AmicalSat downlinks technicals informations

The satellite is made for observing Auroras from space. (more information on <u>this page</u>. Our scientists will give information to the community about space weather from the observations of the satellite.

The spacecraft payload is designed and built by the university. This include the optics, the electronic, the FPGA gateware design. The platform (everything else), is bought from a polish private company, Satrevolution. Of course the RF coms is from them. We tried our best to have the maximum technical details about it for the amateur radio community.

Contents

UHF Telemetry

Downlink frequency

Frequency	436.1Mhz
Modulation	AFSK 1k2
Protocol	APRS

The amateur radio frequency coordination of the satellite:

http://www.amsatuk.me.uk/iaru/finished_detail.php?serialnum=686

The satellite callsign is RS17S (Russian callsign).

Telemetry decoding of the beacon

Analog value interpretation (to be confirm)

- Voltage : value / 1000 => in volt

- Temperature : value => in °C

- Current : value => in mA

- Power : value => in mW

- Timestamps : unix time (https://en.wikipedia.org/wiki/Unix_time)

General arbiter statut :

M1;**LOG**;[Timestamp];[Boot number];[Up time];[CPU voltage];[CPU temperature]

- **Up time**: elapsed time in second.

Current statut flags of the satellite:

M1;**FLAGS**;[Timestamp];[Hex flags];

The meaning of each value is as follow :

Bit	Name	Description
0	IMC AOCS OK	AOCS working
1	IMC CU L OK	Left CU working
2	IMC CU R OK	Right CU working
3	IMC VHF1 OK	VHF working
4	IMC UHF2 OK	UHf working
5	VHF1 _DOWNLINK	VHF downlink enabled
6	UHF2 _DOWNLINK	UHF downlink enabled
7	IMC CHECK	Periodic device check enabled
8	BEACON MODE	Beacon mode flag
9	CYCLIC _RESET ON	Cyclic reset mode flag

Bit	Name	Description
10	SURVIVAL _MODE	Survival mode flag
11	PAYLOAD _OFF	Payload off mode flag
12	CU AUTO _OFF	Automatic CU power off mode flag
13	TM LOG	Telemetric data logging mode flag
14:15	RESERVED _MODE	-
16	CUL _ON	Left CU turned on
17	CUL FAULT	Left CU overcurrent fault
18	CUR _ON	Right CU turned on
19	CUR FAULT	Right CU overcurrent fault
20	CU ON	Any CU on
21:23	RESERVED _CU	-
24:27	CUL DEAD	Number of left CU fault recovery retries
28:31	CUR DEAD	Number of right CU fault recovery retries
32:39	RESERVED	-
40	FAULT 3V3 R	Redundant 3V3 fault
41	FAULT 3V3 M	Main 3V3 fault
42	CHARGE R	*Redundant charging
43	CHARGE M	*Main charging
51	SURVIVAL START	Survival mode on threshold reached
52	SURVIVAL END	Survival mode off threshold reached
53:63	RESERVED	-

Mean value of the last 90 measurements of the power management subsystem:

[EM/ER];MN;[Timestamps];[V in];[V solar];[I in];[P in];[P peak];[T cpu];[V cpu]

- **EM :** Main power management sub module.

- **ER :** Redundant power management sub module

Measurement of the power management subsystem:

EM;LOG;[Timestamp];[Boot number];[Input voltage];[Input current];[Input power];[Peak Power];[Solar panel voltage]

- **EM :** Main power management sub module.

- **ER :** Redundant power management sub module

Communication module information:

[V1];RL;[Timestamp];[CPU voltage];[Battery voltage];[CPU temperature];[Amplifier temperature];[Flags]

[U2];RL;[Timestamp],[CPU voltage];[Battery voltage];[CPU temperature];[Amplifier temperature];[Flags]

- **V1 :** VHF module

- **U2 :** UHF module

Bit	Name	Description
0	FEC	Forward Error Correction
1	DOWNLINK	Transmission on/off
2	BAND_LOCK	Determines if set frequency need to be from band range
3	XOR	XOR-ing incoming frames
4	AES128	AES128 decoding
5	AMP_OVT	Amplifier over-temperature

Radio modem info:

[V1/U2];MS;[Timestamp];[Current rssi];[Latch rssi];[AFC offset]

- **V1** : VHF module

- **U2** : UHF module

Computing unit infos :

[CU_R/CU_L];LOG;[Timestamp];[CPU voltage];[CPU temperature];[flags]

- **CU_L** : first redundant CU

- **CU_R** : second redundant CU

Bit	Name	Description
0	ONYX ON	Payload enabled
1	LLC ONYX _FAULT	Payload sensor fault
2	LLC SRAM _FAULT	Payload SRAM fault
3	FAULT 1V8 _R	Redundant 1V8 over-current/over-temperature
4	FAULT 1V8 _M	Main 1V8 over-current/over-temperature
5	FAULT 3V3 12V	3V3/12V over-current/over-temperature
6	PIC _READY RAW	Raw picture in MRAM
7	PIC READY CONV	Converted picture in MRAM
8	PIC _READY COMPRESSED	Compressed picture in MRAM
9	PIC READY _COMPRESSED _ 8	Compressed 8-bit picture in MRAM
10	SD PIC WRITE OK	SD write sucessful
11	SD _PIC READ OK	SD read sucessful
12	SD _GET INFO OK	SD info sector read sucessful
13	SD _ERASE OK	SD erase sucessful
14	SD FULL	SD capacity reached
15	ADC READY	ADC measurment ready

AOCS basic info:

A1;FLAGS;[Timestamp];[mode];[flags];[faults]

Magnetometer reading:

A1;MAG;[Current timestamp];[MagX];[MagY];[MagZ];[?]

[?] : undocumented by the manufacturer of the platform.

Gyroscope reading :

A1;GYRO;[Current timestamp];[GyroX];[GyroY];[GyroZ][?][?]

[?] : undocumented by the manufacturer of the platform.

Estimate position of the satellite: (time and orbit based, SGP4 algo)

A1;POSITION;[Current timestamp];[Latitude];[Longitude]

Payload imager temperature :

[CU_R/CU_L];ONYX SENSOR T;[Timestamp];[Return value]

S band Payload downlink

Frequency	2.4153Ghz
Modulation	GFSK 1Mbps/s

The downlinks on this frequency will regularly occur in Russia. If you want to receive yourself a picture and you are not living in Russia, you will need to register on our website to ask for a downlink. When the satellite will be near your location, it will point the s-band antenna to earth and then transmit the pictures at the given timeframe.

Decoding

The first part is the metadata of the picture that will follow. The size of the metadata is 512-byte.

Description	Length [bytes]	Type
Timestamp	4	unsigned
Set point	4 x 4	float
Estimated point	4 x 4	float
Position (latitude, longitude)	2 x 4	float
Gyroscope data	3 x 2	signed
Magnetometer data	3 x 2	signed
Earth Magnetic Model (IGRF)	5 x 2	signed
Sun sensor data	2 x 2	signed
Pixel resolution	2	signed
Compression	2	signed
Picture size	4	unsigned
Sensor gains	5 x 2	unsigned
Exposure time	4	unsigned
Sensor temperature	2	unsigned
Dummy bytes (0xAA)	416	unsigned
CRC	2	unsigned

After the metadata, the picture is sent. There is 3 different kinds of pictures: raw pictures, compressed pictures, and converted pictures.

A converted picture is a raw picture on 8-bits (from 12-bits). A compressed picture is a raw picture with a FPAQ0F2 compression. Compressed 8bits is a-8bits picture compressed with FPAQ0F2.

The UHF downlink gives informations about the kind of picture being transmitted.

Kind of picture	APRS data on UHF downlink
Raw	[cu];SEND;[Timestamp];[Picture number];[S-band channel];OK
Compressed (12bits or 8bits)	[cu];SEND CMP;[Timestamp];[S-band channel];OK
Converted	[cu];SEND CONV;[Timestamp];[S-band channel];OK

[cu] : the computing unit used for the operation (there is two redondant CU, R and L)

A picture packet is as follow :

Preamble : 0xE7E7E7E7E7

packet [32bytes] = packet_number [2-bytes] + data [30-bytes]

If Reed Solomon is enabled (Error correction), a picture packet is as follow :

Preamble : 0xE7E7E7E7E7

packet [32bytes] = packet_number [4-bytes] + data [22-bytes] + RS [22-bytes]

Contributors

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AMSAT-F

Licensing of the received pictures

The pictures received from the satellite are licensed under:

Creative common CC BY-NC-SA 4.0 with mandatory mention of CSUG.

(https://creativecommons.org/licenses/by-nc-sa/4.0/)