DTUsat-2 beacon documentation

Authors: Denis Tcherniak & Dennis Noer

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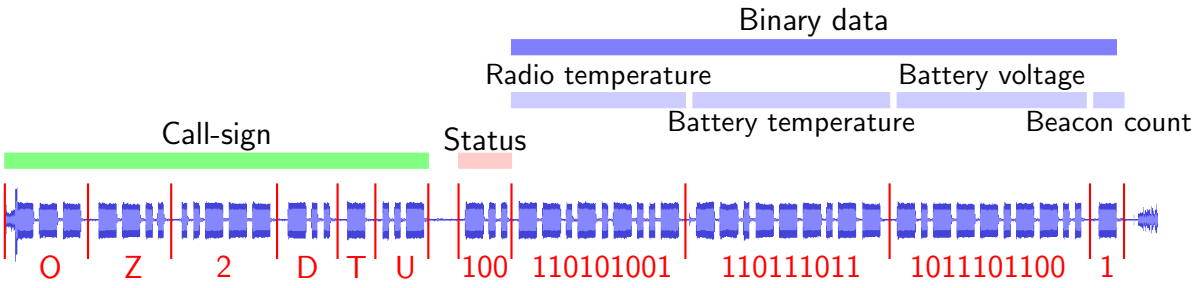
Beacon structure and required equipment

The DTUSat-2 usually[1] transmits 2 separate beacons, separated by approximately 30 s intervals. Both beacons are transmitted at 2.4018 GHz. The first beacon is a morse code OOK beacon, best received on AM. This beacon contains the satellite call-sign followed by morse-coded (dash is 1, dot is 0) binary information. The second beacon is an FSK ±10 kHz offset data beacon, transmitted by the on-board computer. Details regarding the decoding of this beacon will be provided in the future revisions of this document.

Information	Data	Format	Factor
Call-sign	OZ2DTU	International Morse Code	-
Status bits	3 bits	3 bits	-
Radio temperature	1-16 bit	16 bit two's complement	0.0625
Battery temperature	1-16 bit	16 bit two's complement	0.0625
Battery voltage	1-10 bit	Unsigned integer	4.44
Beacon count	1-16 bit	Unsigned integer	-



[1] We reserve the right to disable the beacon during satellite operation.

In order to receive the DTUSat-2 beacon, a radio receiver capable of receiving signals in the S band is required. The satellite transmitter power is 20 dBm, while the antenna gain is about 6-7 dBi. The expected signal strength is about -100 dBm when the satellite is in zenith (600 km).

We have been able to receive the beacon with three different antennas - a 24 dBi WiFi dish, a 3 m dish and a 46 cm dish. During all of the receptions the antennas were equipped with a Kuhne MKU LNC 24 OSCAR 2 2.4 GHz to 144 MHz downconverter, with a built-in 30 dB LNA. Reception has been verified with 3 different receivers: a hand-held Yaesu VR-500 scanner, a stationary Yaesu FT-847 transciever and an RTL-SDR dongle.

Temperature decoding

As described above, the temperature readings are encoded as two's complement values. The values are 16 bit long, but the preceding zeroes are not transmitted, in case of positive temperature readings. As an example, in order to decode the radio temperature value, given in the example beacon, the following calculation has to be performed:

$$\begin{aligned} &110101001_2 = 425_{10} \\ &\Downarrow \\ &425 \cdot 0.0625 = 26.5625\,^{\circ}\mathrm{C} \end{aligned}$$

In case of a negative temperature, all of the 16 bits will be transmitted, due to the sign bit at MSB location (please refer to two's complement theory, found here):

$$\begin{aligned} &1111111001010111_2 = -425_{10} \\ &\Downarrow \\ &-425 \cdot 0.0625 = -26.5625\,^{\circ}\mathrm{C} \end{aligned}$$

Voltage decoding

In order to decode the voltage, given in the example beacon, the following calculation must be performed:

$$1011101100_2 = 748_{10}$$

$$\Downarrow$$

$$748 \cdot \frac{3.3}{1024} \cdot 4.44 = 10.7\,\mathrm{V}$$

Beacon count

The beacon count is the number of beacons since the last full system reboot.

On-board computer data beacon

This information will be available in the future revisions of this document.