Interpretation and Use of Binary OLR Data

This document describes and illustrates extraction of values from binary files generated according to the Open Loop Receiver (OLR) Software Interface Specification (SIS):

[1] *Deep Space Network (DSN) External Interface Specification 820-013, 0222-Science, Open Loop Data Interface, JPL D-76531*

which was released in 2017. There are no known updates.

When the Radio Science Receiver (RSR) was replaced by the Open Loop Receiver (OLR) in 2019, one of the OLR formats was designed to be compliant with the RSR specification [2].

[2] *Deep Space Mission System (DSMS) External Interface Specification 820-013 (D-16765), 0159-SCIENCE, Radio Science Receiver Standard Format Data Unit (SFDU), Revision B*

Revision B was released in 2008. Although the RSR hardware and software are no longer available, the RSR SIS remains useful and describes all known OLR products currently being delivered for radio science. This document is based on interpretation of OLR files using [2].

Record Format:

Each OLR/RSR file comprises one or more records of fixed length. Record length depends on sampling rate and sample resolution; all records within a file have the same record length, sample rate, and sample resolution. Each record includes a 260-byte header followed by n*1000 complex samples, each with an in-phase (I) and quadrature (Q) component. The header contains dozens of parameters in integer, floating point, and character formats occupying fields with 8, 16, 32, or 64 bits. The I and Q samples are binary integers each with 1, 2, 4, 8, or 16 bits. All header and data values are stored in most significant byte first (MSB, or big-endian) order.

Example Data:

Examples of both RSR and OLR/RSR data are used in this document. Each is a file, truncated to the first three records, from a Mars Express radio science observation with 16-bit I and 16-bit Q sample resolution. Each data file is accompanied by a PDS4 label with the same file name except for extension *.xml.

Start Date/Time (UTC)	File Name[1]	Band/Poln	Obsn Type[2]	DSS	Sample Rate (sps)	Record Length (bytes)	Source
2019-05-24T20:04:01	J144200a.rsr	X-RCP	Occn	65	2000	8260	RSR
2019-05-24T20:04:01	J144200m.rsr	X-RCP	Occn	65	2000	8260	OLR

The first file was generated by an RSR, before it was decommissioned. The second was generated by an OLR, operating in parallel with the RSR, with its output converted to RSR format. The files should be identical except for housekeeping fingerprints in the record headers and amplitude scaling of the sample values in the data part of each record.

[1] Truncated binary files (j144200a.rsr and j144200m.rsr) are associated with this document.
[2] Observation type is radio occultation (Occn)

The content of the first header in each file is given in associated files j144200a.hdr and j144200m.hdr. Differences include the following:

Record Sequence Number (not important)
RSR ID (documents the correct signal source)
SCHAN ID (documents the correct signal channel)
Uplink DSS (not specified in RSR, correct in OLR)
FGAIN through ADC seconds (not used in OLR)
DDC LO (slightly different in OLR)
Frequency and Phase Coefficients (different)

Hexadecimal dumps of each binary file can be found in associated files j144200a.hex and j144200m.hex, where the addresses (left column) are given by the unix 'od' command in octal. The converted I/Q sample pairs are in associated files j144200a.tab and j144200m.tab where the record number is given in the leftmost column and the sample pair index is in the second column. The RSR and OLR sample pairs will have different values; but they should contain essentially the same information. Analysis of the full binary files indicates that there is not substantive difference between the results extracted from each source.