid=47](http://www.genso.org/index.php?option=com_content&task=view&id=26&Itemid=47)

GENSO website

<http://www.genso.org/>

## **Spectrum Availability**

### **2400 and 3400 MHz**

The 2400 – 2450 MHz Amateur Satellite Service allocation remains effectively unusable in build-up areas. Even in small villages you can guarantee to find a proliferation of Wi-Fi and other licence exempt systems.

For a number of years AMSAT-UK and other AMSAT organisation have been pressing for an alternative Amateur Satellite allocation at 3400-3410 MHz and we are glad to see that IARU is now pursuing a 3400 MHz Amateur Satellite allocation. See IARU Spectrum Requirements for the Amateur and Amateur-satellite Services <http://www.iaru.org/ac-09spec.pdf>

3400-3410 MHz is already an Amateur Satellite Service allocation in ITU Regions 2 and 3 and a welcome development in Region 1 has been the decision by Denmark to permit Amateur Satellite Service operations in this band.

It would clearly be helpful if other Region 1 administrations were to permit Amateur Satellite Service activity. Currently the 3400- 3600 MHz segment is in a state of flux in the UK so there may be an opportunity to persuade our regulator to incorporate this in the UK licence.

### **435-438 MHz**

The main satellite UHF band is 435-438 MHz which is supporting an increasing number of satellites. We share this band with military users and 432-438 MHz has also been allocated to wide-band satellite-borne Synthetic Aperture Radars (SAR).

A factor not always appreciated is the effect that Doppler shift has on the separation that can be used when co-ordinating frequencies. At 435 MHz the total frequency shift during a pass can be up to 20 kHz making a channel spacing of 50 kHz the smallest that can be realistically used. Whenever possible frequency re-use is employed with as many as four satellites using the same frequency.

An extension of the 70cm satellite allocation remains a long-term goal.

### **50 MHz**

The incorporation of a 50 MHz allocation for the Amateur Satellite Service into the list of IARU objectives has been a very welcome move. An allocation in this part of the spectrum would provide much needed VHF spectrum and could provide the Amateur community with a useful tool for propagation research.

Low Band VHF (30-80 MHz) has a number of characteristics that make it ideal for satellite operation. The path loss is some 6 dB lower than 144 MHz, an important consideration for low power satellites using simple Omni-directional antennas. Additionally the Doppler shift at these frequencies is small, just 3.8 Hz a second instead of the 33 Hz/Sec encountered on 70cm.

### **Spectrum Efficiency**

With its new satellite FUNcube AMSAT-UK is seeking to achieve a 10 fold reduction in nominal bandwidth for the telemetry beacon. Conventional CubeSats have used AX.25 Packet with a 5 kHz deviation FM transmitter, occupying a bandwidth of 13 KHz (+/- Doppler shift).

The BPSK telemetry system, developed by AMSAT-UK members, delivers the same data rate throughput, 1200 bps, but in a bandwidth of only 1 kHz. The beacon also incorporates Forward Error Correction (FEC) techniques to improve data capture, something that is lacking in AX.25.

The South African Amateur Radio satellite SO-67, launched in 2009, was the first to use narrow deviation 2.5 kHz FM for its transponder. This has, however, presented Amateurs with some issues. In the rest of the world, outside of Europe and Japan, 5 kHz deviation is the standard and Amateurs using conventional FM radios have encountered problems. It is an

unfortunate side-effect of regional planning that we do not have a single global standard for FM.

The benefits from reducing FM deviation are not as great as may be first thought, in reality Doppler shift enters into the equation. On 435 MHz the amount of Doppler shift on a pass is typically 20 kHz so in effect a 5 kHz deviation satellite signal occupies 33 kHz of spectrum. Reducing the deviation to 2.5 kHz cuts it to 26.5 kHz a saving of just 20%.

## **ISS**

The Amateur radio station on the International Space Station continues to provide good service. Over a decade ago the IARU agreed on a 5 kHz deviation FM downlink (space-to-earth) on 145.800 MHz with an uplink (Earth-to-Space) at 145.200 KHz. Since the station was established in 2000 Amateur Radio has linked the Astronauts to talk to tens of thousands of young people in schools around the world and enabled the many licensed Astronauts to have 1000's of contacts with other Radio Amateurs on Earth.

The station on the ISS is a QRP station running just 5 watts output and work is underway to add a second QRP station in the ISS Columbus module which will increase the opportunities for Amateurs to work DX that's "out of this world".

## **Interference**

The Amateur Satellite Service, like the Amateur Service, suffers interference from both unlicensed users and licensed users unaware of the band plan.

A YouTube video shows graphically the problem that just a few watts of FM simplex on 145.8-146 and 435-438 MHz can cause. This recording, made on Nov 9, 2010 during orbit 4336 of the Amateur Radio satellite HO-68 shows FM interference from a Russian speaking station transmitting on the 2m uplink.

<http://www.youtube.com/watch?v=ncA5c9BPeNY>

Subsequent to the IARU allocation of a 25 kHz B/W channel on 145.800 MHz for the ISS IARU Region 1 allocated 145.8875 MHz to FM repeater outputs. As a result of that unfortunate decision Amateurs living within range of a R67 repeater suffer interference when they try and listen to the 145.800 MHz downlink.

## **Annual Colloquium**

AMSAT-UK's 2010 Colloquium was again at the Holiday Inn, Guildford. It attracted a high proportion of overseas visitors from North America and across Europe.

Over the two day event, presentations were made on a variety of Amateur satellite related projects and technical discussions between Amateur satellite builders and users continued late into the evening.

The Radio Society of Great Britain (RSGB) supported the event by providing the new GB4FUN Radio Communications Demonstration Centre that proved very popular with attendees.

Once again thanks to the British Amateur Television Club (BATC) the event was webcast live to a worldwide audience.

Video of the presentations are available on the web, see <http://www.uk.amsat.org/content/view/720/68/>

## **Upcoming Amateur Satellite Projects Worldwide**

AMSAT-UK hosts the Satellite Frequency Coordination pages for the IARU. It gives details of the many Amateur Radio satellite projects under development.

<http://www.amsat.org.uk/iaru/>

**AMSAT-UK** <http://www.uk.amsat.org/>

November 2010