URESAT-1 ANTONIO DE NEBRIJA
TRANSMISSIONS DESCRIPTION

This document describes the transmissions of the URESAT-1 Antonio de Nebrija satellite, with ITU designation HADES-B.

Modulations used:

URESAT-1 Antonio de Nebrija uses FSK modulation with 1000 Hz separation between tones, and a speed of 50 bits per second for its telemetry and regenerative digital repeater transmissions. The lowest frequency (mark) represents the value of bit 1, while the highest (space) represents the value of bit 0.

Other modulations used are: FM for the phone repeater (voice), as well as for beacons with pre-recorded voice, CW for greeting messages and Robot 36 for SSTV transmissions.

Transmission Types:

14 types of transmissions are carried out, 13 being originated in the satellite and 1 on Earth:

- Packet type 01: SAT-EARTH FSK Power Telemetry (power)
- Packet type 02: SAT-EARTH FSK Temp Telemetry (temperature)
- Packet Type 03: SAT-EARTH FSK Status Telemetry (satellite status)
- Packet Type 04: SAT-GROUND FSK Power stats Telemetry
- Packet Type 05: SAT-GROUND FSK Temp stats Telemetry
- Packet Type 06: SAT-EARTH FSK Sunvector Telemetry (light sensor data)
- Packet Type 07: SAT-GROUND FSK Radiometer telemetry (radiometer data)
- Packet Type 08: SAT-EARTH FSK Deploy Telemetry (antenna deployment data)
- Packet Type 09: SAT-GROUND FSK Extended Power stats Telemetry
- Packet type 10: GROUND-SAT FSK transmission to send chess moves to the satellite
- Packet Type 11: SAT-EARTH FSK Chessboard telemetry (chess game status)
- CW SAT-EARTH beacon (messages with greetings in Morse, call sign AO4URE)
- Digitized voice on FM SAT-EARTH (messages with telephone greeting, callsign AO4URE)
- SSTV Robot 36 SAT-EARTH (live and pre-recorded images, callsign AM4URE)

FSK packets (all sent at 50 bps) are distinguished from each other by the type field.

Apart from these satellite-generated transmissions (except the type 10 package), three types of retransmissions are available as a service for ground station users:

- FM voice broadcasts (Mode 1)
- FSK / AFSK data retransmissions up to 2400 bps (AX.25, APRS…) (Also included in Mode 1)
- FSK regenerated data retransmissions at 50 bits per second (Mode 2)

Frequencies and work modes

Frequencies are as follows:

URESAT-1

- 145.975/145.925 MHz (aux) uplink, Modes: FM voice (no subtone) and FSK 50 bps, AFSK, AX.25, APRS 1200 / 2400 bps
- 436.888 MHz downlink, Modes: FM voice , CW, FSK 50 bps, SSTV Robot 36 with callsign AM4SAT, FM voice beacon with callsign AO4URE

If the satellite is in FM voice/FSK data repeater mode (mode 1), it is activated by level without the need for a subtone.

For the specific case of the FSK packet regenerative repeater (Mode 2 transponder), when it is active, the received signals are sampled 100 times per second, being digitally restored and sent to the transmission module.

After the launch, by default, URESAT-1 is in mode 0 (transponder deactivated), requiring its activation by remote control.

The satellite also has a limited Storage and Forwarding capacity (byte by byte), conceptually implemented and managed solely through remote commands.

Transmissions format

The format of each broadcast is as follows:

CW beacon

The CW beacon is transmitted every 5-6 minutes, rotating among several available messages, and with format:

VVV DE AO4URE MESSAGE

The greeting and thank you messages are both in Spanish and English.

*The CW beacon, as well as other transmissions, may not be generated if the satellite is in a low power state.

FSK packets

The FSK packets generated on the satellite can be of ten types: Power (power), Temp (temperature), Status (satellite status), Power stats (power statistics), Temp stats (temperature statistics), Sunvector (sensor data). light), Radiometer (radiometer data), Deploy (antenna deployment data), Extended Power stats (extended power data) and Chess board (chess game status).

Each of them is generated at the time of its transmission and its bytes are sent in 'MSB first' format (most significant bit first).

Encoding (scrambling) of data packets

A scrambling process is carried out on all FSK packets. The only fields that are not encoded are the training sequence itself , the synchronization field, the packet type (fields 1, 2 and 3 in all packets) and the CRC, which is placed at the end.

The encoding and decoding algorithms are based on a multiplicative scrambler. The implementation of itself is defined by the following polynomial: G(x)=x^17+x^12+1. Figures 1 and 2 show the multiplicative encoder and decoder respectively.

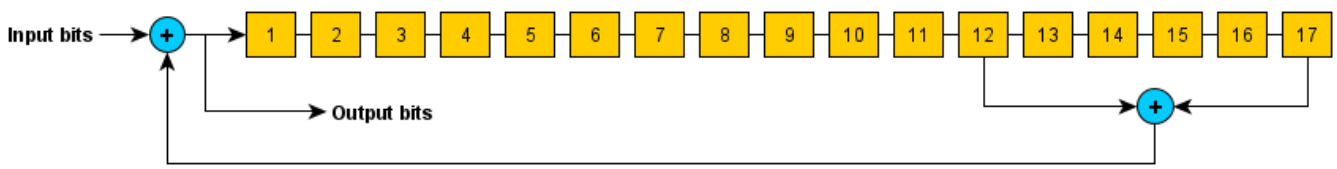

Figure 1. Shift register implementation for the multiplicative encoder.

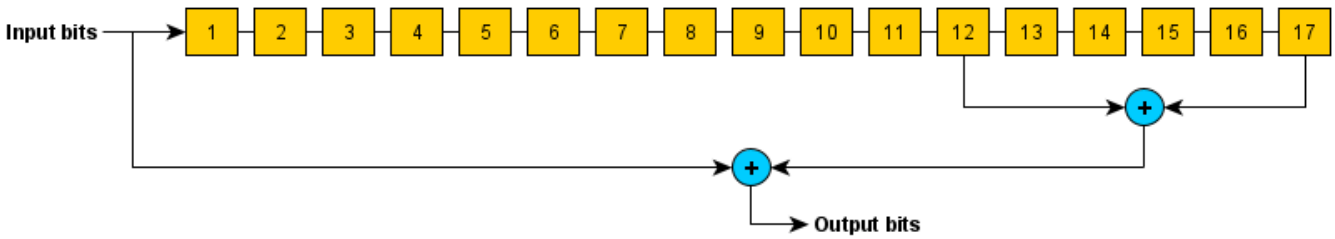

Figure 2. Shift register implementation for the multiplicative decoder.

Although it is not very usual and since not all the fields of the packet are encoded, we initialize the shift registers for e ach received packet. The initial state of the registers (assuming we use a 32-bit variable for the implementation) is 0x2C350000 and we only apply the shift register to the encoded bits.

Example:

Data input (ASCII): "GENESIS-Genesis".
Encoded Data (Hex): 0xC7434C274B1713 D76B05AAD189 9747C8.
Decoded data (ASCII): "GENESIS-Genesis".

CRC calculation

The CRC checksum calculation is done using CRC-CCITT-FALSE. Figure 3 shows the shift register used for the CRC calculation algorithm. The CRC is applied starting with the type field to the end of the data in each packet.

Polynomial: 0x1021.
Initial value: 0xFFFF.
Final Xor value: 0x0.

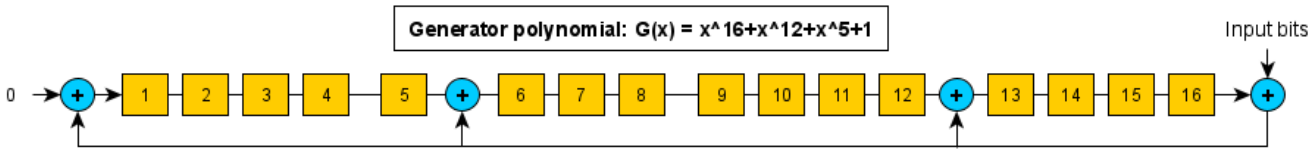

Figure 3. 16-bit shift register CRC-CCITT-FALSE.

Example:

• Input String: "EASAT-2".
• CRC output: 0x7D58.

Packages description

The structure of each package is described below. They all start with a 64-bit training sequence of alternating 1s and 0s, followed by two sync bytes, which allow the receiver to detect the beginning of the packet. The next field will always be the type, which makes it possible to distinguish one from the other, and the source address, which in this case will always be 7, since it is URESAT-1.

The fields are always sent in MSB format first, that is, the most significant bit is the first to be sent (the one furthest t o the left).

FSK packet type 01:

The type 01 packet is sent every 3 minutes, even in low power states. It provides the power data generated as well as the most representative voltages and currents of the satellite.

ID	Bits	FIELD NAME	MU	DESCRIPTION
1	64	**Training**	--	0xAAAAAAAA
2	16	**Sync**	--	0xBF35
3	4	**Type**	--	Packet type: 1
4	4	**Address**	--	Source address: 7 for URESAT
5	8	Spa	mW	SPA (Panel A Power) I2C
6	8	Spb	mW	SPB (Panel B Power) I2C
7	8	Spc	mW	SPC (Panel C Power) I2C
8	8	Spd	mW	SPD (Panel D Power) I2C
9	8	Spe	mW	SPE (Panel E Power) I2C - Sin uso
10	8	Spf	mW	SPF (Panel F Power) I2C - Sin uso
11	12	vbus1	mV	VBUS1 CPU.ADC MPPT Output
12	12	vbat1	mV	VBAT1 EPS.ADC
13	12	Vcpu	mV	VCPU CPU.ADC
14	16	vbus2	mV	VBUS2 EPS.I2C
15	12	vbus3	mV	VBUS3 CPU.I2C
16	12	vbat2	mV	VBAT2 EPS.I2C
17	12	Ibat	mA	IBAT I2C (battery current input/output) I2C
18	12	Icpu	mA	ICPU I2C
19	12	Ipl	mA	IPL (Burn current) I2C, EPS
20	8	powerdul1	dBm	Power detector (main signal)
21	8	powerdul455	dBm	Power detector (IF) – Not used
22	8	Vdac	dBm	VDAC – Not used
23	16	**Checksum**	--	Checksum
utiles	**208**	**Bits**		
	26,00	**Bytes**		
total	**288**	**Bits**		
total	**36**	**Bytes**		
tiempo	**5760**	**Ms**		

FSK Paquet type 02: Temperature

The type 02 packet is also sent every 3 minutes and contains the different temperatures measured in the system. This packet is sent even in low power states.

ID	Bits	VARIABLE	MU	DESCRIPTION
1	64	**Training**	--	0xAAAAAAAA
2	16	**Sync**	--	0xBF35
3	4	**Type**	--	Packet type: 2
4	4	**Address**	--	Source address: 7 for URESAT
5	8	Tpa	oC	TPA (Temperature Panel A) I2C
6	8	Tpb	oC	TPB (Temperature Panel B) I2C

7	8	Tpc	oC	TPC (Temperature Panel C) I2C
8	8	Tpd	oC	TPD (Temperature Panel D) I2C
9	8	Tpe	oC	TPE (Temperature Panel E) I2C - Not used
10	8	Teps	oC	TEPS (Temperature EPS) I2C
11	8	Ttx	oC	TTX (Temperature TX) I2C
12	8	ttx2	oC	TTX2 (Temperature TX) NTC
13	8	Trx	oC	TRX (Temperature RX) NTC
14	8	Tcpu	oC	TCPU (Temperature CPU) ADC
15	16	**Checksum**	--	Checksum
utiles	**104**	**Bits**		
	13,00	**Bytes**		8 bits -> 0.5 grades resolution 0 = -40C , 254 = >=87C 255 = ERROR
total	**184**	**Bits**		
total	**23**	**Bytes**		
tiempo	**3680**	**Ms**		

FSK packet type 03: Status

The type 03 packet contains satellite status information. It is always sent, every 3 minutes, even in low power states.

ID	Bits	VARIABLE	MU	DESCRIPTION
1	64	**Training**	--	0xAAAAAAAA
2	16	**Sync**	--	0xBF35
3	4	**Type**	--	Packet Type: 3
4	4	**Address**	--	Source address: 7 for URESAT
5	32	Sclock	S	Local time on satellite
6	16	Uptime	M	Uptime (minutes)
7	16	Nrun	--	CPU runs
8	8	Npayload	--	Times payload (camera) was activated
9	8	Nwire		Counter of times antenna deployment was tried
10	4	Nbusdrops	--	Counter of bus drops
11	4	Lstrst	--	Last reset reason
12	4	Bate	--	Battery state 0-F (0 fully charged)
13	4	Mote	--	Transponder mode - Mode 0: Off - Mode 1 FM->FM live audiofrequency (voice and FSK not regenerative) - Mode 2 FSK->FSK regenerative
14	8	nTasksNotExecuted	--	Tasks lost by scheduler
15	8	antennaDeployed	--	Antenna deployed: 0 not deployed, 1 deployed, 2 unknown status
16	8	nExtEepromErrors	--	Checksum failures in EEPROM since last check (recoverable)
17	8	failedTaskID	HEX	Id of the last task failed to execute
18	8	mensajeria_habilitada		Messaging enabled yes/no
19	8	strfwd0	HEX	S&F
20	16	strfwd1	HEX	S&F
21	16	strfwd2	HEX	S&F

22	8	strfwd3	HEX	S&F
23	16	**Checksum**	--	Checksum
utiles	**208**	Bits		
	26,00	Bytes		
total	**288**	Bits		
total	**36**	Bytes		
tiempo	**5760**	Ms		

FSK Packet 04: Power stats

Packet type 04 contains power statistics, collected since the last reset of the satellite.

ID	Bits	FIELD NAME	MU	DESCRIPTION
1	64	**Training**	--	0xAAAAAAAA
2	16	**Sync**	--	0xBF35
3	4	**Type**	--	Packet type: 4
4	4	**Address**	--	Source address: 7 for URESAT
6	12	minvbus1	mV	MIN VBUS1 CPU.ADC MPPT
7	12	minvbat1	mV	MIN VBAT1 EPS.ADC
8	12	Minvcpu	mV	MIN VCPU CPU.ADC
9	16	minvbus2	mV	MIN VBUS2 EPS.I2C
10	12	minvbus3	mV	MIN VBUS3 CPU.I2C
11	12	minvbat2	mV	MIN VBAT2 EPS.I2C
12	12	Minibat	mV	MIN IBAT I2C
13	12	Minicpu	mV	MIN ICPU I2C
14	12	Minipl	mV	MIN IPL
15	8	minpowerdul1	dBm	MIN DUL1
16	8	minpowerdul455	dBm	MIN DUL455
17	8	Minvdac		MIN VDAC – Not used
24	12	maxvbus1	mV	MAX VBUS1 CPU.ADC MPPT
25	12	maxvbat1	mV	MAX VBAT1 EPS.ADC
26	12	Maxvcpu	mV	MAX VCPU CPU.ADC
27	16	maxvbus2	mV	MAX VBUS2 EPS.I2C
28	12	maxvbus3	mV	MAX VBUS3 CPU.I2C
29	12	maxvbat2	mV	MAX VBAT2 EPS.I2C
30	12	Maxibat	mV	MAX IBAT I2C
31	12	Maxicpu	mV	MAX ICPU I2C
32	12	Maxipl	mV	MAX IPL
33	8	maxpowerdul1	dBm	MAX DUL1
34	8	maxpowerdul455	dBm	MAX DUL455
35	8	Maxvdac		MAX VDAC – Not used
42	12	medvbus1	mV	MED VBUS1 CPU.ADC MPPT
43	12	medvbat1	mV	MED VBAT1 EPS.ADC
44	12	Medvcpu	mV	MED VCPU CPU.ADC
45	16	medvbus2	mV	MED VBUS2 EPS.I2C
46	12	medvbus3	mV	MED VBUS3 CPU.I2C

47	12	medvbat2	mV	MED VBAT2 EPS.I2C
48	12	Medibat	mV	MED IBAT I2C
49	12	Medicpu	mV	MED ICPU I2C
50	12	Medipl	mV	MED IPL
51	8	medpowerdul1	dBm	MED DUL1
52	8	medpowerdul455	dBm	MED DUL455
53	8	Medvdac		MAX VDAC – Not used
54	16	**checksum**	--	Checksum
utiles	**432**	**Bits**		
	54,00	**Bytes**		
total	**512**	**Bits**		
total	**64**	**Bytes**		
tiempo	**10240**	**Ms**		

FSK Packet type 05: Temp stats

Packet type 5 contains temperature statistics since the last reset of the satellite.

ID	Bits	VARIABLE	MU	DESCRIPTION
1	64	**Training**	--	0xAAAAAAAA
2	16	**Sync**	--	0xBF35
3	4	**Type**	--	Packet type: 5
4	4	**Address**	--	Source address: 7 para URESAT
6	8	Mintpa	oC	MIN TPA (Temperature Panel A) I2C
7	8	Mintpb	oC	MIN TPB (Temperature Panel B) I2C
8	8	Mintpc	oC	MIN TPC (Temperature Panel C) I2C
9	8	Mintpd	oC	MIN TPD (Temperature Panel D) I2C
10	8	Mintpe	oC	MIN TPE (TemperaturaePanel D) I2C - Not used
11	8	Minteps	oC	MIN TEPS (Temperature EPS)
12	8	Minttx	oC	MIN TTX (Temperature TX) I2C
13	8	minttx2	oC	MIN TTX2 (Temperature TX) NTC
14	8	Mintrx	oC	MIN TRX (Temperature RX) NTC
15	8	Mintcpu	oC	MIN TCPU (Temperature CPU) ADC
16	8	Maxtpa	oC	MAX TPA (Temperature Panel A) I2C
17	8	Maxtpb	oC	MAX TPB (Temperature Panel B) I2C
18	8	Maxtpc	oC	MAX TPC (Temperature Panel C) I2C
19	8	Maxtpd	oC	MAX TPD (Temperature Panel D) I2C
20	8	Maxtpe	oC	MAX TPE (Temperature Panel D) I2C - Not used
21	8	Maxteps	oC	MAX TEPS (Temperature EPS)
22	8	Maxttx	oC	MAX TTX (Temperature TX) I2C
23	8	maxttx2	oC	MAX TTX2 (Temperature TX) NTC
24	8	Maxtrx	oC	MAX TRX (Temperature RX) NTC
25	8	Maxtcpu	oC	MAX TCPU (Temperature CPU) ADC
26	8	Medtpa	oC	MED TPA (Temperature Panel A) I2C
27	8	Medtpb	oC	MED TPB (Temperature Panel B) I2C
28	8	Medtpc	oC	MED TPC (Temperature Panel C) I2C

29	8	Medtpd	oC	MED TPD (Temperature Panel D) I2C
30	8	Medtpe	oC	MED TPE (Temperature Panel D) I2C - Not used
31	8	Medteps	oC	MED TEPS (Temperature EPS)
32	8	Medttx	oC	MED TTX (Temperature TX) I2C
33	8	medttx2	oC	MED TTX2 (Temperature TX) NTC
34	8	Medtrx	oC	MED TRX (Temperature RX) NTC
35	8	Medtcpu	oC	MED TCPU (Temperature CPU) ADC
36	16	**checksum**	--	Checksum
utiles	**264**	Bits		
	33,00	Bytes		
total	**344**	Bits		
total	**43**	Bytes		
tiempo	**6880**	Ms		

FSK Packet type 06: Sunsensors

The Type 6 package contains samples of the light sensors. This is an initial experiment to be used in a future orientation control.

ID	**bits**	**VARIABLE**		**DESCRIPTION**
1	64	**Training**	--	0xAAAAAAAA
2	16	**Sync**	--	0xBF35
3	4	**Type**	--	Packet type: 6
4	4	**Address**	--	Source address: 7 for URESAT
5	96	td[6]	S	Table of difference in seconds for samples (possible values 1,2,4,8,16,32,64,128)
6	768	v - valores luz[8][6]		Table for detections (SPA, SPB, SPC, SPD, 90A, 90D), v - valores luz[8][6] - 16 bits
7	128	p - valores pico[8] - 16 bits		Table for peak values (SPA, SPB, SPC, SPD, 90A, 90D), p - valores pico[8] -16 bits
8	64	err sensor en error[8]		Table for sensor status (ok of error), err sensor en error[8] (1 error, 0 ok) - 8 bits
78	16	**checksum**	--	Checksum
utiles	**1080**	**Bits**		
	135,00	**Bytes**		
total	**1160**	**Bits**		
total	**145**	**Bytes**		
tiempo	**23200**	**Ms**		

FSK packet type 07: Radiometer

The type 7 packet contains data from the radiometer. Each sample is an average of the last minute, transmitting the information of the last 60 minutes.

ID	**bits**	**VARIABLE**		**DESCRIPTION**
1	64	**Training**	--	0xAAAAAAAA
2	16	**Sync**	--	0xBF35
3	4	**Type**	--	Packet type: 7
4	4	**Address**	--	Source address: 7 for URESAT

5	32	Sclock	S	Clock in seconds for sample 0
6	8	rad0	--	Signal level in minute 0 (menos actual)
7	8	rad1	--	Signal level in minute 1
8	8	rad2	--	Signal level in minute 2
9	8	rad3	--	Signal level in minute 3
10	8	rad4	--	Signal level in minute 4
11	8	rad5	--	Signal level in minute 5
12	8	rad6	--	Signal level in minute 6
13	8	rad7	--	Signal level in minute 7
14	8	rad8	--	Signal level in minute 8
15	8	rad9	--	Signal level in minute 9
16	8	rad10	--	Signal level in minute 10
17	8	rad11	--	Signal level in minute 11
18	8	rad12	--	Signal level in minute 12
19	8	rad13	--	Signal level in minute 13
20	8	rad14	--	Signal level in minute 14
21	8	rad15	--	Signal level in minute 15
22	8	rad16	--	Signal level in minute 16
23	8	rad17	--	Signal level in minute 17
24	8	rad18	--	Signal level in minute 18
25	8	rad19	--	Signal level in minute 19
26	8	rad20	--	Signal level in minute 20
27	8	rad21	--	Signal level in minute 21
28	8	rad22	--	Signal level in minute 22
29	8	rad23	--	Signal level in minute 23
30	8	rad24	--	Signal level in minute 24
31	8	rad25	--	Signal level in minute 25
32	8	rad26	--	Signal level in minute 26
33	8	rad27	--	Signal level in minute 27
34	8	rad28	--	Signal level in minute 28
35	8	rad29	--	Signal level in minute 29
36	8	rad30	--	Signal level in minute 30
37	8	rad31	--	Signal level in minute 31
38	8	rad32	--	Signal level in minute 32
39	8	rad33	--	Signal level in minute 33
40	8	rad34	--	Signal level in minute 34
41	8	rad35	--	Signal level in minute 35
42	8	rad36	--	Signal level in minute 36
43	8	rad37	--	Signal level in minute 37
44	8	rad38	--	Signal level in minute 38
45	8	rad39	--	Signal level in minute 39
46	8	rad40	--	Signal level in minute 40
47	8	rad41	--	Signal level in minute 41
48	8	rad42	--	Signal level in minute 42
49	8	rad43	--	Signal level in minute 43

50	8	rad44	--	Signal level in minute 44
51	8	rad45	--	Signal level in minute 45
52	8	rad46	--	Signal level in minute 46
53	8	rad47	--	Signal level in minute 47
54	8	rad48	--	Signal level in minute 48
55	8	rad49	--	Signal level in minute 49
56	8	rad50	--	Signal level in minute 50
57	8	rad51	--	Signal level in minute 51
58	8	rad52	--	Signal level in minute 52
59	8	rad53	--	Signal level in minute 53
60	8	rad54	--	Signal level in minute 54
61	8	rad55	--	Signal level in minute 55
62	8	rad56	--	Signal level in minute 56
63	8	rad57	--	Signal level in minute 57
64	8	rad58	--	Signal level in minute 58
65	8	rad59	--	Signal level in minute 59
66	16	**Checksum**	--	Checksum
utiles	**536**	**Bits**		
	67,00	**Bytes**		
total	**616**	**Bits**		
total	**77**	**Bytes**		
tiempo	**12320**	**Ms**		

Paquete FSK tipo 08: Deploy

The type 8 packet contains information about the system parameters during the last deployment of the antenna.

ID	Bits	VARIABLE		DESCRIPTION
1	64	**Training**	--	0xAAAAAAAA
2	16	**Sync**	--	0xBF35
3	4	**Type**	--	Packet type: 8
4	4	**Address**	--	Source address: 7 for URESAT
5	16	v1oc		v1oc; // read with INA-PL side
6	16	v1		v1
7	16	i1		i1
8	16	i1pk		i1pk
9	16	r1		r1
10	16	v2oc		v2oc; //read with INA-BUS side
11	16	v2		v2
12	16	r2		r2
13	32	t0		t0
14	16	Td		Td
15	4	state_begin:1;		state_begin:1;
16	2	state_end:1;		state_end:1;
17	1	state_now:1;		state_now:1;
18	1	enable:1;		enable:1;

19	8	Counter		counter;
20	8	Tmp		tmp; // System temperature
26	16	**checksum**		Checksum
utiles	**224**	**Bits**		
	28,00	**Bytes**		
total	**304**	**Bits**		
total	**38**	**Bytes**		
tiempo	**6080**	**Ms**		

FSK packet type 09: Extended power stats (INA)

The type 9 packet contains extended information about power statistics in the system.

ID	bits	NOMBRE CAMPO	MU	DESCRIPTION
1	64	**Training**	--	0xAAAAAAAA
2	16	**Sync**	--	0xBF35
3	4	**Type**	--	Packet type: 9
4	4	**Address**	--	Source address: 7 for URESAT
5	16	v0	raw	SPA V Instant Voltage
6	16	i0	raw	SPA I Instant current
7	16	p0	raw	SPA P Average power
8	16	vp0	raw	SPA VP Peak voltage
9	16	ip0	raw	SPA IP Peak current
10	16	pp0	raw	SPA PP Peak power
11	16	v1	raw	SPB V Instant Voltage
12	16	i1	raw	SPB I Instant current
13	16	p1	raw	SPB P Average power
14	16	vp1	raw	SPB VP Peak voltage
15	16	ip1	raw	SPB IP Peak current
16	16	pp1	raw	SPB PP Peak power
17	16	v2	raw	SPC V Instant Voltage
18	16	i2	raw	SPC I Instant current
19	16	p2	raw	SPC P Average power
20	16	vp2	raw	SPC VP Peak voltage
21	16	ip2	raw	SPC IP Peak current
22	16	pp2	raw	SPC PP Peak power
23	16	v3	raw	SPD V Instant Voltage
24	16	i3	raw	SPD I Instant current
25	16	p3	raw	SPD P Average power
26	16	vp3	raw	SPD VP Peak voltage
27	16	Ip	raw	SPD IP Peak current
28	16	pp3	raw	SPD PP Peak power
29	16	v4	raw	SUN V Instant Voltage
30	16	i4	raw	SUN I Instant current
31	16	p4	raw	SUN P Average power

32	16	vp4	raw	SUN VP Peak voltage
33	16	ip4	raw	SUN IP Peak current
34	16	pp4	raw	SUN PP Peak power
35	16	v5	raw	BAT V Instant Voltage
36	16	i5	raw	BAT I Instant current
37	16	p5	raw	BAT P Average power
38	16	vp5	raw	BAT VP Peak voltage
39	16	ip5	raw	BAT IP Peak current
40	16	pp5	raw	BAT PP Peak power
41	16	v6	raw	BATP V Instant Voltage
42	16	i6	raw	BATP I Instant current
43	16	p6	raw	BATP P Average power
44	16	vp6	raw	BATP VP Peak voltage
45	16	ip6	raw	BATP IP Peak current
46	16	pp6	raw	BATP PP Peak power
47	16	v7	raw	BATN V Instant Voltage
48	16	i7	raw	BATN I Instant current
49	16	p7	raw	BATN P Average power
50	16	vp7	raw	BATN VP Peak voltage
51	16	ip7	raw	BATN IP Peak current
52	16	pp7	raw	BATN PP Peak power
53	16	v8	raw	CPU V Instant Voltage
54	16	i8	raw	CPU I Instant current
55	16	p8	raw	CPU P Average power
56	16	vp8	raw	CPU VP Peak voltage
57	16	ip8	raw	CPU IP Peak current
58	16	pp8	Raw	CPU PP Peak power
59	16	v9	Raw	PL V Instant Voltage
60	16	i9	Raw	PL I Instant current
61	16	p9	Raw	PL P Average power
62	16	vp9	Raw	PL VP Peak voltage
63	16	ip9	Raw	PL IP Peak current
64	16	pp9	Raw	PL PP Peak power
54	16	**Checksum**	--	Checksum
utiles	**984**	**Bits**		
	123,00	**Bytes**		
total	**1064**	**Bits**		
total	**133**	**Bytes**		
tiempo	**21280**	**Ms**		

FSK packet type 10:

This packet makes it possible to send a chess move from Earth to the satellite, which will reply with the new layout of the board and, seconds later, with its own response move.

ID	bits	NOMBRE CAMPO		DESCRIPTION
1	64	**Training**	--	0xAAAAAAAA
2	16	**Sync**	--	0xBF35
3	4	**Type**	--	Packet type: 10
4	4	**address**	--	Destination address: 7 para URESAT
5	48	**callsign**	--	Callsign playing
6	8	Source	--	Source square (Column and row, like c2) a = 0, b = 1, c = 2, d = 3, e =4, f =5, g=6 h =7 c2c4 = 0x22
7	8	destination	--	Destination square (Column and row, like c4) a = 0, b = 1, c = 2, d = 3, e =4, f =5, g=6 h =7 p ej c4 = 0x24
8	16	**checksum**	--	Checksum
utiles	**88**	Bits		
	11,0	Bytes		
total	**168**	Bits		
total	**21**	**Bytes**		
tiempo	**3360**	Ms		

FSK Packet type 11: Chess board

Package type 11 contains the chessboard layout of the current game with the satellite.

ID	bits	NOMBRE CAMPO		DESCRIPTION
1	64	**training**	--	0xAAAAAAAA
2	16	**Sync**	--	0xBF35
3	4	**Type**	--	Packet type: 11
4	4	**Address**	--	Source address: 7 for URESAT
5	48	**Callsign**	--	Callsign of last move
5	8	player_color		Player colour (0 white, 1 black)
6	16	last_move	--	Last move (Column and row, like c2c4) a = 0, b = 1, c = 2, d = 3, e =4, f =5, g=6 h =7 c2c4 = 0x2224
7	8	game_status	--	0 waiting for game to start 1 waiting for move from player 2 thinking 3 invalid move - waiting for move from player

8	4	chessa8	--	Piece on square a8 (same for other squares): 0x00 EMPTY 0x01 WHITE_PAWN 0x02 WHITE_ROOK 0x03 WHITE_HORSE 0x04 WHITE_BISHOP 0x05 WHITE_QUEEN 0x06 WHITE_KING 0x07 BLACK_PAWN 0x08 BLACK_ROOK 0x09 BLACK_HORSE 0x0A BLACK_BISHOP 0x0B BLACK_QUEEN 0x0C BLACK_KING
9	4	chessb8	--	Piece on square b8
10	4	chessc8	--	Piece on square c8
11	4	chessd8	--	Piece on square d8
12	4	chesse8	--	Piece on square e8
13	4	chessf8	--	Piece on square f8
14	4	chessg8	--	Piece on square g8
15	4	chessh8	--	Piece on square h8
16	4	chessa7	--	Piece on square a7
17	4	chessb7	--	Piece on square b7
18	4	chessc7	--	Piece on square c7
19	4	chessd7	--	Piece on square d7
20	4	chesse7	--	Piece on square e7
21	4	chessf7	--	Piece on square f7
22	4	chessg7	--	Piece on square g7
23	4	chessh7	--	Piece on square h7
24	4	chessa6	--	Piece on square a6
25	4	chessb6	--	Piece on square b6
26	4	chessc6	--	Piece on square c6
27	4	chessd6	--	Piece on square d6
28	4	chesse6	--	Piece on square e6
29	4	chessf6	--	Piece on square f6
30	4	chessg6	--	Piece on square g6
31	4	chessh6	--	Piece on square h6
32	4	chessa5	--	Piece on square a5
33	4	chessb5	--	Piece on square b5
34	4	chessc5	--	Piece on square c5
35	4	chessd5	--	Piece on square d5
36	4	chesse5	--	Piece on square e5
37	4	chessf5	--	Piece on square f5
38	4	chessg5	--	Piece on square g5

39	4	chessh5	--	Piece on square h5
40	4	chessa4		Piece on square a4
41	4	chessb4		Piece on square b4
42	4	chessc4		Piece on square c4
43	4	chessd4		Piece on square d4
44	4	chesse4		Piece on square e4
45	4	chessf4		Piece on square f4
46	4	chessg4		Piece on square g4
47	4	chessh4		Piece on square h4
48	4	chessa3		Piece on square a3
49	4	chessb3		Piece on square b3
50	4	chessc3		Piece on square c3
51	4	chessd3		Piece on square d3
52	4	chesse3		Piece on square e3
53	4	chessf3		Piece on square f3
54	4	chessg3		Piece on square g3
55	4	chessh3		Piece on square h3
56	4	chessa2		Piece on square a2
57	4	chessb2		Piece on square b2
58	4	chessc2		Piece on square c2
59	4	chessd2		Piece on square d2
60	4	chesse2		Piece on square e2
61	4	chessf2		Piece on square f2
62	4	chessg2		Piece on square g2
63	4	chessh2		Piece on square h2
64	4	chessa1		Piece on square a1
65	4	chessb1		Piece on square b1
66	4	chessc1		Piece on square c1
67	4	chessd1		Piece on square d1
68	4	chesse1		Piece on square e1
69	4	chessf1		Piece on square f1
70	4	chessg1		Piece on square g1
71	4	chessh1		Piece on square h1
72	16	**checksum**	--	Checksum
utiles	**360**	Bits		
	45,0	Bytes		
total	**440**	Bits		
	55,0	Bytes		
tiempo	**8800**	Ms		

Timing pattern of FSK telemetry, CW, SSTV and transponder

The transmissions follow a cyclical pattern of 12 minutes. At the start of every minute a status, power or temp packet is always sent under any circumstances. In the 30th second, if the squelch level that activates the transponder has not been broken before (it can be activated just after each transmission), a voice beacon transmission (voice), of morse (CW), a package with the chessboard and so on.

Chess board/SSTV indicates that the first time chessboard is transmitted, and in the next cycle (after 12 minutes) SSTV. Same for sunvector/radiometer.

MIN	TLM (sec 0)	REPEATER	TLM (sec 30)	REPEATER
0	STATUS	RX>TX	VOICE	RX>TX
1	POWER	RX>TX	CW	RX>TX
2	TEMP	RX>TX	CHESS BOARD/SSTV	RX>TX
3	STATUS	RX>TX	POWER STATS	RX>TX
4	POWER	RX>TX	TEMP STATS	RX>TX
5	TEMP	RX>TX	DEPLOY	RX>TX
6	STATUS	RX>TX	VOICE	RX>TX
7	POWER	RX>TX	CW	RX>TX
8	TEMP	RX>TX	CHESS BOARD	RX>TX
9	STATUS	RX>TX	SUNVECTOR/RADIOMETER	RX>TX
10	POWER	RX>TX	EXT POWER STATS	RX>TX
11	TEMP	RX>TX	AUX	RX>TX
goto_1				

Transponder operation

The transponder is turned off after the launch, and must be activated by remote control. Once active, it can be used immediately after any transmission. If it is activated after a status, power or temp transmission, it will continue to be active until the end of the minute. The status, power and temp packets always cut the transponder.

Other packets, as well as voice, CW and SSTV beacons are not transmitted if the transponder is in use.

The transponder works by level without the need for subtones.

More information

More information, updates and implementation of the ground station can be found on the AMSAT EA website, in the projects section: https://www.amsat-ea.org/proyectos/

QSL's

Telemetry reception will be rewarded with a printed QSL. Please send your reports to: genesis@amsat-ea.org or by postal mail:

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