Description of Apollo ALSEP ARCSAV Level-1b Raw Cleaned Binary File Formats by Experiment

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This document describes the format of raw, cleaned[1] (Level-1b) binary data files for ALSEP experiments for Apollo 12, 15, 16, and 17. The source of these data is a recovered set of NASA's original ALSEP data archival tapes, also known as ARCSAV tapes, that recorded time-edited and rearranged, raw data transmitted from the Moon.

Each binary file contains data extracted from a raw, cleaned[1], Level-0a ARCSAV file (intermeshed experiment data from NSSDCA collection PSPG-00917, PSPG-00918, PSPG-00919, or PSPG-0920) for a specific experiment at a given ALSEP station. They are written as an unformatted direct access binary file of fixed record length, and each physical record is divided into 45 logical records except for HFE, which is divided into 128 logical records. The length of each physical/logical record is as follows:

    Lunar Surface Magnetometer (LSM):   1350/30 bytes
    Solar Wind Spectrometer (SWS):   1080/24 bytes
    Suprathermal Ion Detector (SIDE):   1170/26 bytes
    Heat Flow (HFE):   1792/14 bytes
    Lunar Eject and Meteorites (LEAM): 900/20 bytes
    Lunar Surface Gravimeter (LSG):   3960/ 88 bytes

The first 12 bytes of each logical record contain the following (bit 1 is the most-significant bit [MSB] and bit 8 is least-significant bit [LSB]):

    Byte 1, bits 2-4 and 6-8: edited time and data sync copied from ARCSAV tape file
    Byte 2, bits 2-4 and 6-8: unedited time and data sync copied from ARCSAV tape file
    Byte 3, bit 2: this bit is set if an error is indicated for the time string
    Byte 3, bit 3: this bit is set if an error is indicated for the sync bit string and frame count
    Byte 3, bit 4: this bit is set if an error is indicated for any of the data that follow
    Byte 4, bit 5: this bit is set when software clock is used
    Byte 4, bit 6 through byte 8, bit 8: 35-bit time of the year in milliseconds
    Byte 9, bit 3 through byte 11, bit 8: 22-bit sync bit string
    Byte 12, bits 2-8: frame count

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[1] These cleaned (corrected) raw data are the result of removing byte shifts caused by missing bytes, combined bytes, split bytes, etc., due to ARCSAV tape read errors. This correction is necessary before data can be extracted for a specific experiment. Bit errors are corrected only when such an error was obvious, and thus many bit errors still remain.

and, except for HFE[2], this is followed by:

    Byte 13, bit 7 through byte 14, bit 8: Housekeeping (ALSEP word 33)
    Byte 15, bit 7 through byte 16, bit 8: Command Verification (ALSEP word 46 except for
        Apollo 17, for which ALSEP word 7)

and then by the following ALSEP words that contain experiment data, each occupying the last 2 bits of the first and all 8 bits of the second of each pair of bytes:

    LSM: ALSEP words 5, 17, 19, 21, 49, 51 and 53 occupy bytes 17 through 30
    SWS: ALSEP words 7, 23, 39 and 55 occupy bytes 17 through 24
    SIDE: ALSEP words 15, 31, 47, 56 and 63 occupy bytes 17 through 26
    HFE for Apollo 15: ALSEP word 24 occupies bytes 13 and 14
    HFE for Apollo 17: ALSEP word 23 occupies bytes 13 and 14
    LEAM: ALSEP words 31 and 39 occupy bytes 17 through 20
    LMS: ALSEP words 15, 17, 19 and 21 occupy bytes 17 through 24
    LSG: ALSEP words 4, 6, 8, 10,12,14,16, 18, 20, 22, 24-30, 32, 34-38, 40, 42, 44, 46, 48,
        50, 52, 54, 56, 58, 60, 62 and 64 occupy bytes 17 through 88.

For bytes 13-14 (HK), 15-16 (CV), and each pair of bytes 17-88 (containing experiment data as specified above), bit 1 (the most significant bit) of the odd numbered byte is set if a parity error is detected, suggesting an error in reading the ARCSAV tape. This applies to data extracted from the ARCSAV tapes by vendors John Bordynuik Inc. (JBI) and DataBank Data Services (DBDS); the third vendor, Katalyst Data Management (KDM), ignored the parity bit [2]. Please note that parity errors in time strings and sync and frame count words, presented in bytes 4 through 12, are reflected in bits 2 and 3, respectively, of byte 3, as described on the first page.

Unassigned bits are cleared (set to zero). When the data end before a physical record is filled, the remaining logical records in the last physical record of the file are filled with null bytes (set to zero).

To determine which ALSEP words contains science measurements, housekeeping data, or command verification information, the user should consult the ALSEP Archival Tape Description Document [1]. It describes the ALSEP words for each experiment at each ALSEP station, including bit-level definitions of words that contain packed data.

The file naming convention is aMM_EEE_YYYYDDD_l1_arcsav.bin' where 'aMM' identifies the Apollo mission such as 'a12' for Apollo 12, EEE identifies the experiment by its acronym

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[2] ALSEP Housekeeping (HK) and Command Verification (CV) values are not included in the Level-1b HFE files. Unlike all the other experiments, valid HFE data are only on ALSEP frames 0 through 15, while most of HK and CV values relevant to HFE are on other frames. However HK and CV values are contained in ASCII (Level-1a) files archived at the NASA Planetary Data System (dataset ID TBD), https://pds.nasa.gov.

such as 'SWS' for Solar Wind Spectrometer, 'YYYYDDD' provides the year and day of year of data acquisition such as '1975092' for April 2, 1975, and 'l1_arcsav.bin' indicates this file is a Level-1b (binary) ARCSAV data product.

References

[1] Apollo Lunar Surface Experiment Package Archive Tape Description Document, JSC-09652, NASA Johnson Space Center, Houston, Texas, USA, May 1975. (https://repository.hou.usra.edu/handle/20.500.11753/42 or NSSDCA document B56514-000A, https://nssdc.gsfc.nasa.gov/nmc/publicationDisplay.do?id=B56514-000A)

[2] Nakamura, Y., Description of ARCSAV files as produced by JBI, DBDS and KDM, Institute for Geophysics, University of Texas, Nov. 2016. (NSSDCA document B56515-000A, https://nssdc.gsfc.nasa.gov/nmc/publicationDisplay.do?id=B56515-000A.)

Acknowledgements

Updates

26 March 2018: Noted most significant bit of each pair of bytes containing experiment, HK, and CV data is set if a parity error is detected
15 March 2018: Added Byte 3, bit2 and Byte 3, bit 3 descriptions