AMSAT OSCAR-13 Telemetry Block Format

DD1US, March 14th 2019

Qatar OSCAR-100 also features a 400 Baud PSK beacon. To many of us the sound of that beacon is well known from AO-10 and AO-13 days. Some are working on refurbishing their old hardware or software decoders and for reference please find below the telemetry block format of AO-13 as It was described by Peter DB2OS in the AMSAT-DL journal in 1989.

Peter Gülzow, DB2OS

AMSAT OSCAR-13 Telemetrie Block Format

AMSAT OSCAR-13 (like all P3-Satellites) transmits 512 bytes per block, treated as 8 lines of 64 bytes each. Blocks are identified according to the first byte of the block (followed by a space, 20H, ie. 20 hexadecimal).

K, L, M, N blocks are message blocks (flying mailbox) from one command station to another, but also used for broadcast. All characters use ASCII representation. Bit 7 set to 1 may be used to indicate highlighted charcter display. No CR/LF are transmitted, as they should be inserted at the ground after 64 received characters.

Q blocks carry 128 logical telemetry channels in compressed data format.

Y blocks carry 64 plain text analog telemetry channels and will be sent infrequently (less often than Q-blocks). It is proposed to use the Q-blocks for decoding, since Y-blocks may be withdrawn in the future.

```
Q-Block format:

     Q  HI, THIS IS AMSAT OSCAR 13                    hh:mm:ss  dddd
     #hhhh   #hhhh   #hhhh
     ddd ddd ddd ddd ddd ddd ddd

     0123456789ABCDEF0123456789ABCDEF0123456789ABCDEF0123456789ABCDEF
     0123456789ABCDEF0123456789ABCDEF0123456789ABCDEF0123456789ABCDEF
     0123456789ABCDEF0123456789ABCDEF0123456789ABCDEF0123456789ABCDEF
     0123456789ABCDEF0123456789ABCDEF0123456789ABCDEF0123456789ABCDEF


Line specification:

Line Ø:
     Byte pos.= 0     2            48          58
                <Q¦Y> <text,name>   hh:mm:ss    dddd
                                     U T C      AMSAT day number
                                                (1 January 1978 = 0)

Line 1:
     Byte pos.= 0            8            16
                #hhhh        #hhhh        #hhhh
                safety       transponder  command
                information  status       number
                word         (Syspage
                (see below)   byte #5E)

                Safety Information Word (Emergency Flags):
                     bit    significance
                      0..7  as Syspage byte #56
                      8     Low power supply voltage, QRP mode
                      9     Extremely low power supply voltage, QRPP mode
                     10     Loss of Command Lock (Watchdog)
                     11     Temperature too high (battery or transponder)
                     12     Sun angle exceeds 38 degrees
                     13..15 not used

Line 2:
     Byte pos.= 0       4       8       12      16      20      24
                ddd     ddd     ddd     ddd     ddd     ddd     ddd
                2MUX0   2MUX1   2MUX2   2MUX3   2MUX4   2MUX5   2MUX6
     (Syspage   #40     #41     #42     #43     #44     #45     #46)

Line 3:   blank line.

Line 4:
     Byte = Ø             10              20              30
            0123456789ABCDEF0123456789ABCDEF0123456789ABCDEF0123456789ABCDEF
```

Line 5:

```
      Byte = 40              50              60              70
             0123456789ABCDEF0123456789ABCDEF0123456789ABCDEF0123456789ABCDEF
```

Line 4 and 5 are the telemetry channels #ØØ to #7F of the INTERMEDIATE EVENT SYSPAGE buffer. Up to 6 events are stored, 128 bytes per event. The buffers are read out cyclically, one event at a time. The time recorded and the event counter identify the particular event.

Line 6:

```
      Byte = 0               10              20              30
             0123456789ABCDEF0123456789ABCDEF0123456789ABCDEF0123456789ABCDEF
```

Line 7:

```
      Byte = 40              50              60              70
             0123456789ABCDEF0123456789ABCDEF0123456789ABCDEF0123456789ABCDEF
```

Line 6 and 7 are the SYSPAGE logical telemetry channels #ØØ to #7F, normally used to display real time telemetry. Decode according to the OSCAR-13 telemetry decoding document. Bytes are expressed directly, not as character values.

In Y-Blocks only SYSPAGE channels #ØØ to #3F (analog channels) are transmitted in ASCII (16 channels per line, 4 bytes per channel).

Example for Y-Blocks:

```
Y  HI, THIS IS AMSAT OSCAR 13                    19:22:41  3894
#00A6   #0020   #0193
64  1   255 166 19  230 0

193 7   147 7   193 7   164 117 200 7   130 25  118 7   149 32
7   7   133 7   13  7   131 112 14  7   131 7   112 7   131 7
155 129 134 148 191 145 132 142 75  145 132 7   228 129 127 7
179 129 126 128 62  141 132 7   13  127 124 7   208 133 125 7
```

Example for decoded Q-Blocks: (as displayed on the ATARI 800XL IPS ground software package of AMSAT-DL)

Communication:

```
Q  HI, THIS IS AMSAT OSCAR 13                    19:25:57  3894
       #00A6   #0020   #0193      64  1   255 166 19  230 0
SA    1.2
COM-U                                            RUDAK-ON
CMD-F    -140   U9-V       9.1   2-ANT  HI       T-TX      25.7
F-BIT    405.5  U14V-ST   14.6   70-ANT  HI      T-RX      15.7
AGC DB     -6   I14V-ST   2402                   T-S        4.0
MEM         5   CW-S        55                   P-OUT     11.2
```

Power:

```
Q  HI, THIS IS AMSAT OSCAR 13                    19:25:57  3894
       #00A6   #0020   #0193      64  1   255 166 19  230 0
SA    1.2
STROEME:        SPANNUNGEN:     LEISTUNGEN:      PANEL-I UND T:
                BCR-SIN   31.0                   P1         422
BCR-IN      0   BCR-IN    37.2  PANELS     0.0   P2         160
BAT-NET    74                   P-BAT      1.0   P3           0
BAT-CH      0   BCR-SO    14.5                   P4         611
BCR-OUT  2596   BCR-OUT   14.6  BCR-OUT   37.9   P5         694
14V-ST   2402   14V-ST    14.6  P-TRANS   35.0   P6           0
14V-S      43   A-BAT      0.2  P-HF      11.2   SC-ROH   #00F1
10V-C      77   10V-C     10.0                   T-P1       8.1
                BCR-01    10.0                   T-ABAT1    6.4
                BCR-02     0.7                   T-MBAT     6.4

(Currents       Voltages        Power Levels     Panel Current & Temp)
```

Temperatures:

```
Q  HI, THIS IS AMSAT OSCAR 13                    19:25:57  3894
       #00A6   #0020   #0193      64  1   255 166 19  230 0
SA    1.2
```

```
T'S ARM 1:      T'S ARM 2:      T'S ARM 3:      T'S ZENTRUM:
P1        8.1   P3        6.9   P5        6.9   N2O4      6.9
RX-U     15.7   SEU       7.5   HELIUM    5.2   AZ50      7.5
RX-L     14.5   T-TO-S    1.7   IHU       5.8
WALL     12.2   WALL      5.2   RUDAK     5.2
TOP       4.0   BCR      16.9   M-BAT     6.4
BOTTOM    3.4   ABAT-1    6.4   NUT-D     2.8
TX-U     25.7   ABAT-2    6.4
TX-L     14.5
TX-S      4.0
```

Navigation:

```
Q  HI, THIS IS AMSAT OSCAR 13                    19:25:57  3894
      #00A6   #0020   #0193       64  1   255 166 19  230 0
SA    1.2
NAV, POS:   162-165
SPINRATE  36.1  SS-1        0*  S-SENS      5
T-HE       5.2  SS-2        1*  ES-SENS    64
T-N2O4     6.9  LS-A(MV)    0   LS-R'S     7.5
T-AZ50     7.5  LS-M(MV)    8   L-O#,Z  #A26F
                ES-M      241   U-O#,Z  #A26F
                ES-A      241
                SPERR-#    15
                M-STATUS    0
                M-SOLL    246
```

SYSPAGE Logical Telemetry Channels:

This section describes the decoding of the 128 logical telemetry channels of the AMSAT Phase 3C satellite, OSCAR-13.

Bytes are counted in the followings ways:

```
C  - unsigned count (0 to +255)
Cs - signed count (-128 to +127, 2s complement)
Cx - signed count (+63 to -192, #3F=+63, #FF=-1, #80=-128,
                   #7F=-129, #40=-192, modified 2s complement)
```

All temperature channels are decoded identically using the following formula:

```
Temp:  T = (C-120)/1.71  Celsius
```

Current channels are linear, but have different calibrations for 1A, 2.5A and 5A max. current:

```
  1A:  I = (C-15) *  4.854 mA
2.5A:  I = (C-15) * 12.135 mA
  5A:  I = (C-15) * 24.27  mA
```

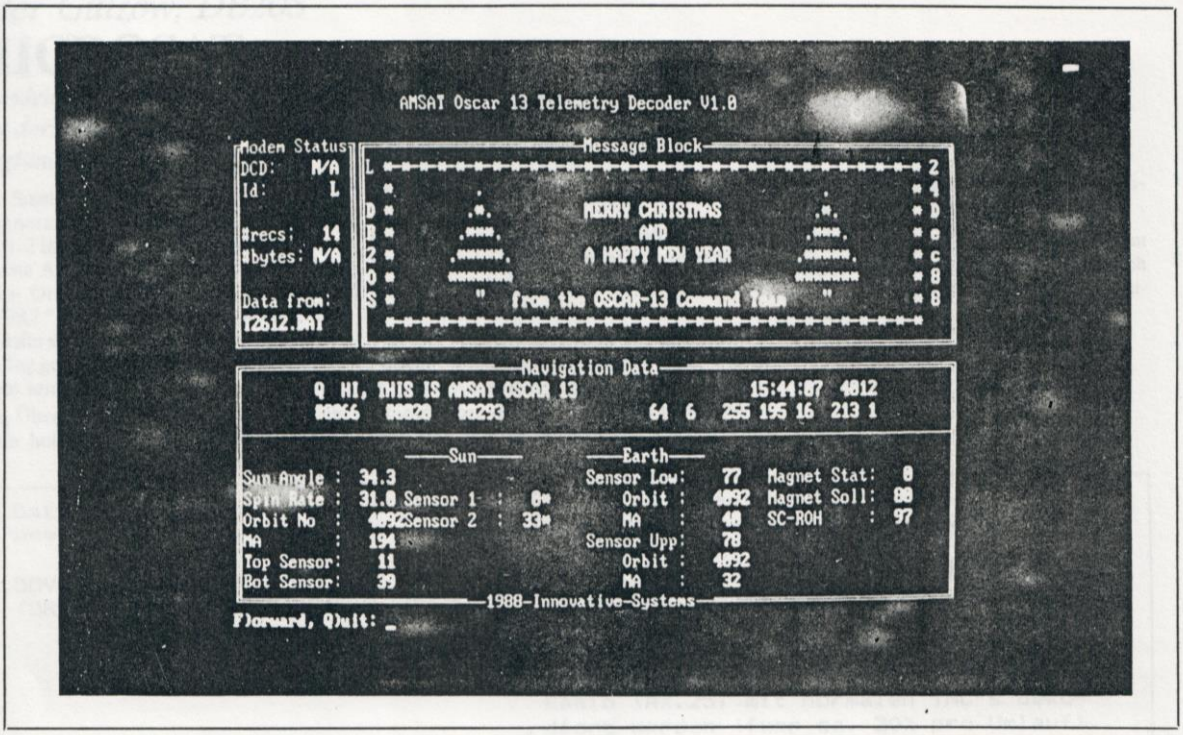
Channel Identification and Decoding Equations:

Byte	Channel	Calibration	Remarks
00	U_{in}-BCR	U=(C-10)*167mV	U-Panel: +0.6V @ 0.35A +0.7V @ 1A
01	Tx-PWR_{out}-L	Average power=(261-C)²/724 Watts	
02	T-Rx-U	Temp	Mode-B receiver temperature.
03	---		
04	U_{out}-BCR	U=(C-10)*79.5mV	BCR output voltage.
05	---		
06	T-TX-U	Temp	Mode-B transmitter temperature.
07	I-14V-ST	5A	Transponder supply voltage.
08	U-10V-C	U=(C-10)*53.2mV	Computer supply voltage
09	P-He-Hi	P=(C-14)*6.56bar	Helium tank pressure.
0A	T-IHU	Temp	Integrated Housekeeping Unit
0B	I-14V-S	1A	Supply voltage, 14V that supplies torquer and LIU.
0C	BCR-Oscill	>~6=OK	BCR status. No count = not working. Typically C=60.
0D	P-He-Lo	P=(C-106)*0.733bar	Helium regulator output.

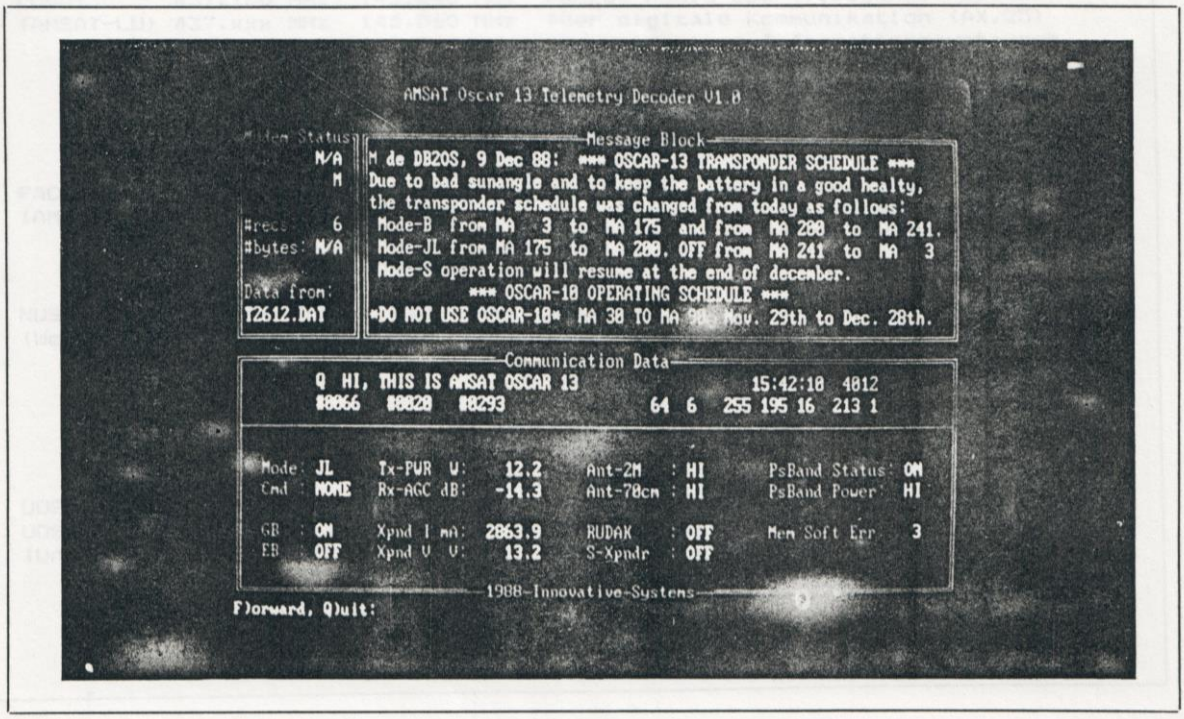
0E	T-BCR	Temp	Battery Charge Regulator.
0F	I-10V-C	1A	10V continuous power supply.
10	BCR-Oscill2	As channel 0C	
11	P-Tank	P=(C-106)*0.733bar	N2O4 tank pressure.
12	T-SEU	Temp	Sensor Electronics Unit
13	I-Bat-Ch	2.5A	Charging current to battery.
14	L-Sensor (Ant)	U=(C-10)*8.53mV	Light-Sensor Antenna Side.
15	Motor Valve	102 closed, 118 open	
16	T-ABAT1	Temp	Auxiliary battery 1
17	I-BCR-OUT	5A	14V line to battery and other consumers.
18	L-Sensor (Mot)	U=(C-10)*8.53mV	Light-Sensor Motor Side.
19	---		
1A	T-ABAT2	Temp	Auxiliary battery 2
1B	I-BCR-IN	Equivalent to total current of all panels, not available due to sensor failure.	
1C	Spin rate	C>131, Spin rate=479/(C-109)-2 rpm C<=131, Spin rate=(131-C)*0.85+20 rpm	
1D	Rx-L-AGC	Gain reduction=$(C-75)^2/1125$ dB	
1E	T-MBAT	Temp	Main battery (normally in use)
1F	I-Panel6	1A	Solar panel 6
20	$Tx\text{-}U\text{-}PWR_{out}$	Average power=$(287-C)^2/1796$ Watts	
21	T-He-Tank	Temp	
22	T-Panel1	Temp	
23	I-Panel5	1A	
24	Rx-U-AGC	Gain reduction=$(C-71)^2/2465$ dB	
25	T-Tx-L	Temp	Mode-JL transmitter.
26	T-Panel3	Temp	
27	I-Panel4	1A	
28	---		
29	T-Rx-L	Temp	Mode-L receiver.
2A	T-Panel5	Temp	
2B	I-Panel3	1A	
2C	U-14V-ST	U=(C-10)*66.8mV	Transponder supply bus.
2D	T-RUDAK	Temp	RUDAK temperature.
2E	T-top	Temp	Arm 1, Antenna side.
2F	I-Panel2	1A	
30	U-9V-U	U=(C-10)*54mV	Internal 9 volt bus from transponder.
31	T-wall-arm2	Temp	
32	T-bottom	Temp	Arm 1, Motor side.
33	I-Panel1	1A	
34	---		
35	T-wall-arm1	Temp	
36	T-N2O4	Temp	
37	---		
38	U-ABAT	U=(C-10)*78.5mV	Auxiliary battery voltage.
39	T-S-xpnder	Temp	Mode-S transponder.
3A	T-L-Sensor	Temp	Light sensor antenna side.
3B	---		
3C	U-9V-L	U=(C-10)*45.4mV	As channel 30.
3D	T-AZ50-Tank	Temp	
3E	T-nutation damper	Temp	Arm 3.
3F	---		
40	ES-Sensitivity	2MUX0	Earth Sensor sensitivity
		bit significance 0 LSB 20mV 1 37mV 2 75mV 3 150mV 4 300mV 5 600mV 6 1.2V 7 MSB 2.4V	Hysteresis 200mV Threshold 600mV
41	Antenna/SERI	2MUX1	Antenna relays and SERI resistors.
		bit significance 0 LSB Hi-gain 2m to U transponder 1 Hi-gain 70cm to L transponder 2 ┐ SERI-1 load resistor for 3 ┐ SERI-2 both Light-Sensors ┐ resistance 00 7.5 Ohm	

```
                              01  3.9 Ohm
                              10  2.3 Ohm
                              11  5.9 Ohm
42   RUDAK-Status    2MUX2              IN-B (ex Motor-PWR).
                     C=82, Standard-ROS  (S)
                     C=78, Emergency-ROS (N, Not-ROS)
                     C=80, Primitive-ROS (P)
43   S&RUDAK-CNTL    2MUX3              Mode-S and RUDAK interface.
                     bit   significance
                     0 LSB RUDAK OFF
                     1       "   NMI/
                     2       "   Byte Clock
                     3       "   Byte Data
                     4      ---
                     5     Mode-S Beacon ON
                     6       "    Squelch forced open
                     7 MSB   "    Squelch high sensitivity
44   BCR-Sin         2MUX4              Solar Array voltage to BCR.
                     U=29.1+(Cs*100)mV  (16.3V...41.8V)
45   BCR-Sout        2MUX5              Battery voltage from BCR.
                     U=14.98+(Cx*20)mV  (11.14...16.2V = 192...63)
46   BCR-relays      2MUX6
                     bit   significance
                     0 LSB BCR-2 ON
                     1     Auxiliary battery charging
                     2     Auxiliary battery connected to BCR,
                           Main battery disconnected from BCR.
47   SS-1            C=255 or C=0, PLL locked
                                        Sun-Sensor angular position
                                        oscillator, Slot antenna side.
48   SS-2            Time offset from SS-1
49   Flag-SS         C=1, SS-1          Sun sensor data.
                     C=2, SS-2
4A   SPIN-RAW                           Raw spin count (1/256).

4B   Sensor-control  bit   significance  (OUT4)
                     0 LSB ──  MUX-CTRL for sensor elec. module
                     1     ─┐
                            ├┐
                            00 - Sun data
                            01 - spin ref./spin counter
                            10 - ES lower beam
                            11 - ES upper beam
                     2     Earth sensor positive edge select.
                           (Strobes value of spin count at transition.)
                     3     Motor Instrumentation ON.
                           (Pressure sensors, motor valve indicator.)
                     4     0.3V Sun Sensor Sensitivity
                     5     0.6V  "    "          "
                     6     1.2V  "    "          "
                     7 MSB 2.4V  "    "          "
                           (Max threshold #F = 1 solar constant)
4C   SS-correction
4D   Last ES-A       Z                  last ES-pulse Antenna side.
4E     "             O#                 (Orbit number and MA value)
4F   Last ES-M       Z                  last ES-pulse Motor side.
50     "             O#                 (Orbit number and MA value)
51   Lockoutrange    Within ±C counts from sun sensor pip, earth sensor
                     handler ignores data (Spin count 1 circle=256 counts.)
52   ES-A            Strobed spin count at edge selected,
                                        Antenna Side beam.
53   Update Flag1    Indicates update,Antenna Side beam.
54   ES-M            As channel 52      Motor Side beam.
55   Update Flag2    As channel 53        "    "    "
56   S/C STATUS      bit   significance
                     0 LSB LIU power ON
                     1     Safe/Arm plug status 0=Safe, 1=Arm
                     2     RUDAK Status
                     3     Mode-S Squelch open
                     4     ---
```

```
                       5       Memory Soft-error Counter
                       6         "       "       "
                       7 MSB     "       "       "
57    ---
58    ---
59    ---
5A    ---
5B    N                number of 20ms per dot, morse speed.
5C    n                running count of units for morse.
5D    ---
5E    TRANSPONDER      bit     significance  (OUT7)
                       Ø LSB GB OFF
                       1     GB FSK (1=+170Hz)
                       2     DPSK OFF
                       3     EB ON
                       4       ─┐ PSK source
                       5       ─┤ for GB (EB: don't care)
                                │
                             ØØ - no PSK
                             Ø1 - ranging
                             1Ø - EB source
                       6     Transponder set to Low Power
                       7 MSB Passband OFF (Beacons and Mode-J +3dB)
5F    ---

6Ø    MODUS            bit     significance  (magnet control)
                       Ø       magnet system ON
                       1       underspun magnet
61    M-Soll           magnet vector desired angle to the despun sun
                       (clockwise as seen from top, 1 circle = 256)
62    M-Out            bit     significance  (OUT3, also L,S,J control)
                       Ø LSB polarity Arm 1
                       1     polarity Arm 2
                       2     polarity Arm 3
                       3     Magnet power ON
                       4     Mode-J ON
                       5     ---
                       6     Mode-S ON
                       7 MSB Mode-L ON
63    O-FRAC-lo        Fractional Z increment in 2Øms
64    O-FRAC-hi                        Counts down to Ø from preset
                                       value. 255th Z has different
                                       value of O-FRAC. ~7ØØØ counts/Z.
65    O/256            Z from perigee.
66    O#-lo            Orbit number
67    O#-hi
68    Clock            1Øms            Time in UTC.
69                     sec
6A                     min
6B                     hour
6C                     day             1st January 1978 = AMSAT day Ø.
6D                     256day
6E    SUØ              1Øms            IPS stopwatch Ø.
6F                     sec
7Ø                     min
71                     min*256
72    SU1              1Øms            IPS stopwatch 1.
73                     sec
74                     min
75                     min*256
76    SU2              1Øms            IPS stopwatch 2.
77                     sec
78                     min
79                     min*256
7A    SU3              1Øms            IPS stopwatch 3.
7B                     sec
7C                     min
7D                     min*256
7E    Event-Lo                         Used as event ID word
7F    Event-Hi                         in intermediate buffer
```



Bildschirmaufnahmen der AO-13-Telemetrie P3C.EXE



Kind regards

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