



HADES-SA SPINNYONE TRANSMISSIONS DESCRIPTION

This document describes the transmissions of the HADES-SA SpinnyONE satellite, which will fly on SpaceX's Transporter-16 mission.

HADES-SA SpinnyONE is a digital satellite that incorporates a message and voice CODEC2 BBS as well as a hardware payload developed by Spinning Around (United Kingdom), consisting of an SSDV digital camera.

Modulations used:

For transmissions from the satellite, FSK modulation is used with a separation of 1600 Hz between tones when the rate is 800 bps and 1125 Hz when the rate is 200 bps. The speed can be modified by telecommand up to 1600 bps. The lower frequency (mark) represents bit value 1, while the higher frequency (space) represents bit value 0. The occupied bandwidth is only 3.6 kHz.

The satellite is programmed to use 800 bps during the first 3 months and then alternate each month between 800 bps and 200 bps.

Types of transmissions:

These are the types of transmissions performed from the satellite:

- Type 01 packet: SAT-TO-EARTH FSK Telemetry Power
- Type 02 packet: SAT-TO-EARTH FSK Telemetry Temp (temperature)
- Type 03 packet: SAT-TO-EARTH FSK Telemetry Status (satellite status)
- Type 04 packet: SAT-TO-EARTH FSK Telemetry Power ranges
- Type 05 packet: SAT-TO-EARTH FSK Telemetry Temp ranges
- Type 06 packet: Not used
- Type 07 packet: Not used
- Type 08 packet: SAT-TO-EARTH FSK Telemetry Deploy (antenna deployment data)
- Type 09 packet: SAT-TO-EARTH FSK Telemetry Extended Power stats
- Type 10 packet: SAT-TO-EARTH SSDV (FSK)
- Type 11 packet: SAT-TO-EARTH CODEC2 (FSK)
- Type 12 packet: SAT-TO-EARTH FSK Telemetry Ephemerides
- Type 13 packet: SAT-TO-EARTH FSK Telemetry PN9 random data (link quality)
- Type 14 packet: SAT-TO-EARTH FSK Telemetry Time series
- Type 15 packet: SAT-TO-EARTH FSK Telemetry BBS data

The FSK packets (all initially at 800 bps) are distinguished from each other by the **type** field.

Operating frequencies and modes

The operating frequencies are as follows:

HADES-SA (SpinnyONE):

- ✓ 145.875 MHz, uplink, modes: FSK 200 bps
- ✓ 436.875 MHz, downlink, modes: FSK 200 bps – 1600 bps

Transmission format

The format of each transmission is as follows:

FSK Packets

The FSK packets generated on the satellite can be of the types indicated above. Each of them is generated at the time of transmission, and their bytes are sent in **MSB-first** format (most significant bit first).

Data packet encoding (scrambling)

A scrambling process is applied to all FSK packets. The only fields that are not scrambled are the training sequence itself, the synchronization field, the packet type (fields 1, 2, and 3 in all packets), and the CRC, which is located at the end. The encoding and decoding algorithms are based on a **multiplicative scrambler**. Its implementation is defined by the following polynomial:

$$G(x) = x^{17} + x^{12} + 1.$$

Figures 1 and 2 show the multiplicative encoder and decoder, respectively.

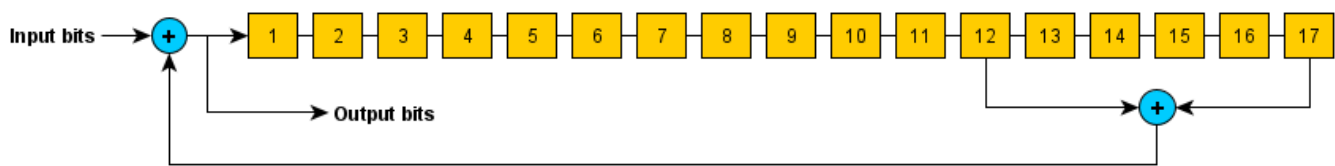


Figure 1. Shift register implementation for the multiplicative encoder

Figura 2. Implementación del registro de desplazamiento para el decodificador multiplicativo.

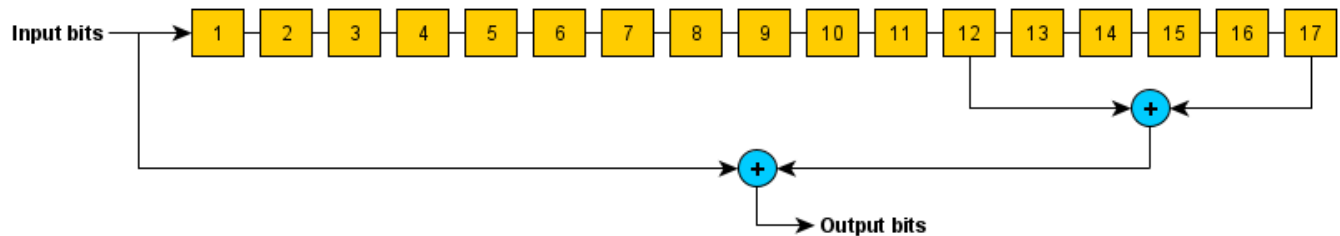


Figure 2. Shift register implementation for the multiplicative decoder.

Although it is not very common, and because not all packet fields are scrambled, we initialize the shift registers for each received packet. The initial state of the registers (assuming a 32-bit variable is used for the implementation) is **0x2C350000**, and the shift register is applied only to the scrambled bits.

Example:

Data input (ASCII): "GENESIS-Genesis".

Encoded data (Hex): 0xC7434C274B1713 D76B05AAD189 9747C8.

Decoded data (ASCII): "GENESIS-Genesis".

CRC Calculation

The checksum is calculated using **CRC-CCITT-FALSE**. Figure 3 shows the shift register used for the CRC calculation algorithm. The CRC is applied starting from the **type** field through to the end of each packet's data.

- Polynomial: 0x1021
- Initial value: 0xFFFF
- Final XOR value: 0x0

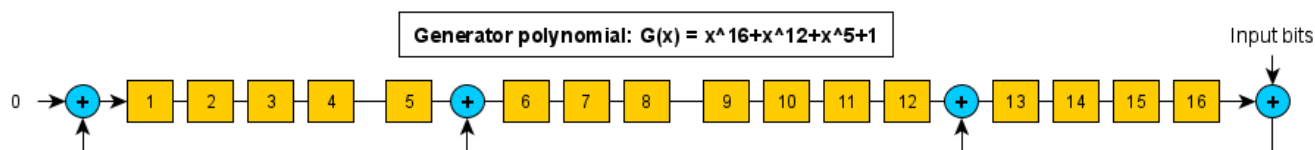


Figure 3. 16-bit CRC-CCITT-FALSE shift register

Example:

- Input string: “EASAT-2”.
- CRC output: 0x7D58.

NOTE: The CRC and Scrambler source code is available on the website.”

FSK Packet Description

The structure of each packet is described below. All packets begin with a **128-bit training sequence** that alternates ones and zeros, followed by **two synchronization bytes**, which allow the receiver to detect the start of the packet. The next field is always **size**, which indicates how many bytes follow, followed by **type**, which allows distinguishing one packet from another. The **source address** in this case is 3 (HADES-SA/SpinnyONE satellite).

Fields are always transmitted in **MSB-first** format, meaning the **most significant bit is sent first** (the leftmost bit).

FSK Packet Type 01:

Type 01 provides data on the generated power, as well as the satellite’s most representative voltages and currents. It is transmitted even when the satellite has low power.

ID	bits	FIELD NAME	MU	DESCRIPTION
1	128	training	--	0xAAAAAAAA
2	16	sync	--	0xBF35
3	8	size	31,00	Data length (including CRC bytes)
4	4	type	--	Packet Type: 1
5	4	address	--	Source Address: 3 for HADES-SA
6	32	sclock	s	System clock at time of tx
7	8	spa	mW	SPA (Panel A Power) I2C Max 3 last minutes power
8	8	spb	mW	SPB (Panel B Power) I2C Max 3 last minutes power
9	8	spc	mW	SPC (Panel C Power) I2C Max 3 last minutes power
10	8	spd	mW	SPD (panel D Power) I2C Max 3 last minutes power
11	16	spi	mW	SPI Total instant power (SPA+SPB+SPC+SPD)
12	12	vbus1	mV	VBUS1 CPU.ADC MPPT Out
13	12	vbat1	mV	VBAT1 EPS.ADC BAT
14	12	vcpu	mV	VCPU CPU.ADC
15	16	vbus2	mV	VBUS2 EPS.I2C (VBUS in EPS board)
16	12	vbus3	mV	VBUS3 CPU.I2C (VBUS in CPU board) I2C
17	12	vbat2	mV	VBAT2 EPS.I2C EPS.I2C
18	12	ibat	mA	IBAT I2C
19	12	icpu	mA	ICPU I2C
20	12	ipl	mA	IPL (Payload current. Last different from 0) I2C, EPS board
21	8	peaksignal	dBm	1 LSB=0.5dB

22	8	modasignal	dBm	Noise level 1 LSB=0.5dB
23	8	lastcmdsignal	dB	1 LSB=0.5dB
24	8	lastcmdnoise	dB	1 LSB=0.5dB
25	16	checksum	--	Checksum
useful	248	bits		
	31,00	bytes		
total	400	bits		Scrambled fields begin after type/address. NOTA: Se scramblea desde después de address hasta último campo sin incluir checksum
total	50	bytes		Checksum includes type/address
time	500	ms		

FSK Packet Type 02: Temperatures

Type 02 contains the different temperatures measured in the system. This packet is transmitted even in low-power states.

ID	bits	VARIABLE	MU	DESCRIPTION
1	128	training	--	0xAAAAAAAA
2	16	sync	--	0xBF35
3	8	size	17,00	Data length (including CRC bytes)
4	4	type	--	Packet Type: 2
5	4	address	--	Source Address: 3 for HADES-SA
6	32	sclock	S	System clock at time of tx
7	8	tpa	oC	TPA (Temperature Panel A) I2C
8	8	tpb	oC	TPB (Temperature Panel B) I2C
9	8	tpc	oC	TPC (Temperature Panel C) I2C
10	8	tpd	oC	TPD (Temperature Panel D) I2C
11	8	tpc	oC	TPE (Temperature Panel E) I2C - Not used
12	8	teps	oC	TEPS (Temperature EPS) I2C
13	8	ttx	oC	TTX (Temperature TX) I2C
14	8	ttx2	oC	TTX2 (Temperature TX) NTC
15	8	trx	oC	TRX (Temperature RX) NTC
16	8	tcpu	oC	TCPU (Temperature CPU) ADC
17	16	checksum	--	Checksum
useful	136	bits		
	17,00	bytes		8 bits -> 0.5 degrees each value starting 0 = <=-40C and 254 = >=87C 255 = ERROR
total	288	bits		
total	36	bytes		
time	360	ms		

FSK Packet Type 03: Status

Type 03 contains satellite status information. It is always transmitted, even in low-power states.

ID	bits	VARIABLE	MU	DESCRIPTION
1	128	training	--	0xAAAAAAAA
2	16	sync	--	0xBF35
3	8	size	41,00	Data length (including CRC bytes)
4	4	type	--	Packet Type: 3
5	4	address	--	Source Address: 3 for HADES-SA
6	32	sclock	s	Local time at satellite (seconds since deployment)
7	32	uptime	s	uptime in seconds
8	16	nrun	--	Number of CPU starts
9	8	npayload	--	Number of payload starts
10	8	nwire	--	Number of deployments attempts
11	8	ntransponder	--	Not used
12	4	npayloadFails	--	Number of errors communicating with payload
13	4	lstrst	--	Last reset cause
14	4	bate	--	maquina estados bateria 0-6
15	4	mote	--	Not used
16	8	systems_status		subsystems status
17	8	nTasksNotExecute d	0-255	Tasks lost by scheduler
18	8	antennaDeployed	0-1	Antenna deployed: 0 not deployed, 1 deployed, 2 unknown status
19	8	nExtEepromErrors	0-255	Checksum failures in EEPROM since last check (recoverable)
20	8	failedTaskID	0-255	Id of the last task failed to execute
21	8	Messaging enabled	0-1	Messaging enabled
22	8	strfwd0 / last id	0-255	S&F
23	16	strfwd1 / last cmd	0-255	S&F
24	16	strfwd2 / last value	0-255	S&F
25	8	strfwd3	0-255	S&F num tcmds
26	8	rx_percentage	0-100	rx_percentage
27	8	telemetry_percenta ge	0-100	telemetry_percentage
28	8	transponder_perce ntage	0-100	transponder_percentage
29	8	ptt_hp_percentage	0-100	ptt_hp_percentage
30	8	ptt_lp_percentage	0-100	ptt_lp_percentage
31	8	ple_percentage	0-100	ple_percentage
32	8	bwe_percentage	0-100	bwe_percentage
33	8	vbat_higher_than_ vbus_percentage	0-100	vbat_higher_than_vbus_percentage
34	8	payload_frames	0-255	num of frames in camera for this picture
35	8	payload_params	0-255	num of configured parameters in payload
36	8	current_image_id	0-255	payload current image id
37	16	checksum	--	checksum
useful	328	bits		

	41,00	bytes		
total	480	bits		
total	60	bytes		
time	600	ms		

FSK Packet Type 04: Power ranges

Type 04 contains the power ranges collected since the satellite's last reset.

ID	bits	FIELD NAME	MU	DESCRIPTION
1	128	training	--	0xAAAAAAAA
2	16	sync	--	0xBF35
3	8	size	35,00	Data length (including CRC bytes)
4	4	type	--	Packet Type: 4
5	4	address	--	Source Address: 3 for HADES-SA
6	32	sclock	S	System clock at time of tx
7	12	minvbus1	mV	MIN VBUS1 CPU.ADC MPPT
8	12	minvbat1	mV	MIN VBAT1 EPS.ADC
9	12	minvcpu	mV	MIN VCPU CPU.ADC
10	4	free	--	
11	8	minvbus2	mV	MIN VBUS2 EPS.I2C (VBUS in EPS)
12	8	minvbus3	mV	MIN VBUS3 CPU.I2C (VBUS in CPU) I2C
13	8	minvbat2	mV	MIN VBAT2 EPS.I2C (Payload Voltage) EPS.I2C
14	8	minibat	mV	MIN IBAT I2C (Battery Current) I2C
15	8	minicpu	mV	MIN ICPU I2C (CPU board current) I2C
16	8	minipl	mV	MIN IPL (Deployment current) I2C, EPS
17	12	maxvbus1	mV	MAX VBUS1 CPU.ADC MPPT
18	12	maxvbat1	mV	MAX VBAT1 EPS.ADC
19	12	maxvcpu	mV	MAX VCPU CPU.ADC
20	4	free	--	
21	8	maxvbus2	mV	MAX VBUS2 EPS.I2C (VBUS in EPS)
22	8	maxvbus3	mV	MAX VBUS3 CPU.I2C (VBUS in CPU) I2C
23	8	maxvbat2	mV	MAX VBAT2 EPS.I2C (Payload Voltage) EPS.I2C
24	8	maxibat	mV	MAX IBAT I2C (Battery Current) I2C
25	8	maxicpu	mV	MAX ICPU I2C (CPU board current CPU) I2C
26	8	maxipl	mV	MAX IPL (Deployment current) I2C, en placa EPS
27	8	ibat_rx_charging	mA	last measured ibat when rx and charging
28	8	ibat_rx_discharging	mA	last measured ibat when rx and discharging
29	8	ibat_tx_low_power_charging	mA	last measured ibat when tx in low power and charging
30	8	ibat_tx_low_power_discharging	mA	last measured ibat when tx in low power and discharging
31	8	ibat_tx_high_power_charging	mA	last measured ibat when tx in high power and charging
32	8	ibat_tx_high_power_discharging	mA	last measured ibat when tx in high power and discharging

33	16	checksum	--	checksum
useful	280	bits		
	35,00	bytes		
total	432	bits		
total	54	bytes		
time	540	ms		

FSK Packet Type 05: Temp ranges

Type 05 contains the ranges of the temperatures measured in the system since the satellite's last reset.

ID	bits	VARIABLE	MU	DESCRIPTION
1	128	training	--	0xAAAAAAAA
2	16	sync	--	0xBF35
3	8	size	27,00	Data length (including CRC bytes)
4	4	type	--	Packet Type: 5
5	4	address	--	Source Address: 3 for HADES-SA
6	32	sclock	S	system clock at time of tx
7	8	mintpa	oC	MIN TPA (Temperature Panel A) I2C
8	8	mintpb	oC	MIN TPB (Temperature Panel B) I2C
9	8	mintpc	oC	MIN TPC (Temperature Panel C) I2C
10	8	mintpd	oC	MIN TPD (Temperature Panel D) I2C
11	8	mintpe	oC	MIN TPE (Temperature Panel D) I2C - Not used
12	8	minteps	oC	MIN TEPS (Temperature EPS)
13	8	minttx	oC	MIN TTX (Temperature TX) I2C
14	8	minttx2	oC	MIN TTX2 (Temperature TX) NTC
15	8	mintrx	oC	MIN TRX (Temperature RX) NTC
16	8	mintcpu	oC	MIN TCPU (Temperature CPU) ADC
17	8	maxtpa	oC	MAX TPA (Temperature Panel A) I2C
18	8	maxtpb	oC	MAX TPB (Temperature Panel B) I2C
19	8	maxtpc	oC	MAX TPC (Temperature Panel C) I2C
20	8	maxtpd	oC	MAX TPD (Temperature Panel D) I2C
21	8	maxtpe	oC	MAX TPE (Temperature Panel D) I2C - Not used
22	8	maxteps	oC	MAX TEPS (Temperature EPS)
23	8	maxttx	oC	MAX TTX (Temperature TX) I2C
24	8	maxttx2	oC	MAX TTX2 (Temperature TX) NTC
25	8	maxtrx	oC	MAX TRX (Temperature RX) NTC
26	8	maxtcpu	oC	MAX TCPU (Temperature CPU) ADC
27	16	checksum	--	Checksum
useful	216	bits		
	27,00	bytes		
total	368	bits		
total	46	bytes		
time	460	ms		

FSK Packet Type 06: Not used

Packet type 6 is not used in this satellite

FSK Packet Type 07: Not used

Packet type 7 is not used in this satellite

FSK Packet Type 08: Deploy

Type 08 contains information about the system parameters during the last antenna deployment.

1	128	training	--	0xAAAAAAAA
2	16	sync	--	0xBF35
3	8	size	31,00	Data length (including CRC bytes)
4	4	type	--	Packet Type: 8
5	4	address	--	Source Address: 3 for HADES-SA
6	16	vloc		vloc;
7	16	v1		v1
8	16	i1		i1
9	16	ilpk		ilpk
10	16	r1		r1
11	16	v2oc		v2oc;
12	16	v2		v2
13	16	r2		r2
14	32	t0		t0
15	16	td		Td
16	8	state_begin:1;		state_begin:1;
17	8	state_end:1;		state_end:1;
18	8	state_now:1;		state_now:1;
19	8	enable:1;		enable:1;
20	8	counter		counter;
21	8	tmp		tmp; // System temperature
22	16	checksum		checksum
useful	248	bits		
	31,00	bytes		
total	400	bits		
total	50	bytes		
time	500	ms		

FSK Packet Type 09: Extended power stats (INA)

Type 09 contains extended information about the system's power.

ID	bits	FIELD NAME	MU	DESCRIPTION
1	128	Training	--	0xAAAAAAAA
2	16	Sync	--	0xBF35
3	8	Size	123,00	Data length (including CRC bytes)

4	4	type	--	Packet Type: 9
5	4	address	--	Source Address: 3 for HADES-SA
6	16	v0	raw	SPA V Instant Voltage
7	16	i0	raw	SPA I Instant Current
8	16	p0	raw	SPA P Mean Power
9	16	vp0	raw	SPA VP Peak Voltage
10	16	ip0	raw	SPA IP Peak Current
11	16	pp0	raw	SPA PP Peak Power
12	16	v1	raw	SPB V Instant Voltage
13	16	i1	raw	SPB I Instant current
14	16	p1	raw	SPB P Mean Power
15	16	vp1	raw	SPB VP Peak Voltage
16	16	ip1	raw	SPB IP Peak Current
17	16	pp1	raw	SPB PP Peak Power
18	16	v2	raw	SPC V Instant Voltage
19	16	i2	raw	SPC I Instant current
20	16	p2	raw	SPC P Mean Power
21	16	vp2	raw	SPC VP Peak Voltage
22	16	ip2	raw	SPC IP Peak Current
23	16	pp2	raw	SPC PP Peak Power
24	16	v3	raw	SPD V Instant Voltage
25	16	i3	raw	SPD I Instant current
26	16	p3	raw	SPD P Mean Power
27	16	vp3	raw	SPD VP Peak Voltage
28	16	ip	raw	SPD IP Peak Current
29	16	pp3	raw	SPD PP Peak Power
30	16	v4	raw	SUN V Instant Voltage
31	16	i4	raw	SUN I Instant current
32	16	p4	raw	SUN P Mean Power
33	16	vp4	raw	SUN VP Peak Voltage
34	16	ip4	raw	SUN IP Peak Current
35	16	pp4	raw	SUN PP Peak Power
36	16	v5	raw	BAT V Instant Voltage
37	16	i5	raw	BAT I Instant current
38	16	p5	raw	BAT P Mean Power
39	16	vp5	Raw	BAT VP Peak Voltage
40	16	ip5	Raw	BAT IP Peak Current
41	16	pp5	Raw	BAT PP Peak Power
42	16	v6	Raw	BATP V Instant Voltage
43	16	i6	Raw	BATP I Instant current
44	16	p6	Raw	BATP P Mean Power
45	16	vp6	Raw	BATP VP Peak Voltage
46	16	ip6	Raw	BATP IP Peak Current
47	16	pp6	Raw	BATP PP Peak Power

48	16	v7	Raw	BATN V Instant Voltage
49	16	i7	Raw	BATN I Instant Current
50	16	p7	Raw	BATN P Mean Power
51	16	vp7	Raw	BATN VP Peak Voltage
52	16	ip7	Raw	BATN IP Peak Current
53	16	pp7	Raw	BATN PP Peak Power
54	16	v8	Raw	CPU V Instant Voltage
55	16	i8	Raw	CPU I Instant Current
56	16	p8	Raw	CPU P Medium Power
57	16	vp8	Raw	CPU VP Peak Voltage
58	16	ip8	Raw	CPU IP Peak Current
59	16	pp8	Raw	CPU PP Peak Power
60	16	v9	Raw	PL V Instant Voltage
61	16	i9	Raw	PL I Instant Current
62	16	p9	Raw	PL P Mean Power
63	16	vp9	Raw	PL VP Peak Voltage
64	16	ip9	Raw	PL IP Peak Current
65	16	pp9	Raw	PL PP Peak Current
66	16	Checksum	--	checksum
useful	984	Bits		
	123,00	Bytes		
total	1136	Bits		
total	142	Bytes		
time	1420	Ms		

FSK Packet Type 10: SSDV Frames

Type 10 consists of SSDV frames generated by the Spinning Around camera. An internal image with identifier 0 is also transmitted in case of camera failure or data unavailability.

ID	bits	FIELD NAME		DESCRIPTION
1	120	Added sync	0x55	0x55 - may be preceded by one or more sync bytes -
2	8	Sync1	0x55	0x55 - may be preceded by one or more sync bytes -
3	8	SSDV Type	0x66	0x66 - normal mode (224 byte packet + 32 byte fec) 0x67 - no-fec mode (256 byte packet) -
4	16	Sync2 part 1 (sync)	0xBF35	0xBF35
5	8	Sync2 part 2 (size)	251,00	Fixed, 251
6	4	Type	-	Packet Type: 10
7	4	Address	-	Source Address: 3 for HADES-SA
8	8	Image ID	-	beginning at 0 and incremented by 1 for each new image
9	16	Packet ID	-	the packet number, beginning at 0 for each new image (big endian)
10	8	Width	-	width of the image in mcu blocks (pixels / 16) 0 = invalid
11	8	Height	-	height of the image in mcu blocks (pixels / 16) 0 = invalid
12	8	Flags	-	qqq = jpeg quality level (0-7 xor 4)
13	8	MCU Offset	-	E = eoi flag (1 = last packet) offset in bytes to the beginning of the first mcu block in the payload, or 0xff if none present

14	16	MCU Index	-	the number of the mcu pointed to by the offset above (big endian), or 0xffff if none present
15	1640	data	-	payload data 205 / 237 (205 fijos en nuestro caso)
16	32	Checksum	-	32-bit crc
17	256	FEC	-	256 bits reed-solomon forward error correction data. Normal mode only (0x66)
useful	2008	bits		
	251,00	bytes		
total	2048	bits		
total	256	bytes		
time	2560	ms		

FSK Packet Type 11: Digital CODEC2 Voice

Type 11 contains digital voice frames encoded with CODEC2.

ID	bits	FIELD NAME		DESCRIPTION
0	128	training	--	0xAAAAAAAA
1	16	frame 0 sync	--	0xBF35 (for each frame)
2	8	frame 0 size	37	Data size (from this field)
3	4	frame 0 type	--	Packet Type: 11 (for each frame)
4	4	frame 0 address	--	Source Address: 3 for HADES-SA
5	8	frame 0 number		0
6	280	frame 0 codec2 data		280 bits raw (codec2 raw data)
1	16	frame 1 sync	--	0xBF35 (for each frame)
2	8	frame 1 size	37	Data size (from this field)
3	4	frame 1 type	--	Packet Type: 11 (for each frame)
4	4	frame 1 address	--	Source Address: 3 for HADES-SA
5	8	frame 1 number		1
6	280	frame 1 codec2 data		280 bits raw (codec2 raw data)
1	16	...	--	0xBF35 (for each frame)
2	8	...	37	Data size (from this field)
3	4	...	--	Packet Type: 11 (for each frame)
4	4	...	--	Source Address: 3 for HADES-SA
5	8	...		frame i
6	280	...		280 bits raw (codec2 raw data)
1	16	frame n sync	--	0xBF35 (for each frame)
2	8	frame n size	37	Data size (from this field)
3	4	frame n type	--	Packet Type: 11 (for each frame)
4	4	frame n address	--	Source Address: 3 for HADES-SA
5	8	frame n number		n
6	280	frame n codec2 data		280 bits raw (codec2 raw data)

FSK Packet Type 12: Ephemeris

This packet contains the satellite's ephemerides. These consist essentially of the TLE, which is sent as a command from the ground station, as well as the onboard calculations of the satellite's latitude, longitude, and altitude.

ID	bits	FIELD NAME		DESCRIPTION
1	128	training	--	0xAAAAAAAA
2	16	sync	--	0xBF35
3	8	size	64,0	Data length (including CRC bytes)
4	4	type	--	Packet Type: 12
5	4	address	--	Source Address: 3 for HADES-SA
6	32	UTC	--	Time UTC
7	16	adr		Satellite address
8	32	ful		Not used
9	32	fdl		Not used
10	32	tle.epoch		TLE element
11	32	tle.xndt2o		TLE element
12	32	tle.xnnd6o		TLE element
13	32	tle.bstar		TLE element
14	32	tle.xincl		TLE element
15	32	tle.xnodeo		TLE element
16	32	tle.eo		TLE element
17	32	tle.omegao		TLE element
18	32	tle.xmo		TLE element
19	32	tle.xno		TLE element
20	16	lat		Calculated latitude
21	16	lon		Calculated longitude
22	16	alt	--	Calculated heigh
23	8	cnt		Not used
24	16	checksum	--	checksum
useful	512	bits		
	64,0	bytes		
total	664	bits		
total	83	bytes		
time	830	ms		

FSK Packet Type 13: Random PN9 Data (Link performance)

This packet is used to determine the downlink quality. It is a fixed-data packet generated randomly.

ID	bits	FIELD NAME		DESCRIPTION
1	128	training	--	0xAAAAAAAA
2	16	sync	--	0xBF35
3	8	size	255	Data length (for this packet this value is 255, although data size is 256)
4	4	type	--	Packet Type: 13
5	4	address	--	Source Address: 3 for HADES-SA

6	2048	random_data [0..255]		(256 bytes) n times repeated (always the same data) - 1 time by default
useful	2056	bits		
	257,0	bytes		
total	2208	bits		
total	276	bytes		
time	2760	ms		

FSK Packet Type 14: Time series

The time series packet displays data for several variables over the last 90 minutes. Its structure is as follows:

ID	bits	FIELD NAME		DESCRIPTION
1	128	training	--	0xAAAAAAAA
2	16	sync	--	0xBF35
3	8	size	38	Data length (including CRC bytes)
4	4	type	--	Packet Type: 14
5	4	address	--	Source Address: 3 for HADES-SA
6	32	sclock	s	system clock for sample 0
7	8	variable	--	00=peak signal, 01=noise, 02=vbat1, 03=tcpu, 04=tpa, 05=(tpa+tpb+tpc+tpd)/4
8	8	byte_00	--	byte_00 oldest, lost each 60 minutes (circular queue). Each sample is taken every 3 minutes
9	8	byte_01	--	byte_01
10	8	byte_02	--	byte_02
11	8	byte_03	--	byte_03
12	8	byte_04	--	byte_04
13	8	byte_05	--	byte_05
14	8	byte_06	--	byte_06
15	8	byte_07	--	byte_07
16	8	byte_08	--	byte_08
17	8	byte_09	--	byte_09
18	8	byte_10	--	byte_10
19	8	byte_11	--	byte_11
20	8	byte_12	--	byte_12
21	8	byte_13	--	byte_13
22	8	byte_14	--	byte_14
23	8	byte_15	--	byte_15
24	8	byte_16	--	byte_16
25	8	byte_17	--	byte_17
26	8	byte_18	--	byte_18
27	8	byte_19	--	byte_19
28	8	byte_20	--	byte_20
29	8	byte_21	--	byte_21
30	8	byte_22	--	byte_22
31	8	byte_23	--	byte_23

32	8	byte_24	--	byte_24
33	8	byte_25	--	byte_25
34	8	byte_26	--	byte_26
35	8	byte_27	--	byte_27
36	8	byte_28	--	byte_28
37	8	byte_29	--	byte_29 newest one
38	16	checksum	--	checksum
useful	304	bits		
	38,0	bytes		
total	456	bits		
	57,0	bytes		
time	570	ms		

FSK Packet Type 15: BBS Data

This packet contains the BBS status information: callsigns with the text messages they have sent, as well as whether they have sent CODEC2 recordings.

1	128	training	--	0xAAAAAAAA
2	16	sync	--	0xBF35
3	8	size	73,0	Data size (from this field to character 13, including it)
4	4	type	--	Packet Type: 15
5	4	address	--	Address: 3 for HADES-SA
6	48	Callsign 0 [0..5]		XXXCCC
7	56	Message 0 [0...6]		ABCDEFGF
8	8	codec2 frames for 0		Codec2 frames number for callsign 0
9	48	Callsign 1 [0..5]		XXXCCC
10	56	Message 1 [0...6]		ABCDEFGF
11	8	codec2 frames for 1		Codec2 frames number for callsign 1
12	48	Callsign 2 [0..5]		XXXCCC
13	56	Message 2 [0...6]		ABCDEFGF
14	8	codec2 frames for 2		Codec2 frames number for callsign 2
15	48	Callsign 3 [0..5]		XXXCCC
16	56	Message 3 [0...6]		ABCDEFGF
17	8	codec2 frames for 3		Codec2 frames number for callsign 3
18	48	Callsign 4 [0..5]		XXXCCC
19	56	Message 4 [0...6]		ABCDEFGF
20	8	codec2 frames for 4		Codec2 frames number for callsign 4
21	16	checksum	--	Checksum
useful	584	bits		
	73,0	bytes		
total	736	bits		

	92,0	bytes		
time	920	ms		

Telemetry timing pattern

The transmissions follow a cyclic pattern shown in the sequence columns of the table below, one for low battery and another for fully charged battery. They occur in 20-second slots. If a slot is occupied when a transmission is about to start (for example, because a previous transmission has not finished or the transponder is active), the transmission will be attempted in the next slot, but no transmission in the sequence is skipped.

Secuencia si batería baja		Secuencia si batería cargada			
Cada 30 segundos:		Cada 20 segundos:			
tx_status	00:00	tx_status			
tx_temp	00:20	tx_temp			
tx_power	00:40	tx_power			
	01:00	tx_bbs			
tx_power_range	01:20	tx_power_range			
tx_temp_range	01:40	tx_temp_range			
	02:00	tx_ephemeris			
	02:20	tx_voice_codec2			
	02:40	tx_payload (SSDV)	----->	Internal image if no camera frames	
tx_status	06:00	tx_status			
tx_time_series	06:20	tx_time_series	----->	0	señal pico
	06:40	tx_time_series		1	ruido moda
tx_bbs_status	07:00	tx_bbs		2	vbat1
	07:20	tx_deploy		3	tcpu
tx_ine	07:40	tx_ine		4	tpa
	08:00	tx_pn9		5	(tpa+tpb+tpc+tpd)/4
	08:20	tx_voice_codec2			
	08:40	tx_payload (SSDV)	----->	Internal image if no camera frames	

More information

More information can be found on the AMSAT EA website, in the Projects section: <https://www.amsat-ea.org/proyectos/>