Chapter 16. SFDU Usage

This standard defines restrictions on the use of Standard Formatted Data Units (SFDUs) in archive quality data sets. PDS does not require that data products be packaged as SFDUs. However, if data products are packaged as SFDUs, the following standards apply.

The Consultative Committee for Space Data Systems (CCSDS) has prepared a recommendation for the standardization of the structure and construction rules of SFDUs for the interchange of digital space-related data. An SFDU is a *type-length-value* object. That is, each SFDU consists of: a type identifier which indicates the type of data within the SFDU; a length field which either states the length of the data or indicates how the data are delimited; and a value field which contains the actual data. Both the type and the length fields are included in a 20-byte label, called an *SFDU label* in this document. The value field immediately follows the 20-byte SFDU Label. For PDS data products, this value field is the PDS label, including one or more data object definitions.

There are three versions of SFDUs. In Version 1, the length of an SFDU is represented in binary. In Version 2, the length could also be represented in ASCII. In Version 3, the length can be represented in binary, ASCII, or using one of several delineation techniques. Unless previously negotiated, all PDS data products packaged as SFDUs must be constructed using Version 3 SFDU Labels.

A Version 3 SFDU label consists of the following parts:

l)	Control Authority ID	4 Bytes
2)	Version ID	1 Byte
3)	Class ID	1 Byte
4)	Delimiter Type	1 Byte
5)	Spare	1 Byte
6)	Description Data Unit ID	4 Bytes
7)	Length	8 Bytes

The Control Authority ID and the Description Data Unit ID together form an identifier called an Authority and Description Identifier which points to a semantic (Planetary Science Data Dictionary, in the PDS case) and syntactic (Object Definition Language, 2.0) description of the value field. . The Data Description Unit ID varies by data product type. It is supplied by the JPL Control Authority and is usually documented in the science data product Software Interface Specifications (SIS).

Version 3 allows delimiting of SFDUs either by end-of-file or by start and end markers rather than by explicit byte counts. Further details of the SFDU architecture will not be discussed here. Other sources of information can be found in the *SFDU References* listed in the *Introduction* to this document.

Since archive quality data sets are internally defined, only a limited set of SFDU labels are used to identify the files on a data volume in order to simplify not only the archive products themselves, but also the processing of those products by software. PDS labels are included in the data products, and the information in these PDS labels are considered more than adequate for data identification and scientific analysis.

PDS does not require SFDU labels in its archive products. However, SFDU labels can be accommodated in PDS products when they are required by projects or other agencies concerned in the preparation of the data. The standard use of SFDUs in PDS labels from current missions and data restorations is different from the use of SFDUs in data products from upcoming missions fully supported by the Jet Propulsion Laboratory's Advanced Multi-Mission Operations System (AMMOS). The following sections define the standards for including SFDUs in each case.

Two SFDU organizations are allowed in PDS data products. The first organization (the ZI Structure) has been used historically in PDS data products from restoration and past missions. The second organization (the ZKI organization) is required for data products that pass through the JPL Advanced Multi-Mission Operations System (AMMOS) project database.

16.1   The ZI SFDU Organization

Any PDS data products packaged as SFDUs that are not required to pass through the AMMOS project database as part of an active mission may use the following SFDU organization.

Each instance of a data product (file) in a data set must include two (and only two) SFDU labels. These are a Z Class SFDU label and an I Class SFDU label. The two SFDU labels are concatenated (i.e. Z, then I) and left justified in the first line or record of the PDS label for each data product.   (See Figure 16.1.) In the case of data products with detached PDS labels, the two SFDU labels must appear in the first record of the PDS label files and no SFDU labels appear in the data object files. (See Figure 16.2.)
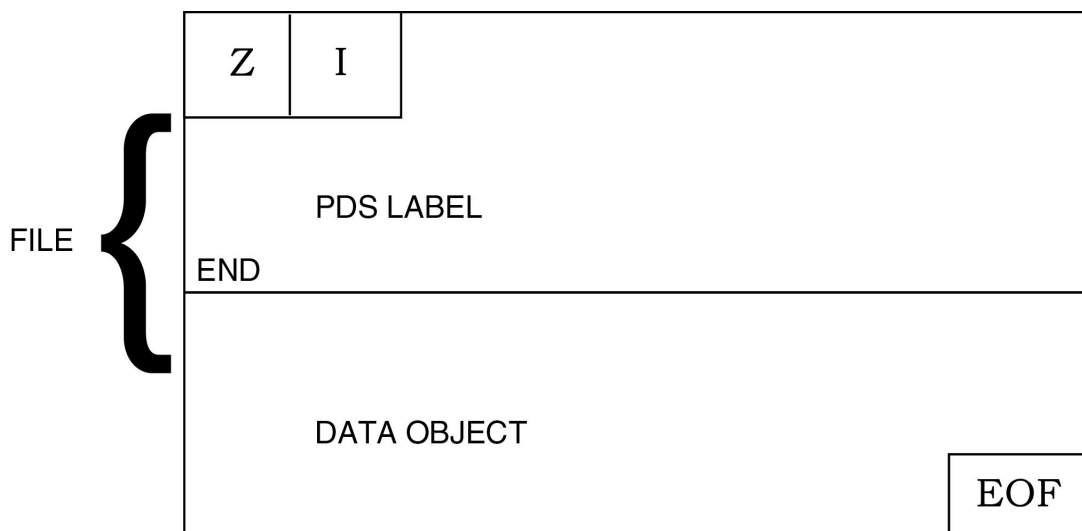
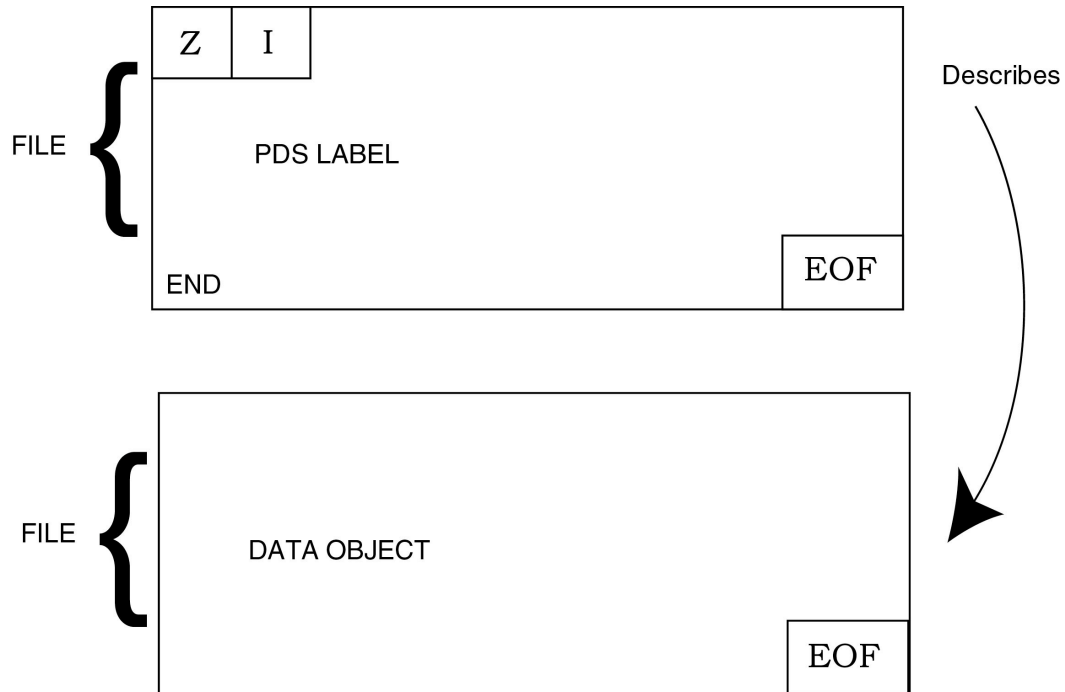*Figure 16.1 Attached PDS Label Example for non-AMMOS compatible products*

Figure 16.2 Detached PDS Label Example for non-AMMOS compatible products

The first SFDU label must be a Z Class Version 3 SFDU label. "Z Class" indicates that the value field (everything after the first 20 bytes) is an aggregation. In this case, the aggregation consists of only the I Class SFDU. This label also indicates that the delimiter type is End-of-File and that this SFDU (data product) is terminated by a single End-of-File. It is formed as follows:

1)	Control Authority ID	CCSD
2)	Version ID	3
3)	Class ID	Z
4)	Delimiter Type	F
5)	Spare	0
6)	Description Data Unit ID	0001
7)	Length Field	00000001

Example: CCSD3ZF0000l00000000l

The second SFDU label must be an I Class Version 3 SFDU label. "Class I" indicates that the value field (everything after the second 20 bytes) is application data, i.e., the PDS label and the data object(s). The Data Description Unit ID of "PDSX" indicates that the data product uses the

Object Description Language (ODL) syntax and the Planetary Science Data Dictionary semantics to present descriptive information. This SFDU label also indicates that the SFDU (data products) will be terminated by a single End-of-File. It is formed as follows:

1)	Control Authority ID	NJPL	
2)	Version ID	3	
3)	Class ID	I	
4)	Delimiter Type	F	
5)	Spare	0	
6)	Description Data Unit ID	PDSX	
7)	Length Field	00000001	

Example: NJPL3IF0PDSX0000000l

```
CCSD3ZF0000100000001NJPL3F0PDSX00000001 <CR> <LF>
PDS_VERSION_ID = PDS3 <CR> <LF>
RECORD_TYPE = STREAM <CR> <LF>
RECORDS = 100 <CR> <LF>
  .
  .
  .
END <CR> <LF>
```
```
DATA OBJECT



                                                              EOF
```
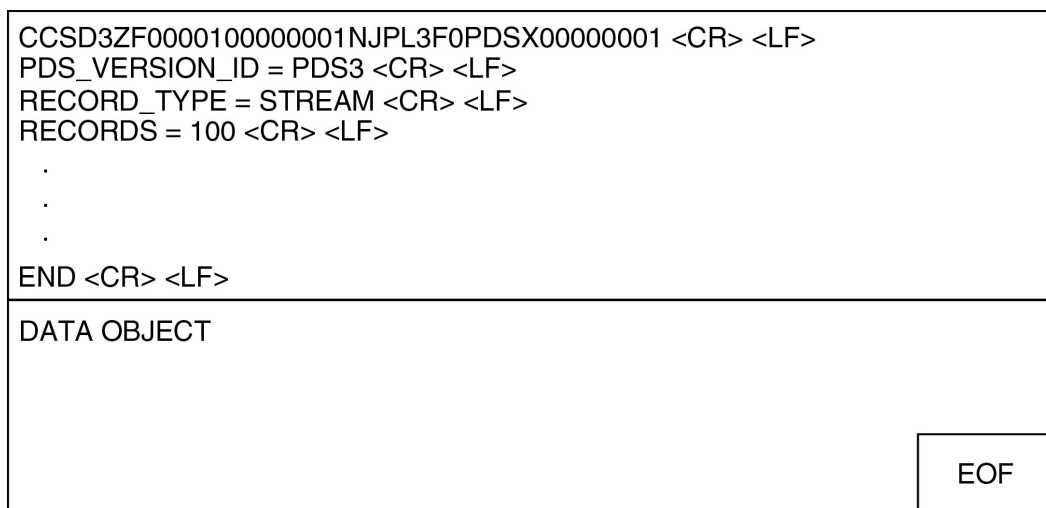
Figure 16.3: SFDU Example

The two SFDU labels are concatenated and left justified in the first line or record of the PDS label. Note that there are no characters between the two SFDU labels. See Figure 16.3.

For RECORD_TYPE = STREAM or FIXED_LENGTH or UNDEFINED, the concatenated SFDU labels must be followed immediately by <CR><LF>. For data products that have RECORD_TYPE =VARIABLE_LENGTH, the two SFDU labels may not be followed by <CR><LF>.

STREAM example	CCSD3ZF0000l0000000lNJPL3IF0PDSX0000000l <CR><LF>
FIXED_LENGTH Example	CCSD3ZF0000l0000000lNJPL3IF0PDSX0000000l<CR><LF>
VARIABLE_LENGTH Example	CCSD3ZF0000l0000000lNJPL3IF0PDSX0000000l
UNDEFINED Example	CCSD3ZF0000l0000000lNJPL3IF0PDSX0000000l<CR><LF>

The remainder of the PDS label begins on the next line or record. The last line of the PDS label

contains the END statement. Then, if the PDS Label is attached, the data object begins on the next record. If the PDS label is detached, the END statement is the last line of the file.

16.2 The ZKI SFDU Organization

Any PDS data products packaged as SFDUs that are required to pass through the AMMOS project database as part of an active mission must use the following SFDU organization. All data products of this type are assumed to have attached PDS labels.

Each instance of a data product (file) in a data set must include four (and only four) SFDU labels. These are: the Z Class SFDU label; the K Class SFDU label; the End-Marker label for the K Class SFDU; and the I Class SFDU label. The Z and K Class SFDU labels are concatenated (i.e., Z, then K) and left justified in the first line or record of the PDS label for each data product. The End-Marker for the K Class SFDU label and the I Class SFDU label are right justified on the last record of the PDS label (following the END statement). See Figure 16.4.
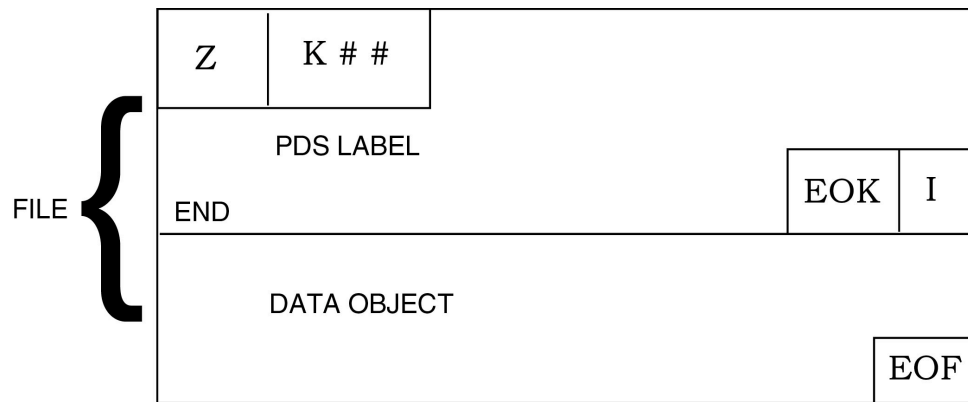

Figure 16.4: PDS Label Example for AMMOS compatible products

The first SFDU label must be a Z Class Version 3 SFDU label. The Z Class indicates that the value field (everything after the first 20 bytes) is an aggregation. In this case, the aggregation consists of a K Class (PDS label) and an I Class (data object) SFDU. This label also indicates that the delimiter type is End-of-File and that this SFDU (data product) is terminated by a single End-of-File. It is formed as follows:

1)	Control Authority	CCSD
2)	Version ID	3
3)	Class ID	Z
4)	Delimiter Type	F
5)	Spare	0
6)	Description Data Unit ID	0001
7)	Length Field	00000001

Example: CCSD3ZF0000l00000000l

The second SFDU label must be a K Class Version 3 SFDU label. "Class K" indicates that the value field (everything after the second 20 bytes) is catalog and directory information, i.e., the PDS label (sometimes referred to as the K Header). The Data Description Unit ID of PDSX indicates that the PDS label uses the Object Description Language (ODL) syntax and the Planetary Science Data Dictionary semantics to present data descriptive information. The SFDU label also indicates that the SFDU is delimited by a Start-Marker/End-Marker pair. It is formed as follows:

1)	Control Authority ID	NJPL
2)	Version ID	3
3)	Class ID	K
4)	Delimiter Type	S
5)	Spare	0
6)	Description Data Unit ID	PDSX
7)	Length Field	##mark##

The marker pattern ("##mark##" in the example) can be set to any string that is unlikely to be repeated elsewhere in the data product.

Example: NJPL3KS0PDSX##mark##

The two SFDU labels must be concatenated and left justified in the first line or record of the PDS label. Note that there are no characters between the two SFDU labels. For data products with RECORD_TYPE equal to VARIABLE_LENGTH, the two concatenated SFDU labels must not be followed by <CR><LF>.

Example: CCSD3ZF0000l0000000lNJPL3KS0PDSX##mark##

The remainder of the PDS label begins on the next line. The last line of the PDS label contains the END statement. Then, in the same line or record, right justified, is the End-Marker for the K Class SFDU and the I Class SFDU label. The End-Marker pattern must appear as:

Example: CCSD$$MARKER##mark##

Note that the start marker and the end marker fields must be identical within the SFDU (in the example, "##mark##"). Next must be an I Class Version 3 SFDU label. "Class I" indicates that the value field (everything after the SFDU label) is application data, i.e., the data object. The Data Description Unit ID varies by data product type. It is supplied by the JPL Control Authority and is usually documented in the science data product Software Interface Specifications (SIS). The SFDU label also indicates that the SFDU will be terminated by a single End-of-File. It is formed as follows:

1)	Control Authority ID	NJPL

2)	Version ID	3
3)	Class ID	I
4)	Delimiter Type	F
5)	Spare	0
6)	Description Data Unit ID	XXXX
7)	Length Field	00000001

Example: NJPL3IF001060000000l   (where XXXX has been replaced by 0106.)

The two SFDU labels must be concatenated, right justified, and appear in the last line or record of the PDS label following the END statement. (If it happens that there are not 40 bytes left in the last record of the PDS label, add an additional record and right justify the two SFDU labels.) Note that there are no characters between the two SFDU labels, and that the marker pattern and I Class SFDU Labels are transparent to PDS label processing software.

Example: END   CCSD$$MARKER##mark##NJPL3IF001060000000l

The data object begins with the next physical record.

16.3 Examples

RECORD_TYPE = STREAM:

End Statement blank(s)   End marker   I Class SFDU   End of record

END   CCSD$$MARKER##mark##NJPL3IF0010600000001<CR><LF>

RECORD_TYPE = FIXED_LENGTH:

End Statement Terminator   Record Boundary

END <CR><LF> bbbbb CCSD$$MARKER##mark##NJPL3IF0010600000001

RECORD_TYPE = UNDEFINED:

                         Statement terminator

End Statement
END<CR><LF> CCSD$$MARKER##mark##NJPL3IF0010600000001

RECORD_TYPE = VARIABLE_LENGTH:

    Record Length   END end of statement

    END   CCSD$$MARKER##mark##NJPL3IF0010600000001

16.4 Exceptions to this Standard

Software files and document files should not be packaged as SFDUs.

Previous versions of the PDS standards expressed the ZI SFDU labels as an ODL statement. The ZI SFDU labels were followed by "= SFDU_LABEL".

Example: CCSD3ZF0000100000001NJPL3IF0PDSX00000001 = SFDU_LABEL