Interpretation and Use of Binary RSC-11-5 Data

This document describes and illustrates extraction of values from binary files generated according to the NASA Deep Space Network (DSN) RSC-11-5 Software Interface Specification (SIS) [1]. RSC-11-5 was one of several modules within DSN 820-013 that governed open loop radio science raw data products created over about two decades starting in the late 1970s.

RSC-11-5 specifies the format and content of files containing frequency tuning profiles for open loop receivers during the Voyager encounters with Saturn. These binary data supplement the RSC-11-6 digital samples from the receiver outputs [2]; both are needed for scientific analysis of the Voyager radio science observations at Saturn. Receiver operation, including equations describing the down-conversion process, is documented in [3].

Applicable Documents:

[1] *Document 820-013, DSN System Requirements, Detailed Interface Design, RSC-11-5, Medium-Band POCA Data ODR Tape*.

[2] *Document 820-013 (Rev. A), DSN System Requirements, Detailed Interface Design, RSC-11-6, DSN Interfaces Radio Science, Medium Band Computer Compatible IDR,* effective date 1 July 1981.

[3] H. Donnelly and H. Nishimura, *Multi-Mission Receiver (MMR), DSN Progress Report 42-52,* May-June 1979, pp. 75-81.

File and Record Formats:

Files were originally written to magnetic tape; 'tape' terminology is retained here. Each RSC-11-5 record comprises 56 bytes of header data followed by 400 bytes of receiver tuning data. The 400 bytes are divided into ten 40-byte summaries of receiver tuning at one second intervals. The structure and an example of unpacking are summarized in Table 1. Bytes are numbered sequentially, starting with '1' for the first byte in the file. Bits are also numbered sequentially, starting from '1' in the most significant bit position of the first byte.

Example Data File:

An example RSC-11-5 file generated during the Voyager 1 encounter with Saturn has been included in the Radio Science Documentation bundle. Data were collected at DSN antenna 63 on day-of-year 318 in 1980. The example file is a truncated version of the original file; it contains the first 4 of 1408 original records. The logical identifier of the example product is

urn:nasa:pds:radiosci.documentation:dsn.rsc-11-5:poca_ex

A hexadecimal dump of the first 800 bytes of the binary file is shown in Figure 1. It was generated using the unix command

od -t x1 poca_ex.dat +0. | head -50

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0000000    40  01  00  01  00  e4  1f  3f  53  41  30  31  00  00  02  7a
0000016    32  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
0000032    00  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
0000048    00  00  00  00  00  00  00  00  9f  00  32  64  00  00  09  15
0000064    80  29  00  00  00  02  b8  00  12  75  00  cc  90  d3  66  a2
0000080    00  cc  90  d3  66  98  00  00  09  15  82  aa  00  00  00  00
0000096    9f  00  32  65  00  00  09  18  38  27  00  00  00  02  b8  00
0000112    12  75  00  cc  a8  ab  f8  0d  00  cc  a8  ab  f8  03  00  00
0000128    09  18  3a  aa  00  00  00  00  9f  00  32  66  00  00  09  1a
0000144    f0  26  00  00  00  02  b8  00  12  75  00  cc  c0  84  89  ab
0000160    00  cc  c0  84  89  a1  00  00  09  1a  f2  aa  00  00  00  00
0000176    9f  00  32  67  00  00  09  1d  a8  24  00  00  00  02  b8  00
0000192    12  75  00  cc  d8  5d  1b  6b  00  cc  d8  5d  1b  61  00  00
0000208    09  1d  aa  aa  00  00  00  00  9f  00  32  68  00  00  09  20
0000224    60  22  00  00  00  02  b8  00  12  75  00  cc  f0  35  ad  5d
0000240    00  cc  f0  35  ad  52  00  00  09  20  62  aa  00  00  00  00
0000256    9f  00  32  69  00  00  09  23  18  20  00  00  00  02  b8  00
0000272    12  75  00  cd  08  0e  3f  76  00  cd  08  0e  3f  6c  00  00
0000288    09  23  1a  aa  00  00  00  00  9f  00  32  6a  00  00  09  25
0000304    d0  1e  00  00  00  02  b8  00  12  75  00  cd  1f  e6  d1  c0
0000320    00  cd  1f  e6  d1  b6  00  00  09  25  d2  aa  00  00  00  00
0000336    9f  00  32  6b  00  00  09  28  88  1c  00  00  00  02  b8  00
0000352    12  75  00  cd  37  bf  64  37  00  cd  37  bf  64  2d  00  00
0000368    09  28  8a  aa  00  00  00  00  9f  00  32  6c  00  00  09  2b
0000384    40  1a  00  00  00  02  b8  00  12  75  00  cd  4f  97  f6  cf
0000400    00  cd  4f  97  f6  c5  00  00  09  2b  42  aa  00  00  00  00
0000416    9f  00  32  6d  00  00  09  2d  f8  18  00  00  00  02  b8  00
0000432    12  75  00  cd  67  70  89  9a  00  cd  67  70  89  90  00  00
0000448    09  2d  fa  aa  00  00  00  00  00  01  00  02  00  e4  1f  3f
0000464    53  41  30  31  00  00  02  7a  32  00  00  00  00  00  00  00
0000480    00  00  00  00  00  00  00  00  00  00  00  00  00  00  00  00
*
0000512    9f  00  32  6e  00  00  09  30  b0  16  00  00  00  02  b8  00
0000528    12  75  00  cd  7f  49  1c  8d  00  cd  7f  49  1c  84  00  00
0000544    09  30  b2  aa  00  00  00  00  9f  00  32  6f  00  00  09  33
0000560    68  14  00  00  00  02  b8  00  12  75  00  cd  97  21  af  b0
0000576    00  cd  97  21  af  a6  00  00  09  33  6a  aa  00  00  00  00
0000592    9f  00  32  70  00  00  09  36  20  12  00  00  00  02  b8  00
0000608    12  75  00  cd  ae  fa  43  03  00  cd  ae  fa  42  f9  00  00
0000624    09  36  22  aa  00  00  00  00  9f  00  32  71  00  00  09  38
0000640    d8  10  00  00  00  02  b8  00  12  75  00  cd  c6  d2  d6  73
0000656    00  cd  c6  d2  d6  6a  00  00  09  38  da  aa  00  00  00  00
0000672    9f  00  32  72  00  00  09  3b  90  0e  00  00  00  02  b8  00
0000688    12  75  00  cd  de  ab  6a  18  00  cd  de  ab  6a  0e  00  00
0000704    09  3b  92  aa  00  00  00  00  9f  00  32  73  00  00  09  3e
0000720    48  0c  00  00  00  02  b8  00  12  75  00  cd  f6  83  fd  e4
0000736    00  cd  f6  83  fd  db  00  00  09  3e  4a  aa  00  00  00  00
0000752    9f  00  32  74  00  00  09  41  00  0a  00  00  00  02  b8  00
0000768    12  75  00  ce  0e  5c  91  e0  00  ce  0e  5c  91  d6  00  00
0000784    09  41  02  aa  00  00  00  00  9f  00  32  75  00  00  09  43
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Figure 1. Hexadecimal dump of the first 800 bytes in example file *poca_ex.dat*; the byte counter along the left margin is given in decimal. The first 56 bytes (yellow highlighting) contain header information; the first three 'data' bytes are hexadecimal '9f', '00', and '32' in bytes 57-59. The second header begins at byte 457 (green highlighting).

Table 1. Unpacked Data from Record 1				
Bytes	**Bit Numbers**	**Value** (b = binary) (h = hexadecimal)	**Description**	**Unpacked Value**
1	1-8	40_h	Undefined	N/A
2	9-16	01_h	Tape number	1
3-4	17-32	0001_h	Record number	1
5-6	33-48	$00e4_h$	Record length (16-bit words); set to 228	228
7	49-56	$1f_h$	Spacecraft number	31
8	57-64	$3f_h$	Source station (DSN antenna number)	63
9-12	65-96	53413031_h	Predict set ID (4 ASCII characters)	SA01
13-14	97-112	0000_h	Undefined	N/A
15-18	113-144	$027a3200_h$	Predict base frequency (Hz)	41562624
19-56	145-448	0_h	Undefined	N/A
57-58	449-457	100111110_b	Day of year	318
58	458-463	000000_b	Undefined	N/A
58-60	464-480	00011001001100100_b	Time of day (seconds since 0h)	12900
61-66	481-528	000009158029_h	POCA frequency, displaced (2^{-20} Hz)	152404009
67-72	529-576	$00000002b800_h$	POCA ramp rate (2^{-20} Hz/s)	178176
73	577	0_b	FMS status (0=ON, 1=OFF)	0*
73	578	0_b	Undefined	N/A
73	579-580	01	Test signal select (01=POCA, 10=Input #2, 11=internal, signal 00=spare (not used)	01*
73	581-582	00_b	Undefined	N/A
73	583	1_b	Counter #1 select (1=POCA, 0=test signal)	1
73	584	0_b	Counter #2 select (1=input #2, 0=test signal)	0
74	585	0_b	POCA control (1=manual, 0=computer)	0
74	586	1_b	POCA readiness (1=ready, 0=not ready)	1
74	587	1_b	POCA synthesizer power (1=ON, 0=OFF)	1
74	588	1_b	POCA synthesizer lock (1=in lock, 0=out of lock)	1
74	589	0_b	POCA limit enable (1=ON, 0=OFF)	0
74	590	1_b	POCA track (1=ON, 0=OFF)	1
74	591	0_b	POCA acquisition (1=ON, 0=OFF)	0
74	572	1_b	POCA sweep (1=ON, 0=OFF)	1
75-80	573-640	$00cc90d366a2_h$	Cumulative phase #1 (2^{-8} cycles)	878603101858
81-86	641-688	$00cc90d36698_h$	Cumulative phase #1 (2^{-8} cycles)	878603101848
87-92	689-736	$0000091582aa_h$	Predict frequency, displaced (2^{-20} Hz)	152404650
93-96	737-768	00000000_h	Undefined	N/A
97-136	769-1088		Bytes 57-96 repeated for second n+1	
…	…		…	
417-456	3249-3648		Bytes 57-96 repeated for second n+9	

All numerical fields are binary integers. Except for the record number, the headers of each record in the example file are identical.