

EDSN Beacon Packet Decoding

1. Introduction

EDSN sends AX.25 packets at 437.10MHz AFSK. There are 2 types of packets: State of Health (SOH) and Science.

Each packet contains ASCII values from 32 to 255. Depending on the TNC being used, the data string received could be preceded by the following set of characters:

KE6QLL>UNDEF,TELEM/I: <<UI>>:

This denotes the sender and recipient of the packet. Ignore this when decoding the packet.

The satellite will typically send either SOH or Science packets at a 60 second periodicity. When the satellite is detumbling, soon after launch, it will transmit only SOH packets every 120 seconds. The beacon will not transmit during space-to-space crosslink communication activities, which occur 4 times in a 25-hour period. Each crosslink activity lasts up to 46 minutes.

2. Beacon Packet Format

Each packet type contains different information, and Tables 1-3 show the breakdown of each packet type.

Packets are divided between header and sensor values. The header contains an ASCII character sequence of "EDSN", an exclamation mark (!) or double quotation mark ("), and a letter between "A" and "H" that do not need decoding. The remaining values are encoded extended ASCII characters from 32 to 255. There are then 224 possible values per character (Base224). Therefore, the number of possible values per variable is 224^n , where n is the length of the variable in bytes.

Each packet starts with a sync character sequence of "EDSN". This is used to find the start of the packet. The fifth character (! or ") denotes the message type. The sixth character identifies the spacecraft that sent the packet (A to H). The "Science Data" group of the science packet uses a Base224 to Base256 decoding (see Section 2.1). The remaining characters are converted from base 224 to decimal values and scaled applying the following formula:

$$R = \sum_{i=0}^{n-1} 224^{n-1-i} (d - A - i - 32) \frac{(m - m_0)}{224^n - 1} + m_0$$

Where sensor data byte order is big-endian and the index of the first byte is $i=0$, dec_ASCII is the decimal value of the ASCII character, n is the size of the variable, max is the maximum value of the variable and min is the minimum value of the variable.

2.1. SOH packet

SOH packets are 187 bytes long and are sent every 120 seconds. These packets have a constant length and have an exclamation mark (!) after the “EDSN” start word. Below is a packet decoding example.

Example of received RF data (in hex format, with checksum):

```
45 44 53 4E 21 47 21 33 9E 49 98 3E 24 46 20 20 24 88 20 21 21 20 20 20 20 20 20 20 20 20 20 20 22 20 22 22 20 20 20 20 20
20 20 20 20 20 20 20 20 20 20 20 20 20 20 21 F5 D1 FC F9 90 5E 76 E4 68 EC 61 47 EA A6 C3 43 CF 49 49 DA 21 F6 D0 A5 47 21 24 82
60 A0 7A 86 30 A2 A8 A7 E0 8F F2 90 20 90 5F FF FF 20 20 20 20 2F F2 85 BF A2 F4 A8 3C 8F 9B 8F CC 90 42 9B 7D E1 58 88 35 8F
E5 90 4C 90 32 64 20 9E 49 98 36 23 2F 20 51 30 B0 A1 DD 20 20 20 20 53 B7 20 29 20 28 20 20 21 20 20 21 20 20 A6 83 A7 67 A7
67 A7 67 A6 A9 39 39 39 39 38 38 4E 9E 9E 49 A2 2B DC
```

Example after being decoded and scaled (in CSV format, no checksum)

```
EDSN,33,G,243,1418251550,934,0,1000,1,1,0,0,0,0,2,2,2,0,0,0,0,0,0,0,0,0,1102205202000,-3543725.6877,-
2791998.8419,-5149681.4383,3654.2501,4513.3234,-5012.0578,1104707188257,4,1104703578,-
88.5412,165.9923,212.8213,-0.0026906,9.9651e-005,0.012656,255,-255,-255,3570,-91.7666,169.0187,215.2106,-
0.02003,-0.010264,0.0068759,25.9955,184.9976,-17.9961,-0.052815,0.08869,0.036871,68,0,1418251542,
68.4606,0.22708,16.7676,115.9322,0,0,46.1377,0.29446,0.26174,0,1.1212,0,0,1.1212,0,0,26.9751,28.9284,28.9284,28.92
84,27.3239,34.0509,28.6715,28.6715,28.6715,28.6715,27.5247,27.5247,20126,1418253771,8.4519
```

2.2. Science packet

Science packets are 192 bytes long and are sent every 120 seconds. These packets have a constant length and have a double quotation mark (") after the “EDSN” start word. The science payload used on EDSN outputs binary data, which is then encoded in order to conform to the Base224 RF packet format. In order to decode the “Science Data” group from a Base224 byte array into the original binary data, follow these steps:

- 1) Determine the number of 8 byte chunks in the encoded data (Science Data has 176 encoded bytes = 22 chunks)
- 2) Determine the size of the decoded byte array based on 60 bits per chunk (22 chunks = 165 bytes decoded data)
- 3) Convert each 8 byte chunk to an integer representation
 - a) Take the first byte integer and subtract 32 (call the value x)
 - b) Take the x from step 3a and calculate $x*224^n$, where $n=7$
 - c) Repeat step 3a and step 3b for $n-1$, until $n=0$
 - d) Sum all 8 values obtained from step a to step c
- 4) Convert the integer from step 3 to a 60 bit binary value (http://en.wikipedia.org/wiki/Binary_number#Decimal)
 - a) Take the integer from step 3d and divide it by 2
 - b) If the remainder of step 4a is =0, then the least-significant bit (call it y_n , where $n=59$) is 0, otherwise it is 1

Table 1: SOH Packet Description (part 1 of 2)

| Group | Var Name | Description | Final Unit | BINARY FORMAT | | | SCALED VALUES | | | ENGINEERING UNITS | |
|---|-----------------|---|--------------|---------------|-------|------|---------------|-------------|------------|-------------------|-------------------------------|
| | | | | Offset | Bytes | Bits | Range Min | Range Max | Resolution | Valid Range | Conversion |
| Header | start_word | Start of packet definition, "ED5N" in ASCII | [Characters] | 0 | 4 | 32 | -- | -- | -- | ASCII 'ED5N' | [Binary to ASCII] |
| | msg_type | Message Type Definition (value 33 to 256, defined on "Types" tab) | [Character] | 4 | 1 | 8 | -- | -- | -- | dec 33 | [Binary to ASCII] |
| | src_id | Identification Symbol "A"- "Z" of the spacecraft sending the packet, in ASCII | [Character] | 5 | 1 | 8 | -- | -- | -- | ASCII A-H | [Binary to ASCII] |
| | msg_num | Message Number (separate count for each message type, starts with zero, loops after max value) | [Count] | 6 | 2 | 16 | 0 | 50175 | 1.000 | | [Base224 to decimal] |
| | time_s | Posix Time message created (4B for s and 2B for ms, from 1970/1/1 00:00) | Seconds | 8 | 4 | 32 | 0 | 2517630975 | 1.000 | | [Base224 to decimal] |
| System | time_ms | Posix Time message created (4B for s and 2B for ms, from 1970/1/1 00:00, only uses 0 to 999) | mSeconds | 12 | 2 | 16 | 0 | 50175 | 1.000 | dec 0-999 | [Base224 to decimal] |
| | phone_reboots | number of phone reboots (can rail at 50175) | [Count] | 14 | 2 | 16 | 0 | 50175 | 1.000 | | [Base224 to decimal] |
| | router_reboots | number of router reboots (initialized at 1000 due to known bug, can rail at 50175) | [Count] | 16 | 2 | 16 | 0 | 50175 | 1.000 | | [Base224 to decimal] |
| | wd_reboots | number of WD reboots (can rail at 50175) | [Count] | 18 | 2 | 16 | 0 | 50175 | 1.000 | | [Base224 to decimal] |
| | gps_fix | GPS fix counter (first valid GPS vector in activity, loops at 255, remains 223 for 32 extra counts) | [Count] | 20 | 1 | 8 | 0 | 223 | 1.000 | | [Base224 to decimal] |
| RF Communication | is_captain | isCaptain flag ("0"=false or "1"=true) | [Count] | 21 | 1 | 8 | -- | -- | -- | ASCII 0 to 1 | [Binary to ASCII] |
| | last_dl_start_s | Last Captain Data Structure downlink start time (from 1970/1/1 00:00) | Seconds | 22 | 4 | 32 | 0 | 2517630975 | 1.000 | | [Base224 to decimal] |
| | next_dl_start_s | Next Downlink activity start time (from 1970/1/1 00:00, only populated for captain) | Seconds | 26 | 4 | 32 | 0 | 2517630975 | 1.000 | | [Base224 to decimal] |
| | dl_lock | Downlink contact count (when first MHX lock signal received in activity, updates after event, loops at 255) | [Count] | 30 | 1 | 8 | 0 | 223 | 1.000 | | [Base224 to decimal] |
| | dl_tx | Count of total downlink packets sent (when a downlink packet is sent; CPT only, updates after event) | [Count] | 31 | 2 | 16 | 0 | 50175 | 1.000 | | [Base224 to decimal] |
| | xl_pkt | Count of total packets created (when a Science or XL SOH packet is created, includes DL science) | [Count] | 33 | 2 | 16 | 0 | 50175 | 1.000 | | [Base224 to decimal] |
| | xl_tx | Count of total crosslink packets sent (when a Sci or SOH packet is sent to captain; LT only; no ping) | [Count] | 35 | 2 | 16 | 0 | 50175 | 1.000 | | [Base224 to decimal] |
| | xl_sessions | Number of comm sessions (counts first ping received for XL session, updates after event; LT only, loops at 255) | [Count] | 37 | 1 | 8 | 0 | 223 | 1.000 | | [Base224 to decimal] |
| | xl_rx | Count of total crosslink packets received (when a CPT receives a packet from a crosslink target LT) | [Count] | 38 | 2 | 16 | 0 | 50175 | 1.000 | | [Base224 to decimal] |
| | cross_rx_A | Total valid packets received from SC-A (when a CPT receives a packet from LT SC-A, no pings) | [Count] | 40 | 2 | 16 | 0 | 50175 | 1.000 | | [Base224 to decimal] |
| | cross_rx_B | Total valid packets received from SC-B (when a CPT receives a packet from LT SC-B, no pings) | [Count] | 42 | 2 | 16 | 0 | 50175 | 1.000 | | [Base224 to decimal] |
| | cross_rx_C | Total valid packets received from SC-C (when a CPT receives a packet from LT SC-C, no pings) | [Count] | 44 | 2 | 16 | 0 | 50175 | 1.000 | | [Base224 to decimal] |
| | cross_rx_D | Total valid packets received from SC-D (when a CPT receives a packet from LT SC-D, no pings) | [Count] | 46 | 2 | 16 | 0 | 50175 | 1.000 | | [Base224 to decimal] |
| | cross_rx_E | Total valid packets received from SC-E (when a CPT receives a packet from LT SC-E, no pings) | [Count] | 48 | 2 | 16 | 0 | 50175 | 1.000 | | [Base224 to decimal] |
| | cross_rx_F | Total valid packets received from SC-F (when a CPT receives a packet from LT SC-F, no pings) | [Count] | 50 | 2 | 16 | 0 | 50175 | 1.000 | | [Base224 to decimal] |
| | cross_rx_G | Total valid packets received from SC-G (when a CPT receives a packet from LT SC-G, no pings) | [Count] | 52 | 2 | 16 | 0 | 50175 | 1.000 | | [Base224 to decimal] |
| | cross_rx_H | Total valid packets received from SC-H (when a CPT receives a packet from LT SC-H, no pings) | [Count] | 54 | 2 | 16 | 0 | 50175 | 1.000 | | [Base224 to decimal] |
| GPS (only updates when GPS locks) | gps_time | GPS time in milliseconds (from 1980/1/6 00:00; accounts for 16 leap seconds) | mSeconds | 56 | 6 | 48 | 0 | 1.26325E+14 | 1.000 | | [Base224 to decimal] |
| | gps_pos_x | Most recent GPS position X: ref to center of earth (ECEF) | meters | 62 | 3 | 24 | -8000000 | 8000000 | 1.424 | | [Base224 to decimal & scaled] |
| | gps_pos_y | Most recent GPS position Y: ref to center of earth (ECEF) | meters | 65 | 3 | 24 | -8000000 | 8000000 | 1.424 | | [Base224 to decimal & scaled] |
| | gps_pos_z | Most recent GPS position Z: ref to center of earth (ECEF) | meters | 68 | 3 | 24 | -8000000 | 8000000 | 1.424 | | [Base224 to decimal & scaled] |
| | gps_vel_x | Most recent GPS velocity X (ECEF) | meters/sec | 71 | 2 | 16 | -8000 | 8000 | 0.319 | | [Base224 to decimal & scaled] |
| | gps_vel_y | Most recent GPS velocity Y (ECEF) | meters/sec | 73 | 2 | 16 | -8000 | 8000 | 0.319 | | [Base224 to decimal & scaled] |
| | gps_vel_z | Most recent GPS velocity Z (ECEF) | meters/sec | 75 | 2 | 16 | -8000 | 8000 | 0.319 | | [Base224 to decimal & scaled] |
| ADCS (only updates when alignment/detumble activity runs) | gps_posix_ms | Posix time at moment when GPS time is received (from 1970/1/1 00:00; accounts for 16 leap seconds) | mSeconds | 77 | 6 | 48 | 0 | 1.26325E+14 | 1.000 | | [Base224 to decimal] |
| | ACS Mode | Recently completed ACS activity (bdot data only updates for Detumble and MagAlign, see "Types" tab) | [Character] | 83 | 1 | 8 | -- | -- | -- | ASCII 1-4 | [Binary to ASCII] |
| | bdot_time | (1) start time of Detumble/MagAlign (from 1970/1/1 00:00) | Seconds | 84 | 4 | 32 | 0 | 2517630975 | 1.000 | | [Base224 to decimal] |
| | bdot_mag_x | (1) Non-calibrated magnetic field intensity-x | uTesla | 88 | 2 | 16 | -999 | 999 | 0.040 | | [Base224 to decimal & scaled] |
| | bdot_mag_y | (1) Non-calibrated magnetic field intensity-y | uTesla | 90 | 2 | 16 | -999 | 999 | 0.040 | | [Base224 to decimal & scaled] |
| | bdot_mag_z | (1) Non-calibrated magnetic field intensity-z | uTesla | 92 | 2 | 16 | -999 | 999 | 0.040 | | [Base224 to decimal & scaled] |
| | bdot_gyro_x | (1) calibrated spin rate-x (should be greater than final to verify maneuver phase performance) | Radians/sec | 94 | 2 | 16 | -5 | 5 | 0.000 | | [Base224 to decimal & scaled] |
| | bdot_gyro_y | (1) calibrated spin rate-y (should be greater than final to verify maneuver phase performance) | Radians/sec | 96 | 2 | 16 | -5 | 5 | 0.000 | | [Base224 to decimal & scaled] |
| | bdot_gyro_z | (1) calibrated spin rate-z (should be greater than final to verify maneuver phase performance) | Radians/sec | 98 | 2 | 16 | -5 | 5 | 0.000 | | [Base224 to decimal & scaled] |
| | bdot_magtor_x | (1) magnetorquer value-x (typically railed) | [Cmd value] | 100 | 2 | 16 | -255 | 255 | 0.010 | | [Base224 to decimal & scaled] |
| | bdot_magtor_y | (1) magnetorquer value-y (typically railed; high during alignment) | [Cmd value] | 102 | 2 | 16 | -255 | 255 | 0.010 | | [Base224 to decimal & scaled] |
| | bdot_magtor_z | (1) magnetorquer value-z (typically railed) | [Cmd value] | 104 | 2 | 16 | -255 | 255 | 0.010 | | [Base224 to decimal & scaled] |
| | bdot_dtime | (C) time since start of Detumble/MagAlign | Seconds | 106 | 2 | 16 | 0 | 50175 | 1.000 | | [Base224 to decimal] |
| | bdot_mag_x | (C) Non-calibrated magnetic field intensity-x | uTesla | 108 | 2 | 16 | -999 | 999 | 0.040 | | [Base224 to decimal & scaled] |
| | bdot_mag_y | (C) Non-calibrated magnetic field intensity-y | uTesla | 110 | 2 | 16 | -999 | 999 | 0.040 | | [Base224 to decimal & scaled] |
| | bdot_mag_z | (C) Non-calibrated magnetic field intensity-z | uTesla | 112 | 2 | 16 | -999 | 999 | 0.040 | | [Base224 to decimal & scaled] |
| | bdot_gyro_x | (C) calibrated spin rate-x (should be <2deg/s for final detumble, <1deg/s for alignment) | Radians/sec | 114 | 2 | 16 | -5 | 5 | 0.000 | | [Base224 to decimal & scaled] |
| | bdot_gyro_y | (C) calibrated spin rate-y (should be <2deg/s for final detumble, <1deg/s for alignment) | Radians/sec | 116 | 2 | 16 | -5 | 5 | 0.000 | | [Base224 to decimal & scaled] |
| | bdot_gyro_z | (C) calibrated spin rate-z (should be <2deg/s for final detumble, <1deg/s for alignment) | Radians/sec | 118 | 2 | 16 | -5 | 5 | 0.000 | | [Base224 to decimal & scaled] |
| | bdot_magtor_x | (C) magnetorquer value-x (typically railed) | [Cmd value] | 120 | 2 | 16 | -255 | 255 | 0.010 | | [Base224 to decimal & scaled] |
| | bdot_magtor_y | (C) magnetorquer value-y (typically railed; high during alignment) | [Cmd value] | 122 | 2 | 16 | -255 | 255 | 0.010 | | [Base224 to decimal & scaled] |
| | bdot_magtor_z | (C) magnetorquer value-z (typically railed) | [Cmd value] | 124 | 2 | 16 | -255 | 255 | 0.010 | | [Base224 to decimal & scaled] |
| | bdot_bdot_X | (C) Bdot X | uTesla/Sec | 126 | 2 | 16 | -50 | 50 | 1.993E-03 | | [Base224 to decimal & scaled] |
| | bdot_bdot_Y | (C) Bdot Y | uTesla/Sec | 128 | 2 | 16 | -50 | 50 | 1.993E-03 | | [Base224 to decimal & scaled] |
| | bdot_bdot_Z | (C) Bdot Z | uTesla/Sec | 130 | 2 | 16 | -50 | 50 | 1.993E-03 | | [Base224 to decimal & scaled] |
| | Alignment Error | Average measured magnetic field to target magnetic field vector, absolute angle (non-calibrated) | Radians | 132 | 1 | 8 | 0 | 3.2 | 0.014 | | [Base224 to decimal & scaled] |
| | Pointing Error | Average measured sun to target sun vector absolute angle (T0+160 to T0+300 in Pointing Packet) | Radians | 133 | 1 | 8 | 0 | 3.2 | 0.014 | | [Base224 to decimal & scaled] |

Table 2: SOH Packet Description (part 2 of 2)

| Group | Var Name | CONTENT Description | Final Unit | BINARY FORMAT | | | SCALED VALUES | | | ENGINEERING UNITS | |
|-------------|--|--|------------|---------------|-------|------|---------------|------------|------------|--|---|
| | | | | Offset | Bytes | Bits | Range Min | Range Max | Resolution | Valid Range | Conversion |
| EPS Current | Sl_time | Posix time of Sensor Interface readings (EPS Current and Temp, from 1970/1/1 00:00) | Seconds | 134 | 4 | 32 | 0 | 2517630975 | 1.000 | | [Base224 to decimal] |
| | i_sat | Current of satellite (original value is an integer) | mAmps | 138 | 2 | 16 | 0 | 1023 | 0.020 | dec 0-1023 | $mA=4.8876 * [Base224 \text{ to dec \& scale}]$ |
| | i_sten | Current of stensat board (original value is an integer, can saturate) | mAmps | 140 | 2 | 16 | 0 | 1023 | 0.020 | dec 0-1023 | $mA=0.2273 * [Base224 \text{ to dec \& scale}]$ |
| | i_EPS | Current of EPS board (original value is an integer) | mAmps | 142 | 2 | 16 | 0 | 1023 | 0.020 | dec 0-1023 | $mA=0.2206 * [Base224 \text{ to dec \& scale}]$ |
| | i_phone | Current of phone board (original value is an integer, can saturate) | mAmps | 144 | 2 | 16 | 0 | 1023 | 0.020 | dec 0-1023 | $mA=0.1955 * [Base224 \text{ to dec \& scale}]$ |
| | i_ADCS | Current of ADCS Arduino (original value is an integer, can saturate) | mAmps | 146 | 2 | 16 | 0 | 1023 | 0.020 | dec 0-1023 | $mA=0.2506 * [Base224 \text{ to dec \& scale}]$ |
| | i_MHX | Current of MHX radio (original value is an integer) | mAmps | 148 | 2 | 16 | 0 | 1023 | 0.020 | dec 0-1023 | $mA=2.4438 * [Base224 \text{ to dec \& scale}]$ |
| | i_router | Current of router board (original value is an integer) | mAmps | 150 | 2 | 16 | 0 | 1023 | 0.020 | dec 0-1023 | $mA=0.1955 * [Base224 \text{ to dec \& scale}]$ |
| | i_GPS | Current of GPS Receiver (original value is an integer, 3200=0) | mAmps | 152 | 2 | 16 | 0 | 32000 | 0.638 | dec 0-1023 | $mA=0.0513 * [Base224 \text{ to dec \& scale}]$ |
| | i_PL | Current of EPISEM Payload (original value is an integer, 3200=0) | mAmps | 154 | 2 | 16 | 0 | 32000 | 0.638 | dec 0-1023 | $mA=0.0513 * [Base224 \text{ to dec \& scale}]$ |
| | i_Lithium | Current of Lithium Radio (original value is an integer) | mAmps | 156 | 2 | 16 | 0 | 1023 | 0.020 | dec 0-1023 | $mA=1.4375 * [Base224 \text{ to dec \& scale}]$ |
| | i_solarXp | Current of solar panel X+ (original value is an integer) | mAmps | 158 | 1 | 8 | 0 | 1023 | 4.587 | dec 0-1023 | $r = [Base224 \text{ to decimal \& scaled}]$ |
| | i_solarXn | Current of solar panel X- (original value is an integer) | mAmps | 159 | 1 | 8 | 0 | 1023 | 4.587 | dec 0-1023 | |
| | i_solarYp | Current of solar panel Y+ (original value is an integer) | mAmps | 160 | 1 | 8 | 0 | 1023 | 4.587 | dec 0-1023 | $mA=0.2444 * r$ |
| | i_solarYn | Current of solar panel Y- (original value is an integer) | mAmps | 161 | 1 | 8 | 0 | 1023 | 4.587 | dec 0-1023 | |
| i_solarZp | Current of solar panel Z+ (original value is an integer) | mAmps | 162 | 1 | 8 | 0 | 1023 | 4.587 | dec 0-1023 | $r = [Base224 \text{ to decimal \& scaled}]$ | |
| i_solarZn | Current of solar panel Z- (original value is an integer) | mAmps | 163 | 1 | 8 | 0 | 1023 | 4.587 | dec 0-1023 | | |
| t_Lithium | Temp of Lithium Radio (original value is an integer) | Celsius | 164 | 2 | 16 | 0 | 1023 | 0.020 | dec 0-1023 | | |
| Temperature | t_EPS | Temp of EPS board (original value is an integer) | Celsius | 166 | 2 | 16 | 0 | 1023 | 0.020 | dec 0-1023 | $r = [Base224 \text{ to decimal \& scaled}]$ |
| | t_ADCS_MHX | Temp of ADCS_MHX board (original value is an integer) | Celsius | 168 | 2 | 16 | 0 | 1023 | 0.020 | dec 0-1023 | |
| | t_router | Temp of router board (original value is an integer) | Celsius | 170 | 2 | 16 | 0 | 1023 | 0.020 | dec 0-1023 | $C = 0.4888 * r - 273.15$ |
| | t_sten | Temp of stensat board (original value is an integer) | Celsius | 172 | 1 | 8 | 0 | 1023 | 4.587 | dec 0-1023 | |
| | t_phone | Temp of phone board (original value is an integer) | Celsius | 173 | 1 | 8 | 0 | 1023 | 4.587 | dec 0-1023 | $r = [Base224 \text{ to decimal \& scaled}]$ |
| | t_solarXp | Temp of solar panel X+ (original value is an integer) | Celsius | 174 | 1 | 8 | 0 | 1023 | 4.587 | dec 0-1023 | |
| | t_solarXn | Temp of solar panel X- (original value is an integer) | Celsius | 175 | 1 | 8 | 0 | 1023 | 4.587 | dec 0-1023 | |
| | t_solarYp | Temp of solar panel Y+ (original value is an integer) | Celsius | 176 | 1 | 8 | 0 | 1023 | 4.587 | dec 0-1023 | if <512, $C = 0.25 * r$, |
| | t_solarYn | Temp of solar panel Y- (original value is an integer) | Celsius | 177 | 1 | 8 | 0 | 1023 | 4.587 | dec 0-1023 | |
| | t_solarZp | Temp of solar panel Z+ (original value is an integer) | Celsius | 178 | 1 | 8 | 0 | 1023 | 4.587 | dec 0-1023 | if ≥ 512 $C = -0.25 * (r - 1024)$ |
| | t_solarZn | Temp of solar panel Z- (original value is an integer) | Celsius | 179 | 1 | 8 | 0 | 1023 | 4.587 | dec 0-1023 | |
| Check | CHKSUM | Checksum for the packet (Modified Fletcher-16, IETF RFC1145; offset each byte by +32, sum, apply modulo 224) | [Check] | 180 | 2 | 16 | -- | -- | -- | | |
| Dyn. | WD_time_s | Posix time of battery voltage measure (updated periodically by WD; before GPS, WD uses run-time) | Seconds | 182 | 4 | 32 | 0 | 2517630975 | 1.000 | | [Base224 to decimal] |
| | WD_voltage | Scaled battery voltage (updated periodically by WD, integer) | Volts | 186 | 1 | 8 | 0 | 1023 | 4.567 | dec 0-1023 | $V=[Base224 \text{ to dec \& scale}]/102.4$ |

Table 3: Science Packet Description

| Group | Var Name | Description | Final Unit | BINARY FORMAT | | | SCALED VALUES | | | ENGINEERING UNITS | |
|---|------------------------------------|---|-------------|---------------|-------|------|---------------|------------|------------|----------------------|---------------------------------------|
| | | | | Offset | Bytes | Bits | Range Min | Range Max | Resolution | Valid Range | Conversion |
| Header | start_word | Start of packet definition, "EDSN" in ASCII | [tag] | 0 | 4 | 32 | ~ | ~ | ~ | ASCII "EDSN" | [Binary to ASCII] |
| | msg_type | Message Type Definition (value 33 to 255, defined on "Types" tab) | [character] | 4 | 1 | 8 | ~ | ~ | ~ | dec 34 | [Binary to ASCII] |
| | src_id | Identification Symbol "A"-Z" of the spacecraft sending the packet | [character] | 5 | 1 | 8 | ~ | ~ | ~ | ASCII A-H | [Binary to ASCII] |
| | msg_num | Message Number (separate count for each message type, starts with zero, loops after max value) | [count] | 6 | 2 | 16 | 0 | 50175 | 1.000 | | [Base224 to decimal] |
| | time_s | Posix Time message created (4B for s and 2B for ms, from 1970/1/1 00:00) | sec | 8 | 4 | 32 | 0 | 2517630975 | 1.000 | | [Base224 to decimal] |
| Science Data (Entire block is encoded with Base224 algorithm. See instructions below.) | time_ms | Posix Time message created (4B for s and 2B for ms, from 1970/1/1 00:00, only uses 0 to 999) | msec | 12 | 2 | 16 | 0 | 50175 | 1.000 | dec 0-999 | [Base224 to decimal] |
| | [Encoding] | Base224 encoding overhead (1768 encoded for 1658 decoded; 8/7.5 ratio) | [Encoding] | 14 | 11 | 88 | ~ | ~ | ~ | | |
| | pl_start_s | Receipt Time of EPISEM Measurement (4B for s and 1B for ms, from 1970/1/1 00:00) | sec | | 4 | 32 | 0 | 4294967295 | 1.000 | | [Base224 to Base256 to decimal] |
| | pl_start_ms | Receipt Time of EPISEM Measurement (4B for s and 1B for ms, from 1970/1/1 00:00) | msec | | 1 | 8 | 0 | 999 | 3.918 | | [Base224 to Base256 to dec & scale] |
| | pl_data0 | Serial Number | [count] | | 1 | 8 | 0 | 255 | 1.000 | | [Base224 to Base256 to decimal] |
| | pl_data1 | Control Register (see comment, should return 0x16 after proper command) | [binary] | | 1 | 8 | ~ | ~ | ~ | hex 16 | [Base224 to Base256 binary] |
| | pl_data2 | Packet Counter (counter resets at payload restart) | [count] | | 2 | 16 | 0 | 65535 | 1.000 | dec 0-10 | [Base224 to Base256 to decimal] |
| | pl_data4 | Temp Monitor 0 (AD590 sensor, +X/+Z corner) | [count] | | 1 | 8 | 0 | 255 | 1.000 | dec >0 | r = [Base224 to Base256 to decimal] |
| | pl_data5 | Temp Monitor 1 (AD590 sensor, -X/-Z corner) | [count] | | 1 | 8 | 0 | 255 | 1.000 | dec >0 | celcius= 3.06663*r-273.15 |
| | pl_data6 | HVPS Volt Mon | [count] | | 2 | 16 | 0 | 65535 | 1.000 | dec >0 | volts=(- 1E-4)*r^2+0.82*r-1.75 |
| | pl_data8 | HVPS Set Volt | [count] | | 1 | 8 | 0 | 255 | 1.000 | dec >0 | volts=(-2.8898E-4)*r^2+3.1335*r+25.69 |
| | pl_data9 | 5V Voltage | [count] | | 1 | 8 | 0 | 255 | 1.000 | dec >0 | volts=0.021353*r |
| | pl_data10 | 5V Current | [count] | | 2 | 16 | 0 | 65535 | 1.000 | dec >0 | milliamp=0.035448*r |
| | pl_data12 | 3.3V Voltage | [count] | | 1 | 8 | 0 | 255 | 1.000 | dec >0 | volts=0.021353*r |
| | pl_data13 | 3.3V Current | [count] | | 2 | 16 | 0 | 65535 | 1.000 | dec >0 | milliamp=0.035448*r |
| | pl_data15 | FSW Revision (should be 0x4c) | [count] | | 1 | 8 | 0 | 255 | 1.000 | dec 76 | [Base224 to Base256 to decimal] |
| | pl_data16 | VBATT Voltage (volts=0.054935*r) | [count] | | 1 | 8 | 0 | 255 | 1.000 | 6.5V-8.5V | volts=0.054935*r |
| | pl_data17 | VBATT Current | [count] | | 2 | 16 | 0 | 65535 | 1.000 | | milliamp=0.035448*r |
| | pl_data19 | CPU Status (binary, see comment) | [binary] | | 1 | 8 | ~ | ~ | ~ | hex 00 | [Base224 to Base256 binary] |
| | pl_data20 | CPU Status (binary, see comment) | [binary] | | 1 | 8 | ~ | ~ | ~ | hex 83 | [Base224 to Base256 binary] |
| | pl_data21 | CRC Fail Counter (number of commands received with bad CRCs) | [count] | | 1 | 8 | 0 | 255 | 1.000 | | [Base224 to Base256 to decimal] |
| | pl_data22 | Invalid Command Counter | [count] | | 1 | 8 | 0 | 255 | 1.000 | | [Base224 to Base256 to decimal] |
| | pl_data23 | Bytes Sent | [count] | | 3 | 24 | 0 | 16777215 | 1.000 | | [Base224 to Base256 to decimal] |
| | pl_data27 | Bytes Received (should return 0x11 after proper command) | [count] | | 2 | 16 | 0 | 65535 | 1.000 | dec 17 | [Base224 to Base256 to decimal] |
| | pl_data28 | Low Voltage Reset Flag | [count] | | 1 | 8 | 0 | 255 | 1.000 | | [Base224 to Base256 to decimal] |
| | pl_data29 | Science Data 1 - 60 (2 bytes per one-second bin) | [count] | | 120 | 960 | 0 | 65535 | 1.000 | | [Base224 to Base256 to decimal] |
| | pl_data149 | Spare Data Fields | [none] | | 9 | 72 | ~ | ~ | ~ | | [Base224 to Base256] |
| pl_data158 | CCITT 16-bit CRC of bytes 0 to 157 | [crc] | | 2 | 16 | ~ | ~ | ~ | | [Base224 to Base256] | |
| Check | CHKSUM | Checksum for the packet (Modified 8-bit Fletcher, IETF RFC1145; offset each byte by +32, sum, apply modulo 224) | [check sum] | 190 | 2 | 16 | ~ | ~ | ~ | | |

Table 4: Science Data Decoding Byte Order

| | | | | | | | | | | | | | | | | | | |
|--------------|-------|--------|---------|---------|---------|---------|---------|---------|-------|--------|---------|---------|---------|---------|---------|---------|-----|-----|
| encoded byte | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | ... | 175 |
| encoded bits | 0...7 | 8...15 | 16...23 | 24...31 | 32...39 | 40...47 | 48...55 | 56...63 | 0...7 | 8...15 | 16...23 | 24...31 | 32...39 | 40...47 | 48...55 | 56...63 | ... | |
| chunk number | 0 | | | | | | | | 1 | | | | | | | | ... | 22 |
| decoded bits | 0...7 | 8...15 | 16...23 | 24...31 | 32...39 | 40...47 | 48...55 | 56...59 | 0...3 | 4...11 | 12...19 | 20...27 | 28...35 | 36...43 | 44...51 | 52...59 | | |
| decoded byte | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | ... | 164 | |