OSCAR-1 Launched 50 Years Ago

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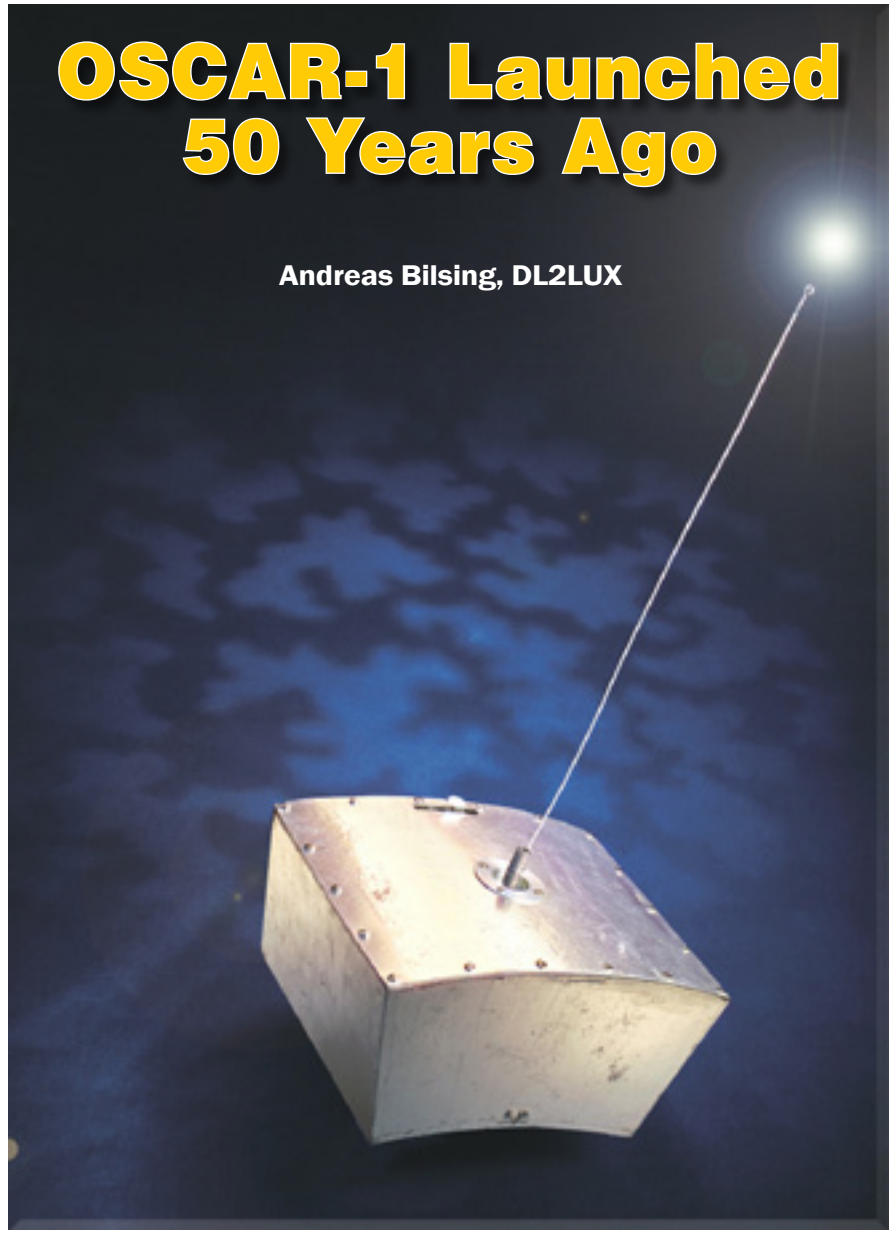

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Launching the Amateur Radio Satellite Era

On December 12, 1961, a Thor-Agena-B rocket with a special payload lifted off from Vandenberg Air Force Base in California. The launch of the reconnaissance satellite Discoverer 36 was considered routine, except that a piggyback passenger was aboard — Amateur Radio's first satellite, OSCAR-1.

The uniqueness of the OSCAR-1 spacecraft was not only that it was built by amateurs, only about four years after the launch of Sputnik-1, but that it was the world's first piggyback satellite and the world's first private non-government spacecraft.

Yes, it was 50 years ago that OSCAR-1 blazed the trail, beaming its message of "HI" to the world's hams for 22 days and paving the way for many more OSCARs, and other Amateur Radio satellites in the ensuing years.

Immediately following the launch of OSCAR-1, Vice President Lyndon B. Johnson honored it with a congratulatory telegram to the group sponsoring this momentous event in the history of Amateur Radio.[1] It read:

"For me this project is symbolic of the type of freedom for which this country stands — freedom of enterprise and freedom of participation on the part of individuals throughout the world."

More Early Satellite History

Barely four months after the successful launch of Sputnik I, the United States orbited Explorer I. That was January 31, 1958. It was at about that same time that a group of West Coast hams begin toying with the idea of launching an Amateur Radio satellite. To accomplish that goal, they formed an organization they dubbed "Project OSCAR." OSCAR stood for then, and still does stand for, Orbiting Satellite Carrying Amateur Radio. Included in that early Project OSCAR group were Chuck Smallhouse, W6MGZ; Ed Beck, K6ZX; Al Diem; Chuck Townes, K6LFH (SK), Nick Marshall, W6OLO (SK) and Lance Ginner, K6GSJ.

Figure 1 — Lance Ginner, K6GSJ with OSCAR-1.

To get the project started, they called a series of high-level meetings of the members of the Project OSCAR group, the ARRL, representatives of the U.S. Air Force and the Lockheed Missiles and Space Company in Sunnyvale, California.

At the time, Lance Ginner worked for Lockheed, having begun in January 1960 as an "A" Technician working in the Agena A and B space vehicle checkout complex. He was responsible for designing and building test aids to facilitate final systems checkout prior to shipment to Vandenberg Air Force Base for launch. The following year he advanced to a salaried position as a test conductor in satellite subsystems and systems level checkout. It was then that he became aware of Project OSCAR through meeting Chuck Townes and Nick Marshall, both of whom were also employed by Lockheed.

In an interview, Ginner answered a question about the most challenging aspects in the first OSCARs:[2]

"Getting the early OSCAR satellites approved for launch was a highly political process. I was a 21 year old just starting out in the field and was tremendously impressed by the talents of the OSCAR Board of Directors. The challenges the board faced in obtaining the permissions from the various government agencies and Lockheed were enormous. We had to keep in mind that ejectable sub-satellites were unknown at the time. And, convincing the various agencies that this 'honor' should go to a home built satellite with no official credentials was seen as a big risk. A premature release of the OSCAR satellite would keep the Agena satellite from deploying its booster adapter and would be a catastrophic end to the main mission. There were numerous meetings with government and military representatives, including many well-connected hams. These discussions and the creation of the OSCAR 'White Paper,' helped establish the political and technical credibility we needed to obtain launch permission. The bureaucratic efforts probably exceeded those required to build the satellite.

Figure 2 — OSCAR-1's successor, OSCAR-2 was also developed in the shack of K6GSJ and at similar venues.

"There were certainly technical risks in space hardware. In 1961, there were no transistors that would put out any real power at 144 MHz. We ended up using a prototype Fairchild part that was not even on the market. In those days, you did not have someone saying, 'you can't do it that way,' because no one had ever done it before!"

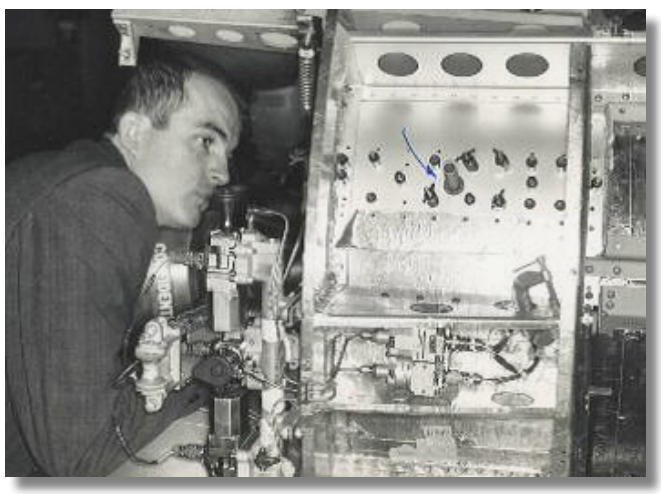

Figure 3 — K6GSJ working on the upper stage of the Thor-Agena A rocket. The transport capacity for OSCAR-1 and ejection mechanism can be seen. Note the curved shape to conform to the exterior surface of the carrier rocket.

Spacecraft Hardware

OSCAR-1 was built, quite literally, in the basements and garages of the Project OSCAR team. The satellite's case was approximately 30 cm × 25 cm × 12 cm and was slightly curved to conform to the shape of the carrier rocket. The casing was constructed mostly of magnesium, used because of its strength and to meet weight requirements. The total mass of the satellite was about 4.5 kg. As already mentioned, OSCAR-1 was the first satellite ejected as a secondary payload of another, primary mission, and then reach its own orbit. This was done with a very sophisticated technique: a $1.15 spring purchased from a local hardware store. The total out-of-pocket cost (not including donated material) was only $68.

OSCAR-1 was attached near the tail-end of the rocket, adjacent to the engine nozzle. To survive the extreme environment of launch and separation, it was designed and tested to handle nearly 50 Gs of force, the level of shock that would be encountered.

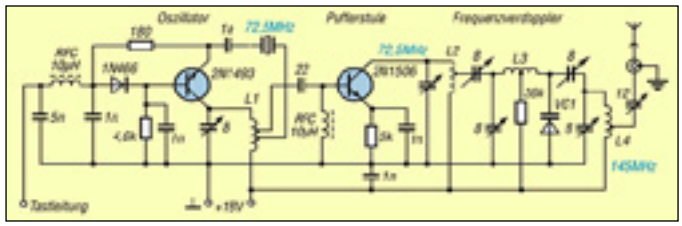

Figure 4 — The circuit diagram of the telemetry transmitter without keyer and without timer.

Figure 5 — OSCAR-1's transmitter circuit board

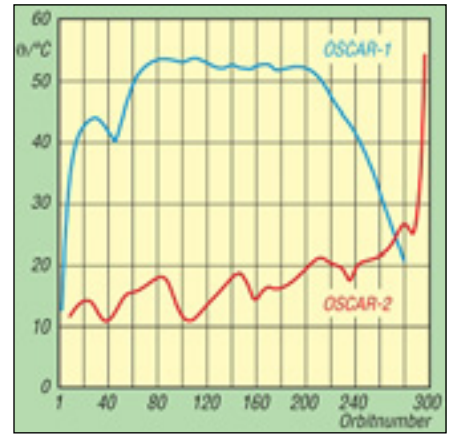

Figure 6 — Telemetry displaying OSCAR 1's and 2's internal temperatures. The lessons learned from OSCAR-1 were used to improve the thermal design of the successor. Note the sharp rise in temperature of OSCAR-2 near the end of its mission.

Explosive squibs and compression springs propelled OSCAR-1 away from the rocket (see Figure 3). Spring switches released the antenna and applied power to the transmitter and keying circuits. The final version of OSCAR-1 was gold-plated and had black metallic strips across its case to regulate its internal temperature.

Power for the transmitter and keying circuits was provided by three 18 V batteries connected in parallel. The transmitter sent the letters, "HI" in Morse code using CW on 144.9830 MHz with an output power of 140 mW. A simple rod served as the antenna. This power level was a compromise between providing adequate signal on the ground, and the battery life. The letters "HI" were chosen over any particular call sign, since it was, and still is, recognized internationally as a friendly greeting among radio amateurs.

Figure 4 shows the diagram of the transmitter.[3] It consists of three stages, a quartz oscillator operating at 72.5 MHz, a buffer stage and a varactor diode doubler. In those days, transistors for 145 MHz were not available. The resonant circuit, L4, is tuned to 145 MHz. Figure 5 shows the PCB of the transmitter. In it can be seen the crystal, the two transistors in the heatsinks, inductor L3 which is connected to the right of the varactor diode.

The internal temperature was transmitted as telemetry. To encode the temperature, the Morse speed was varied. A keyer and timer were used for this purpose. Two thermistors inside the satellite controlled the timer so that the Morse speed was function of temperature. Since there was no solar-cell charging system, the satellite fell silent after the batteries became discharged. The expected battery life was 28 days. Samples of how OSCAR-1 sounded can be heard on the web.[4]

Results

More than 570 amateurs in 28 countries forwarded observations to the Project OSCAR team. These reports made it possible to draw conclusions regarding signal propagation, the orbit and the thermal condition of the satellite. The graph in Figure 6 shows the results of the telemetry of OSCAR-1 and its successor, OSCAR-2. It can be seen that the temperature in OSCAR-1 was in a range around 50°C, dropping towards the end of the mission. During decay of the satellite, the telemetry transmitter had already failed, so that there are no data. The findings with OSCAR-1 led to modifications of the thermal design of OSCAR-2. It can be seen that OSCAR-2 achieved a significantly lower average temperature. Since OSCAR-2's telemetry continued to function until near the end, it can be seen that its temperature increased markedly at mission end.

Conclusion

The mission of OSCAR-1 made three things clear. Radio amateurs are able to:

1) Design and construct reliable operational satellites.

2) Coordinate with government launch agencies

3) Track satellites and collect and process related scientific and engineering information.

Then as now, Amateur Radio is an experimental radio service. As the pioneering hams of Project OSCAR showed us 50 years ago, in addition to merely engaging in QSOs, amateurs should always be seeking new technical challenges.

Notes

[1]Astronautical and Aeronautical Events of 1962; *Report of the National Aeronautics and Space Administration Committee on Science and Astronautics*; 88th Congress; 12. June 1963

[2]Hartzell, D., NØTGD: Between a Rock and Outer Space: Interview with OSCAR Pioneer Lance Ginner; *The AMSAT Journal* September/October 2006.

[3]Davidoff, M., K2UBC: *The Radio Amateur's Satellite Handbook*; The American Radio Relay League, Newington, ISBN 978-0-87259-658-0. Out of print.

[4]Welch, R., WØSL: Sounds from the first satellites. **www.amsat.org/amsat/features/sounds/firstsat.html**

[5]**www.arrl.org/news/oscar-i-and-amateur-radio-satellites-celebrating-50-years**

[6]Grebert, M. J., KJ4ZZV: OSCAR 1 — Historic Satellite at Dayton Hamfest 2011. **www.youtube.com/user/kj4zzv**