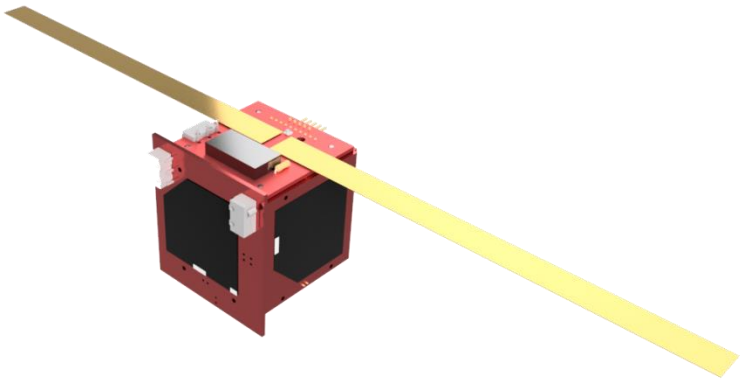
Transmission Protocol for SanoSat-1 Satellite



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SanoSat-1 transmits in CW Morse, RTTY-FSK and GFSK schemes. Downlink can be done in all three schemes whereas the uplink can only be done in GFSK Modulation within the protocol defined below.

CW BEACON TRANSMISSION

SanoSat-1 transmits CW Beacon with Call sign and the general health parameters of the satellite. It can also be used to detect the presence of the satellite, measure basic properties of the satellite such as strength, fading, Doppler speed, etc.

The satellite transmits temperature of the communication module in degree Celsius, temperature of the battery in degree Celsius, charging current in mA, battery voltage per 10mV and antenna deployment status.

Speed: 20WPM

The Transmission Protocol is as follows:

AM9NPQXXXYYYZZZ1122?33

XXX: Temperature of the communication board. The length and the sign can be calculated from the residue.

YYY: Temperature of the Battery board. The length and the sign can be calculated from the residue.

ZZZ: Charging current in mA. The length can be calculated from the residue.

11: Battery voltage per 10 mV. i.e. 3.7V is represented by 37.

22: Residue containing the length for battery temperature, current, signs for the temperatures, and the deployment status. The figure below describes the arrangement in residue.

Deployment Status: 0-> Not Deployed, 1->Deployed

Sign of Temperature: 0 -> Positive and 1->Negative

?: Delimiter to separate data from NMEA checksum.

33: NMEA checksum calculated over XXXYYYZZZ1122

Table 1 : CW Beacon Transmission Protocol

S.N.	Type	Length	Data Type	Value	Remarks
1.	Call Sign	6	ASCII	AM9NPQ	
2.	Temperature COM	2-3	INT		Calculate the Integer
3.	Temperature Battery	2-3	INT		Calculate the Integer
3.	Current mA	2-3	INT		Calculate the Integer
4.	VBat /10 V	2	INT		Calculate the Integer
5.	Residuals	2	HEX		
6.	Delimiter	1	ASCII	?	
7.	NMEA Checksum	2	HEX		Calculated over the data i.e. except the call sign

Example for CW Beacon Transmission: **AM9NPQ373003506?37**

S.N.	Type	Length	Example
1.	Call Sign	6	AM9NPQ
2.	Temperature COM	2	37
3.	Temperature Battery	2	30
3.	Current mA	1	0
4.	VBat /10 V	2	35
5.	Residuals	2	06
6.	Delimiter	1	?
7.	NMEA Checksum	2	37

Residue:	06	HEX	00000110	Antenna Deployment Status	OBC Temperature Sign	Battery Temperature Sign	Length of Current			Length of Bat Temp		
				B7	B6	B5	B(4-2)			B(1-0)		
				0	0	0	0	0	1	1	0	
Battery Voltage	35	DEC										
Charging Current	0	DEC										
Battery Temperature	30	DEC										
OBC Temperature	37	DEC										
	Antenna Deployment Status:		Not Deployed									
	OBC Temperature		37	Celsius								
	Battery Temperature		30	Celsius								
	Charging Current		0	mA								
	Battery Voltage		350	mV								

RTTY-FSK TRANSMISSION

SanoSat-1 transmits Radio-Teletype FSK in ASCII-8 Mode. It transmits Call sign, battery temperature, charging current, battery voltage, no of resets, deployment status and the radiation intensity.

The settings for RTTY FSK reception are as follows:
Mode: ASCII-8
Speed: 45 Baud
Shift: 425 Hz
Separated by Commas

The transmission protocol is as follow:

CALL_SIGN, $TBAT, ICHG, VBAT, NOR, DEP, RAD?CSM

CALL_SIGN: AM9NPQ
TBAT: Battery temperature in Celsius.
ICHG: Charging current in mA.
VBAT: Battery voltage in mV.
NOR: Number of resets.
DEP: Antenna deployment status.
RAD: Radiation intensity in uSv/hr.
CSM: NMEA Checksum from $ to ?

Table 2 : RTTY FSK transmission protocol

S.N.	Type	Data Type	Remarks
1.	Call Sign	ASCII	
2.	Temperature BAT	INT	Degree Celcuis
3.	Current mA	INT	mA
4.	VBat mV	INT	mV
5.	No of Resets	INT	Calculate the Integer
6.	Deployment Status	INT	Deployed/Not Deployed
7.	Radiation Intensity	INT	uSv/hr
8.	Checksum over the data from $ to ?	ASCII	

Example: AM9NPQ,$12,230,392,123,1,10?26

S.N.	Type	Value	Remarks
1.	Call Sign	AM9NPQ	
2.	Temperature BAT	12	Degree Celcuis
3.	Current mA	230	mA
4.	VBat mV	392	mV
5.	No of Resets	123	Calculate the Integer
6.	Deployment Status	1	Deployed/Not Deployed
7.	Radiation Intensity	10	uSv/hr
8.	NMEA Checksum of 12,230,392,123,1,10	26	In ASCII

GFSK Transmission

SanoSat-1 uses GFSK modulation scheme to transmit the telemetry and in digipeater mode.
The settings for the GFSK modulation scheme are as follows:

Deviation: 1 kHz
Speed: 500 bps
Si4463 Packet Protocol
CRC: CRC CCIT

The GFSK transmission uses Si446x's default packet structure. Preamble and sync are always sent LSB first according to the Si446x's packet format.
Table 3 represents the packet structure for both telemetry and digipeater packets.

Table 3 : GFSK packet structure

S.N.	Type	Size	Value
1.	Preamble	4 bytes	4 bytes of alternating 0s and 1s (55 55 55 55) sent LSB first. (AA AA AA AA, if received as MSB first)
2.	Sync Word	2 Bytes	2D D4 send LSB first. (B4 2B, if received as MSB first)
3.	Message Length (Field 1)	1 Bytes	Length Message including CRC1+Message+CRC2 (MSB first)
4.	CRC1	2 Bytes	CRC of Message Length (MSB first)
5.	Header/Flag	4 Bytes	0xFFFF and 0x0000 (MSB first)
6.	Message	1 to 126 Bytes	Data (MSB first)
7.	CRC2	2 Bytes	Computed on Message length, 0xFFFF, 0x0000 and Data (MSB first)

CRC scheme = CRC CCIT with initial value 0xFFFF

1. Message Breakdown for Telemetry (Packet Type=0001)

Message from Table 3 is further divided according to Table 4 for telemetry packets.

Table 4 : Message structure for Telemetry Packet

S.N.	Type	Size	Value
1.	Call Sign	6 Bytes	AM9NPQ
2.	Packet Type	2 Bytes	0x0001
3.	COM Temperature	2 Bytes	
4.	Charging Voltage mV	2 Bytes	
5.	Charging Current mA	2 Bytes	
6.	Battery Temperature	2 Bytes	
7.	Radiation uSv/hr	2 Bytes	
8.	No of Resets	2 Bytes	
9.	Antenna Deployment Status	1 Byte	0x00 or 0xFF
10.	**Total**	**21**	

Total No of Bytes including preamble, sync, message, header, and CRC: 36
Total No of Bytes for Message in Telemetry Packet: 21

Example

S.N.	Type	Value (HEX)	Value (Decimal /ASCII)	Explanation
1.	Preamble	AA AA AA AA		(55555555 sent LSB first)
2.	Sync	B4 2B		(2DD4 sent LSB first)
3.	Length	19	25 (INT)	Length of CRC1+Data+CRC2
4.	CRC 1	E8 62		CRC CCIT of 19 is 62E8
5.	Delimiter	FF FF 00 00		
6.	Call Sign	41 4D 39 4E 50 51	AM9NPQ (ASCII)	AM9NPQ
7.	Packet Type	01 00	1 (INT)	Telemetry Packet (Decimal of 00 01)
8.	COM Temperature	20 00	32 (INT)	Decimal of (00 20)
9.	Battery Voltage mV	54 01	340 (INT)	Decimal of (01 54)
10.	Charging Current mA	40 01	320 (INT)	Decimal of (01 40)
11.	Battery Temperature	1E 00	30 (INT)	Decimal of (00 1E)
12.	Radiation Level uSv/hr	0C 00	12 (INT)	Decimal of (00 0C)
13.	No of Resets	33 00	51 (INT)	Decimal of (00 33)
14.	Antenna Deployment Status	01	1 (BOL)	Decimal
15.	CRC 2	9B A0		CRC CCIT of 19FFFF0000414D394E5051010 02000540140011E000C00330001 is A0 9B

2. Message Breakdown for Digipeater Packets

Message from Table 3 is further divided according to Table 5 for digipeater packets. For digipeater packets,

Table 5 : Message structure for digipeater packets

S.N.	Type	Size	Value
1.	Header	3 Bytes	4E 50 51 (NPQ in ASCII)
2.	Data	0-60 Bytes	
3.	**Total**	**1-63 Bytes**	

Total No of Bytes including preamble, sync, message, header and CRC: 16-78 Bytes
Total No of Bytes for Message in Telemetry Packet: 1-63 Bytes

Example

S.N.	Type	Value (HEX)	Value (Decimal /ASCII)	Explanation
1.	Preamble	AA AA AA AA		(55555555 sent LSB first)
2.	Sync	B4 2B		(2DD4 sent LSB first)
3.	Length	1E	30 (INT)	Length of CRC1+Data+CRC2
4.	CRC 1	AA 42		CRC CCIT of 1B is 42AA
5.	Delimiter	FF FF 00 00		
6.	Data	4E 50 51 44 49 47 49 50 45 41 54 45 52 20 54 45 53 54 20 53 41 4E 4F 53 41 54	NPQDIGIPEATER TEST SANOSAT	
7.	CRC 2	44 63		CRC CCIT of 1BFFFF00004E5051444947 4950454154455220544553542053414E4F534154 is 63 44