



AMSAT-UK

Spectrum Forum Meeting – Saturday 1st November 2014

Spectrum Report – Amateur-Satellite Service

Spacecraft

The past year has seen three FUNcube STEM and SSB/CW linear transponder payloads developed by AMSAT-UK deployed in space.

FUNcube-1 Satellite

The [AMSAT-UK FUNcube-1 satellite](#) has the primary goal of enthusing and educating young people about radio, space, physics and electronics. It is designed to support the educational Science, Technology, Engineering and Maths (STEM) initiatives. FUNcube-1 carries a 1200 bps BPSK telemetry beacon and a 435/145 MHz linear transponder for SSB/CW communications.

AMSAT-UK started the FUNcube project in 2009 and soon discovered the UK Outer Space Act 1986 imposes constraints which would make it almost impossible for AMSAT-UK to obtain a licence from the UK based authorities. Our partners in The Netherlands, were very helpful in getting the necessary licence and ITU registration from their authorities, who have a more flexible approach. Hence FUNcube-1 is now formally owned by AMSAT-NL. It was launched on November 21, 2013.

AMSAT-UK operated a monitoring station at the National Radio Centre immediately following the launch. The BBC visited the station and broadcast a news item about FUNcube-1 both from the NRC and at Abbeys Primary School in Bletchley where AMSAT-UK members gave a presentation to the pupils about the satellite. Watch the BBC video at <http://www.bbc.co.uk/news/science-environment-25084547>

FUNcube-2 on the UKube-1 Satellite

AMSAT-UK was approached in 2010 by the UK Space Agency to provide a set of FUNcube boards for use in their first satellite [UKube-1](#). The set of boards provides a 1200 bps BPSK educational telemetry beacon and a 435/145 MHz linear transponder for SSB/CW communications and the satellite was launched on July 8, 2014. While the transponder has not yet been made available it has been briefly tested successfully and the FUNcube telemetry beacon was activated shortly after launch and has proved to be of great benefit to the UK Space Agency. The spacecraft is undergoing commissioning by the UK Space Agency, and it is anticipated that when they have completed their mission, it will be 'handed over' to AMSAT-UK for continuous use in amateur service.

FUNcube-3 on the QB50 Satellite

AMSAT-UK members supplied the FUNcube-3 SSB/CW linear transponder payload for the QB50p1 satellite which is part of the QB50 precursor mission launched on June 19, 2014. As yet the transponder has not been activated for general use.

FUNcube Software for the Educational Beacons

The FUNcube Dashboard and FUNcube Data Warehouse have been developed to support the FUNcube-1 and 2 educational telemetry beacons.

The FUNcube Dashboard software is available free of charge to schools and individuals. It runs on Windows computers and provides the user with a meaningful display of the telemetry data. The software takes data from the FUNcube Dongle SDR or a standard SSB receiver while it is receiving live signals from the satellite and, if so configured, will relay any received telemetry to the Data Warehouse via the Internet. In this way a store of telemetry from all over the world is being built up.

The FUNcube Data Warehouse software collects, collates, de-duplicates, stores and displays data from the Dashboards. It enables everyone to see what telemetry is being received, by whom and where they are, all in real time. Historical telemetry data can also be retrieved for analysis by the command team and by students for their own research purposes.

So far 1286 amateurs and listeners around the world have registered with the data warehouse. 1.5 GB of telemetry has been transmitted by the satellite of which 376.9 MB has been received and stored. The warehouse is at <http://warehouse.funcube.org.uk/>

A number of schools have been tracking the satellite, one pupil Max Callé from Roundwood School in Harpenden featured in an article in the November 2014 issue of RadCom.

Mark Spencer WA8SME has published a [Guide for Using the FUNCube \(AO-73\) Materials Science Experiment in the Classroom](#).

European Student Space Orbiter (ESEO)

AMSAT-UK is supplying a 1260/145 MHz FM transponder with FUNcube compatible telemetry for this European Space Agency (ESA) project. The beacon downlink should have a higher power than FUNcube-1/2 and give even easier reception for schools. The estimated launch date is the summer of 2015.

Delta-Dsat

This is a 2U CubeSat being developed by Cranfield University in Bedfordshire expected to launch in 2016 as part of the QB50 constellation. The Ground Station Equipment (GSE) at Cranfield is now installed and operational.

The UK Outer Space Act 1986

Since the 2013 report there has been no change regarding this Primary Legislation which effectively precludes UK individuals or organisations procuring the launch of a low cost educational satellite.

WUSAT

In 2013 students at Warwick University developed a CubeSat WUSAT-1 and tested it at an altitude of 30 km using a High Altitude Balloon. Due to restrictions in the amateur licence it used Licence Exempt spectrum. In early 2015 their second CubeSat [WUSAT-2](#) should be launched on a rocket from northern Sweden on a sub-orbital flight. The students hope that a subsequent satellite will achieve Earth orbit although as mentioned elsewhere in this report the UK Outer Space Act 1986 may be an obstacle.

International Space Station

AMSAT-UK welcome the recent announcement by Ofcom that the callsign GB1SS will be made available for issue to UK astronauts who wish to operate from the ISS. UK astronaut Tim Peake KG5BVI is expected to fly to the ISS in November 2015. He has recently been trained in the use of the amateur radio station located in the ISS Columbus module. During training he tweeted *"Will be great to chat with schools next year from space using this ham radio on board the ISS."*

The Digital ATV equipment for the [HamTV project](#) has been operated from the Columbus module of the International Space Station. It has been the culmination of over ten years work to establish an amateur radio TV transmitter on the ISS using patch antennas fixed on the Meteorite Debris Panels (MDP) protecting the hull of the ISS Columbus module. These antennas were installed while Columbus was being constructed. A fund-raising campaign took place during 2005-7 to raise over 65,000 Euros for the antennas. Individual radio amateurs from around the world donated generously as did several organisations such as **AMSAT-UK** and the **RSGB**.

The main mission of HamTV is to perform contacts between the astronauts on the ISS and school students, not only by voice as now, but also by unidirectional video from the ISS to the ground.

Tests of the system revealed that the high levels of interference from Wi-Fi and other devices meant reception was best when a frequency **outside** the Amateur Satellite Service allocation was used e.g. 2395.0 MHz. ARISS minutes record - *The 2.3 GHz frequencies will be used under secondary user conditions, and we would cease operations if there any interference is experienced, as per ITU Radio Regulations article 4.4.*

Es'hail 2 Geostationary Amateur Radio Transponders

Two amateur radio transponders will be flown on a Qatar geostationary satellite expected to launch in 2016, this will be the first time that amateur transponders have been put into geostationary orbit. The satellite will be positioned at 25.5 degrees East and will provide coverage of almost half the globe from Brazil to Việt Nam.

A linear transponder will cater for SSB and CW communications
2400.050-2400.300 MHz Uplink
10489.550-10489.800 MHz Downlink

A wideband digital transponder will cater for Digital ATV
2401.5-2409.5 MHz Uplink
10491.0-10499.0 MHz Downlink

In the UK the 10475-10500 MHz section of the Amateur Satellite Service allocation was [auctioned](#) by Ofcom for nationwide cell-phone backhaul links. The winner of the auction was T-Mobile(UK) now part of the phone company EE. The use of this segment of the band by cell-phone masts may cause problems to UK amateurs wishing to receive the transponders. See this [spreadsheet of spectral masks for the 10 GHz links](#).

There may be issues with the 2400 MHz uplinks. In some countries there have been moves to protect unlicensed users in 2400-2450 MHz from amateur transmissions. In Sweden the amateur licence restricts the transmitter output in that segment to just 100 milliwatts.

Spectrum

The IARU Region 1 Conference in Varna-Albena approved a new Amateur Satellite segment at 144.0 – 144.025 MHz. This decision means all three IARU regions have agreed the allocation.

By 2017 the Galileo constellation of GNSS satellites should be approaching completion. The satellites transmit across 1260-1300 MHz which covers the Amateur Satellite Service uplink band used by the ESEO satellite mentioned above. So far four Galileo satellites have been used in orbit for system validation and it is of great concern that two German 23cm ATV repeaters have been closed down in order to protect a receiver being used for testing. DB0QI was located 18 km from the receiver while DB0ITV was 55 km away. It is believed both repeaters were running about 15 watts ERP.

This action raises fears as to what may happen in 2017 when the constellation is completed and receivers are being sold to the public. Will national regulators move to protect them from interference from radio amateurs? Peter Blair G3LTF has highlighted the problem in his paper [Potential interference To Galileo From 23cm band operations](#).

It is an aspiration that the Amateur-Satellite Service allocations at UHF and Microwaves should align with the weak-signal sections of the bands. In particular it is desirable that the European Common Frequency Allocation Table Footnote EU17 sub-bands, **3400-3410 MHz**, **5660-5670 MHz** and **10360-10370 MHz** along with **50-51 MHz** and a 10 MHz wide L-band segment become available to the Amateur-Satellite Service for both Earth-to-Space and Space-to-Earth communications.

Annual Colloquium

AMSAT-UK's 2014 Colloquium was held at the Holiday Inn, Guildford and it was pleasing to see an increase in the number of young people giving presentations. The British Amateur Television Club (BATC) provided a webcast live to a world-wide audience.

Video of the presentations are available via the [AMSAT-UK website](#).

Other Activities

On October 25, 2014 the AMSAT-UK [FUNcube Yahoo Group](#) had 3794 members.

AMSAT-UK hosts the [Amateur Satellite Frequency Coordination Status](#) pages for the IARU. These pages give details of the many Amateur Radio satellite projects under development.

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