EUROPEAN COOPERATION

ECSS

FOR SPACE STANDARDIZATION

Space engineering

Space data links – Telemetry transfer frame protocol

Foreword

This Standard is one of the series of ECSS Standards intended to be applied together for the management, engineering and product assurance in space projects and applications. ECSS is a cooperative effort of the European Space Agency, National Space Agencies and European industry associations for the purpose of developing and maintaining common standards.

Requirements in this Standard are defined in terms of what must be accomplished, rather than in terms of how to organize and perform the necessary work. This allows existing organizational structures and methods to be applied where they are effective, and for the structures and methods to evolve as necessary without rewriting the standards.

The formulation of this Standard takes into account the existing ISO 9000 family of documents.

This Standard has been prepared by the ECSS-E-50-03 Working Group, reviewed by the ECSS Executive Secretariat and approved by the ECSS Technical Authority.

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Scope

This Standard contains the definition for Telemetry Transfer Frames which are fixed-length data structures, suitable for transmission at a constant frame rate on a space data channel.

The Telemetry Transfer Frame provides a standardized data structure for the transmission of space-acquired data over a telemetry space data link.

Usually, the source of the data is located in space and the receiver is located on the ground. However, this Standard may also be applied to space-to-space telemetry data links.

Further provisions and guidance on the application of this standard can be found, respectively, in the following publications:

- The higher level standard ECSS-E-50B, Communications General Requirements, which defines the principle characteristics of communication protocols and related services for all communication layers relevant for space communication (physical- to application-layer), and their basic relationship to each other.

- The handbook ECSS-E-HB-50A, Communications guidelines, which provides information about specific implementation characteristics of these protocols in order to support the choice of a certain communications profile for the specific requirements of a space mission..

Users of this present standard are invited to consult these documents before taking decisions on the implementation of the present one.

When viewed from the perspective of a specific project context, the requirements defined in this Standard should be tailored to match the genuine requirements of a particular profile and circumstances of a project.

> NOTE   Tailoring is a process by which individual requirements or specifications, standards and related documents are evaluated and made applicable to a specific project, by selection, and, in some exceptional cases, modification of existing or addition of new requirements.

2
Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this ECSS Standard. For dated references, subsequent amendments to, or revisions of any of these publications do not apply. However, parties to agreements based on this ECSS Standard are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references the latest edition of the publication referred to applies.

ECSS-P-001B	ECSS - Glossary of terms
ECSS-E-50-01A	Space engineering - Space data links – Telemetry synchronization and channel coding
ECSS-E-50-04A	Space engineering - Space data links – Telecommand protocols, synchronization and channel coding
CCSDS 133.0-B-1	Space Packet Protocol – Blue Book, Issue 1, September 2003
CCSDS 135.0-B-3	Space Link Identifiers – Blue Book, Issue 3, October 2006

3
Terms, definitions and abbreviated terms

3.1   Terms and definitions

The following terms and definitions are specific to this Standard in the sense that they are complementary or additional to those contained in ECSS-P-001B.

3.1.1
idle data

data which carries no information, but is sent to conform to timing or synchronization requirements

> NOTE   The bit pattern of idle data is not specified.

3.1.2
mission phase

period of a mission during which specified telemetry characteristics are fixed

> NOTE   The transition between two consecutive mission phases can cause an interruption of the telemetry services.

3.1.3
octet

group of eight bits

> NOTE 1   The numbering for octets within a data structure starts with 0.
>
> NOTE 2   Refer to 3.3 for the convention for the numbering of bits.

3.1.4
packet

variable-length data structure consisting of higher layer user data encapsulated within standard header information

3.1.5
static

unchanged within a specific virtual channel or within a specific master channel

> NOTE   This Standard contains requirements on the invariability, throughout one or all mission phases, of certain characteristics of the data structures specified in it.

3.2 Abbreviations

The following abbreviations are used within this Standard.

Abbreviation	Meaning
ASM	attached sync marker
CCSDS	Consultative Committee for Space Data Systems
FECF	Frame Error Control Field
MSB	most significant bit
TM	telemetry

3.3 Conventions

3.3.1.
bit 0, bit 1, bit N−1

To identify each bit in an N-bit field, the first bit in the field to be transferred (i.e. the most left justified in a graphical representation) is defined as bit 0; the following bit is defined as bit 1 and so on up to bit N-1.

BIT 0   BIT N−1

N-BIT DATA FIELD

FIRST BIT TRANSFERRED = MSB
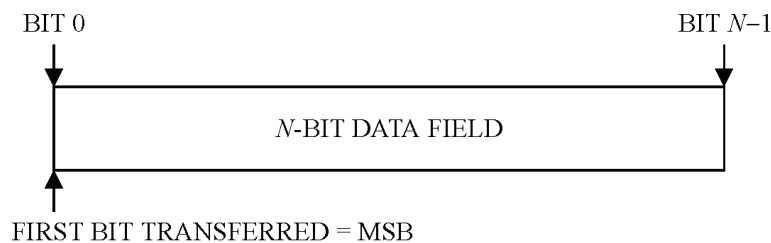
Figure 1: Bit numbering convention

3.3.2.
most significant bit

When an N-bit field is used to express a binary value (such as a counter), the most significant bit is the first bit of the field, i.e. bit 0 (see Figure 1).

3.3.3.
Use of capitals for the names of data structures and fields

In this Standard initial capitals are used for the names of data structures and fields.

This enables field names to be easily identified in the surrounding text. For example, the field Transfer Frame Data Field is easier to see than transfer frame data field in text containing words such as frame and data and field.

It also prevents ambiguity over where the name begins and ends. For example, there are fields Transfer Frame Secondary Header and Transfer Frame Secondary Header Length. The capitals help the reader to distinguish between the Transfer Frame Secondary Header length (meaning 'the length of the Transfer Frame Secondary Header') and the Transfer Frame Secondary Header Length (meaning the field of that name).

4
Overview

4.1   General

The Telemetry Transfer Frame is a fixed-length data structure that provides an envelope for transmitting data units of several types over a telemetry space link. The frame is compatible with the ECSS standard for telemetry synchronization and channel coding defined in ECSS-E-50-01A.

The telemetry transfer frame protocol can operate in various configurations of the telemetry space link, depending on the telemetry channel coding scheme and security options selected. The correct operation of the protocol can only occur if a high-quality data channel is provided between the peer entities of the protocol.

> NOTE 1   The Standard for telemetry channel coding, ECSS-E-50-01, defines the coding mechanisms for a high-quality data channel, including frame synchronization and randomization. CCSDS 350.0-G-2 describes the security options.

> NOTE 2   In this Standard the terms TM Transfer Frame and Telemetry Transfer Frame are used interchangeably, i.e. they are synonyms and have the same meaning as.

> NOTE 3   Annex D describes the mission configuration parameters within the scope of this Standard.

4.2   Physical channel

A data channel carrying a stream of bits in a single direction is referred to as a physical channel.

For the TM Transfer Frame specified in this Standard, the value of the Transfer Frame Version Number is constant for all frames of a physical channel.

The length of the frames for a given physical channel is fixed for a mission phase.

4.3   Master channels and virtual channels

The TM Transfer Frame supports the division of the physical channel into master channels and virtual channels by means of identifier fields in the frame header.

A master channel is identified by the values of the Transfer Frame Version Number and the Spacecraft Identifier. Within a given physical channel, a master channel consists of all the frames that have the same Transfer Frame Version Number and the same Spacecraft Identifier.

For a typical space mission, all the frames on a physical channel have the same value for the Spacecraft Identifier, so in this case there is one master channel on the physical channel. However, multiple master channels can share a physical channel, which, for example, can be the case when one spacecraft is transporting another spacecraft such as a probe.

A master channel is divided into virtual channels using the Virtual Channel Identifier field. This is a 3-bit field and therefore supports up to eight virtual channels on a master channel.

4.4   Sharing transmission resources

Virtual channels enable one physical channel to be shared among multiple higher-layer data streams, each of which can have different characteristics.

The mechanisms and parameters for sharing access by the virtual channels to the physical channel are implementation dependent and not within the scope of this Standard.

4.5   Data fields in the frame

Every TM Transfer Frame contains the Transfer Frame Data Field, which is the main data-carrying field in the frame. Within a virtual channel, the length of the Transfer Frame Data Field is static during a mission phase.

There are status fields in the frame header that are related to the use of the Transfer Frame Data Field. The Transfer Frame Data Field carries packets or other data units.

Additionally to the Transfer Frame Data Field, the TM Transfer Frame has two optional fields for carrying data:

- The Transfer Frame Secondary Header, used to carry fixed-length mission-specific data.

- The Operational Control Field, used to carry status information to control the operation of the telecommand space link or other spacecraft activities.

5
TM Transfer Frame

5.1   General

a.   The TM Transfer Frame shall encompass the major fields, positioned contiguously if present, in the sequence shown in Table 1.

   NOTE 1   Figure 2 shows the format of the TM Transfer Frame.

   NOTE 2   In the case that TM Transfer Frames are directly submitted to telemetry channel coding, the start of the TM Transfer Frame is always signalled by the attached sync marker (ASM) which immediately precedes the TM Transfer Frame. The ASM is specified in ECSS-E-50-01.

   When the TM Transfer Frame is embedded in a Reed-Solomon codeblock or turbo codeblock, the ASM signals the start of both.

Table 1: Major fields in a TM Transfer Frame

Field	Presence in TM Transfer Frame	Length in bits
Transfer Frame Primary Header	always present	48
Transfer Frame Secondary Header	optional	16, 24, ... or 512
Transfer Frame Data Field	always present	variable
Transfer Frame Trailer	optional	16, 32 or 48

b.   The maximum length for a TM Transfer Frame shall be 2048 octets.

c.   The TM Transfer Frame shall be of constant length throughout a specific mission phase.

   NOTE   Because a change of frame length also changes the time interval between the start of successive frames, it can result in a loss of synchronization at the data capture element.

d.   The TM Transfer Frame length shall be consistent with the specifications contained in the standard for telemetry channel coding, ECSS-E-50-01A.

> NOTE   For some coding schemes, ECSS-E-50-01 limits the TM Transfer Frame length to certain specific values.

e. TM Transfer Frames shall be transferred over a physical channel at a constant rate.

f. In order to assure correct decoding at the receiving end, the same telemetry channel coding options shall be applied to all TM Transfer Frames of a physical channel.

g. At the receiving end, TM Transfer Frames containing detected errors need not be delivered.

h. The handling of TM Transfer Frames containing detected errors shall be specified for each mission or mission phase.

> NOTE   Depending on the coding scheme in use, errors in a TM Transfer Frame can be detected during the telemetry channel decoding at the receiving end (see ECSS-E-50-01). The Frame Error Control Field specified in 5.6 can be used to detect errors in TM Transfer Frames.

i. All TM Transfer Frames with the same Master Channel Identifier on a physical channel shall constitute a master channel.

> NOTE 1   The Master Channel Identifier is defined in 5.2.2.

> NOTE 2   In most cases, the master channel is identical to the physical channel. However, if the physical channel also carries TM Transfer Frames with other Spacecraft Identifiers, a distinction between the master channel and physical channel is made. In this case, multiplexing of TM Transfer Frames with different Spacecraft Identifiers is performed by multiplexing the different master channels on the same physical channel.

j. A master channel shall consist of between one to eight virtual channels.

k. On a physical channel that carries TM Transfer Frames, all the frames shall have the same Transfer Frame Version Number.

> NOTE   The TM Transfer Frames specified in this Standard do not share a physical channel with other types of frame.
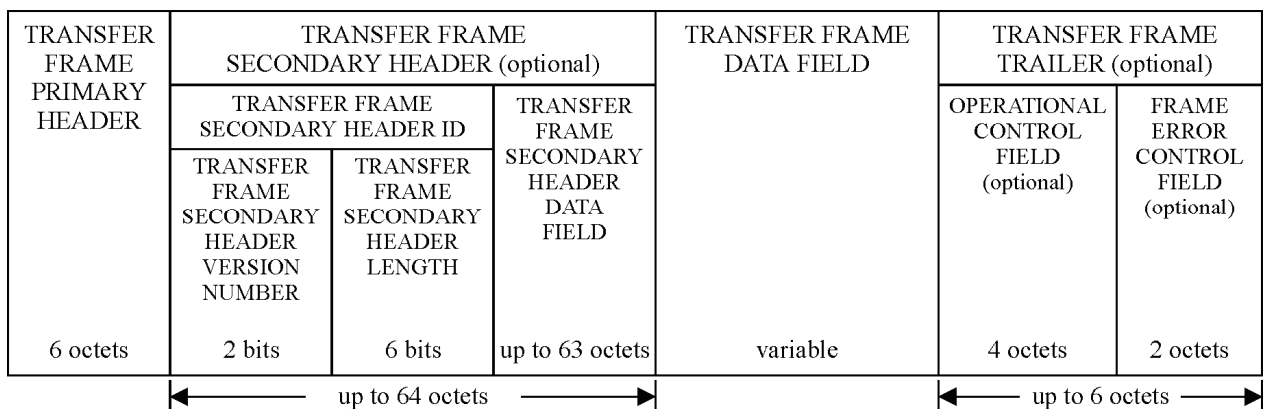
Figure 2: TM Transfer Frame format

5.2   Transfer Frame Primary Header

5.2.1   General

a.   The Transfer Frame Primary Header shall always be present in a TM Transfer Frame.

b.   The Transfer Frame Primary Header shall consist of six fields, positioned contiguously, in the following sequence:

- Master Channel Identifier   12 bits
- Virtual Channel Identifier   3 bits
- Operational Control Field Flag   1 bit
- Master Channel Frame Count   8 bits
- Virtual Channel Frame Count   8 bits
- Transfer Frame Data Field Status   16 bits

NOTE 1   All six fields are always present in a Transfer Frame Primary Header.

NOTE 2   Figure 3 shows the format of the Transfer Frame Primary Header.

NOTE 3   The Transfer Frame Primary Header covers the following main functions:

* to identify the data unit as a TM Transfer Frame;

* to identify the master channel and virtual channel to which the frame belongs;

* to provide a counting mechanism for the virtual channels and the master channel;

* to provide status fields related to the data in the Transfer Frame Data Field.

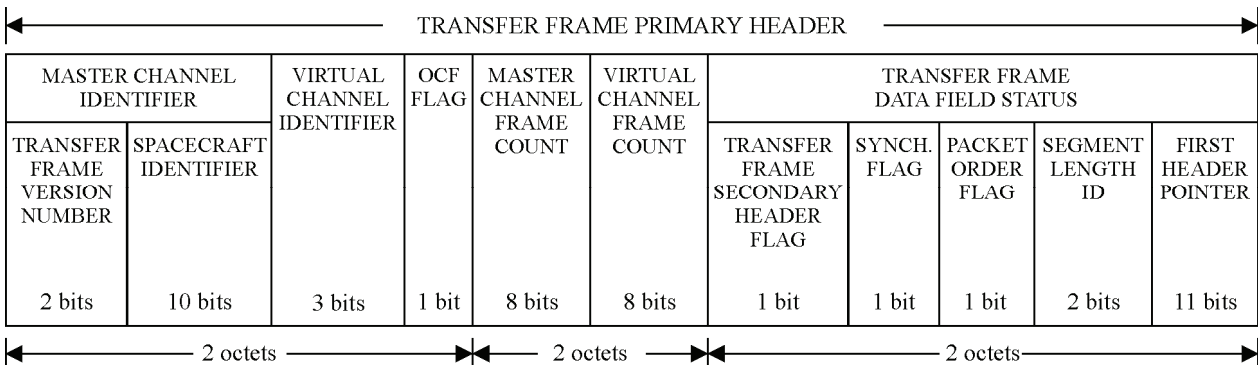| TRANSFER FRAME PRIMARY HEADER										
MASTER CHANNEL IDENTIFIER		VIRTUAL CHANNEL IDENTIFIER	OCF FLAG	MASTER CHANNEL FRAME COUNT	VIRTUAL CHANNEL FRAME COUNT	TRANSFER FRAME DATA FIELD STATUS				
TRANSFER FRAME VERSION NUMBER	SPACECRAFT IDENTIFIER					TRANSFER FRAME SECONDARY HEADER FLAG	SYNCH. FLAG	PACKET ORDER FLAG	SEGMENT LENGTH ID	FIRST HEADER POINTER
2 bits	10 bits	3 bits	1 bit	8 bits	8 bits	1 bit	1 bit	1 bit	2 bits	11 bits
← 2 octets →			← 2 octets →			← 2 octets →				

Figure 3: Format of Transfer Frame Primary Header

5.2.2   Master Channel Identifier

5.2.2.1   General

a.   The Master Channel Identifier shall always be present in a Transfer Frame Primary Header.

b. The Master Channel Identifier shall be contained within bits 0-11 of the Transfer Frame Primary Header.

c. The Master Channel Identifier shall consist of two fields, positioned contiguously, in the following sequence:

- Transfer Frame Version Number   2 bits

- Spacecraft Identifier   10 bits

NOTE   Both fields are always present in a Master Channel Identifier.

5.2.2.2 Transfer Frame Version Number

a. The Transfer Frame Version Number shall always be present in a Master Channel Identifier.

b. The Transfer Frame Version Number shall be contained within bits 0-1 of the Transfer Frame Primary Header.

c. The Transfer Frame Version Number shall be set to '00'.

NOTE   This is the value defined in CCSDS 135.0-B-3 for the Transfer Frame Version Number of a TM Transfer Frame.

5.2.2.3 Spacecraft Identifier

a. The Spacecraft Identifier shall always be present in a Master Channel Identifier.

b. The Spacecraft Identifier shall be contained within bits 2-11 of the Transfer Frame Primary Header.

c. The Spacecraft Identifier shall provide the identification of the spacecraft which is associated with the data contained in the TM Transfer Frame.

NOTE 1   The Secretariat of the CCSDS assigns Spacecraft Identifiers according to the procedures in CCSDS 320.0-B-4.

NOTE 2   Different Spacecraft Identifiers can be assigned for normal operations and for development vehicles using the ground networks during pre-launch test operations, and for simulated data streams.

d. The Spacecraft Identifier shall be static throughout all mission phases.

5.2.3 Virtual Channel Identifier

a. The Virtual Channel Identifier shall always be present in a Transfer Frame Primary Header.

b. The Virtual Channel Identifier shall be contained within bits 12-14 of the Transfer Frame Primary Header.

c. The Virtual Channel Identifier shall provide the identification of the virtual channel to which the TM Transfer Frame belongs.

NOTE   The order of occurrence of TM Transfer Frames belonging to different virtual channels on a master channel can vary.

5.2.4 Operational Control Field Flag

a. The Operational Control Field Flag shall always be present in a Transfer Frame Primary Header.

b. The Operational Control Field Flag shall be contained in bit 15 of the Transfer Frame Primary Header.

c. The Operational Control Field Flag shall indicate the presence or absence of the Operational Control Field, as follows:

- '1' Operational Control Field is present;

- '0' Operational Control Field is not present.

d. The Operational Control Field Flag shall be static in the associated master channel or virtual channel throughout a mission phase.

   NOTE   See subclause 5.5.1.

5.2.5 Master Channel Frame Count

a. The Master Channel Frame Count shall always be present in a Transfer Frame Primary Header.

b. The Master Channel Frame Count shall be contained within bits 16-23 of the Transfer Frame Primary Header.

c. The Master Channel Frame Count shall contain a sequential binary count (modulo 256) of each TM Transfer Frame transmitted in a specific master channel.

   NOTE   This field provides a running count of the frames transmitted through the same master channel.

d. The Master Channel Frame Count shall not be reset before reaching 255 unless there is a major system reset.

   NOTE   If the Master Channel Frame Count is reset due to a re-initialisation, the completeness of a sequence of TM Transfer Frames cannot be determined.

5.2.6 Virtual Channel Frame Count

a. The Virtual Channel Frame Count shall always be present in a Transfer Frame Primary Header.

b. The Virtual Channel Frame Count shall be contained within bits 24-31 of the Transfer Frame Primary Header.

c. The Virtual Channel Frame Count shall contain a sequential binary count (modulo 256) of each TM Transfer Frame transmitted through a specific virtual channel of a master channel.

   NOTE   This field provides individual accountability for the frames of each virtual channel. It can be used to detect gaps in the stream of data carried in the Transfer Frame Data Fields of the frames for a virtual channel.

d. The Virtual Channel Frame Count shall not be reset before reaching 255 unless there is a major system reset.

   NOTE   If the Virtual Channel Frame Count is reset due to a re-initialisation, the completeness of a sequence of TM Transfer Frames in the related virtual channel cannot

be determined.

5.2.7 Transfer Frame Data Field Status

5.2.7.1 General

a. The Transfer Frame Data Field Status shall always be present in a Transfer Frame Primary Header.

b. The Transfer Frame Data Field Status shall be contained within bits 32-47 of the Transfer Frame Primary Header.

c. The Transfer Frame Data Field Status shall consist of five fields, positioned contiguously, in the following sequence:

- Transfer Frame Secondary Header Flag   1 bit
- Synchronization Flag   1 bit
- Packet Order Flag   1 bit
- Segment Length Identifier   2 bits
- First Header Pointer   11 bits

NOTE 1. All these five fields are always present in a Transfer Frame Data Field Status.

NOTE 2. This field indicates whether a secondary header is present and provides information relating to the data contained in the Transfer Frame Data Field.

5.2.7.2 Transfer Frame Secondary Header Flag

a. The Transfer Frame Secondary Header Flag shall always be present in a Transfer Frame Data Field Status.

b. The Transfer Frame Secondary Header Flag shall be contained in bit 32 of the Transfer Frame Primary Header.

c. The Transfer Frame Secondary Header Flag shall indicate the presence or absence of the Transfer Frame Secondary Header, as follows:

- '1'   Transfer Frame Secondary Header is present;
- '0'   Transfer Frame Secondary Header is not present.

d. The Transfer Frame Secondary Header Flag shall be static in a specific master channel, throughout a mission phase, when the Transfer Frame Secondary Header is associated with a master channel.

e. The Transfer Frame Secondary Header Flag shall be static in a specific virtual channel, throughout a mission phase, when the Transfer Frame Secondary Header is associated with a virtual channel.

5.2.7.3 Synchronization Flag

a. The Synchronization Flag shall always be present in a Transfer Frame Data Field Status.

b. The Synchronization Flag shall be contained in bit 33 of the Transfer Frame Primary Header.

c. The Synchronization Flag shall signal the formatting of the Transfer Frame Data Field, as follows:

- '0' if octet-synchronized and forward-ordered packets or idle data are inserted;

- • '1' otherwise.

NOTE 1 The values of the Packet Order Flag, the Segment Length Identifier and the First Header Pointer are also affected by the value of the Synchronization Flag. See subclauses 5.2.7.4, 5.2.7.5 and 5.2.7.6.

NOTE 2 When the Synchronization Flag is set to '0', the value of the First Header Pointer is used to distinguish between packets and idle data as defined in subclause 5.2.7.6.

d. The Synchronization Flag shall be static in a specific virtual channel throughout a mission phase.

5.2.7.4 Packet Order Flag

a. The Packet Order Flag shall always be present in a Transfer Frame Data Field Status.

b. The Packet Order Flag shall be contained in bit 34 of the Transfer Frame Primary Header.

c. If the Synchronization Flag is set to '0', the Packet Order Flag shall be set to '0'.

NOTE 1 When the Synchronization Flag is set to '0', the Packet Order Flag is reserved for future use.

NOTE 2 If the Synchronization Flag is set to '1', the use of the Packet Order Flag is undefined.

5.2.7.5 Segment Length Identifier

a. The Segment Length Identifier shall always be present in a Transfer Frame Data Field Status.

b. The Segment Length Identifier shall be contained in bits 35-36 of the Transfer Frame Primary Header.

c. If the Synchronization Flag is set to '0', the Segment Length Identifier shall be set to '11'.

NOTE 1 This identifier was used in earlier standards to support an optional feature which is now obsolete. Its value is set to '11' because this value indicates that the feature is not used.

NOTE 2 If the Synchronization Flag is set to '1', the Segment Length Identifier is undefined.

5.2.7.6 First Header Pointer

a. The First Header Pointer shall always be present in a Transfer Frame Data Field Status.

b. The First Header Pointer shall be contained in bits 37-47 of the Transfer Frame Primary Header.

c. If the Synchronization Flag is set to '0', the First Header Pointer shall contain information on the data in the Transfer Frame Data Field, as specified in d. to g. below.

NOTE If the Synchronization Flag is set to '1', the First Header Pointer is undefined.

d. If at least one packet starts in the Transfer Frame Data Field, the First Header Pointer shall contain the location of the first octet of the first packet that starts in the Transfer Frame Data Field.

   NOTE If the last packet in the Transfer Frame Data Field of frame X spills over into frame Y of the same virtual channel (X<Y), the First Header Pointer in frame Y ignores the residue of the split packet and indicates the start of the first packet that starts in frame Y.

e. The locations of the octets in the Transfer Frame Data Field shall be numbered in ascending order starting with '0'.

f. If no packet starts in the Transfer Frame Data Field, the First Header Pointer shall be set to '11111111111'.

   NOTE This can occur if a long packet extends across multiple frames.

g. If the Transfer Frame Data Field contains only idle data, the First Header Pointer shall be set to '11111111110'.

5.3 Transfer Frame Secondary Header

5.3.1 General

a. If present, the Transfer Frame Secondary Header shall follow, without gap, the Transfer Frame Primary Header.

b. The presence or absence of the Transfer Frame Secondary Header shall be signalled by the Transfer Frame Secondary Header Flag in the Transfer Frame Primary Header (see 5.2.7.2).

c. If present, the Transfer Frame Secondary Header shall comprise an integral number of octets: between 2 and 64 octets.

d. The Transfer Frame Secondary Header shall be associated with either a master channel or a virtual channel.

   NOTE 1 If the Transfer Frame Secondary Header is associated with a master channel, then the Transfer Frame Secondary Header is present in every frame on the master channel. In this case, the Transfer Frame Secondary Header has the same length for all virtual channels of the master channel.

   NOTE 2 If the Transfer Frame Secondary Header is associated with a given virtual channel, then the Transfer Frame Secondary Headers of other virtual channels can be absent or can be used for other purposes. For example, the Transfer Frame Secondary Header can have a different length on different virtual channels.

e. The Transfer Frame Secondary Header shall have a fixed length in the associated master channel or in the associated virtual channel throughout a mission phase.

f. The Transfer Frame Secondary Header shall consist of two fields, positioned contiguously, in the following sequence:

- Transfer Frame Secondary Header
  Identification   8 bits

- Transfer Frame Secondary Header
  Data Field   8, 16, ... or 504 bits

NOTE 1   Both fields are always present in a Transfer Frame Secondary Header.

NOTE 2   The format of the Transfer Frame Secondary Header is shown in Figure 2.

g.   The Transfer Frame Secondary Header shall be used to carry fixed length data defined at mission level.

h.   The Transfer Frame Secondary Header may be used to provide an extended virtual channel frame count as specified in 5.3.4.

5.3.2   Transfer Frame Secondary Header Identification

5.3.2.1   General

a.   The Transfer Frame Secondary Header Identification shall always be present in a Transfer Frame Secondary Header.

b.   The Transfer Frame Secondary Header Identification shall be contained in bits 0-7 of the Transfer Frame Secondary Header.

c.   The Transfer Frame Secondary Header Identification shall comprise two fields, positioned contiguously, in the following sequence:

- Transfer Frame Secondary Header Version
  Number   2 bits

- Transfer Frame Secondary Header Length   6 bits

NOTE   Both fields are always present in a Transfer Frame Secondary Header Identification.

5.3.2.2   Transfer Frame Secondary Header Version Number

a.   The Transfer Frame Secondary Header Version Number shall always be present in a Transfer Frame Secondary Header Identification.

b.   The Transfer Frame Secondary Header Version Number shall be contained in bits 0-1 of the Transfer Frame Secondary Header.

c.   The Transfer Frame Secondary Header Version Number shall be set to '00'.

NOTE   This field indicates which of, up to, four secondary header versions is used. This Standard only recognizes one version: Version 1 which is represented by setting the field to the binary value '00'.

5.3.2.3   Transfer Frame Secondary Header Length

a.   The Transfer Frame Secondary Header Length shall always be present in a Transfer Frame Secondary Header Identification.

b.   The Transfer Frame Secondary Header Length shall be contained in bits 2-7 of the Transfer Frame Secondary Header.

c.   The Transfer Frame Secondary Header Length shall contain the total length of the Transfer Frame Secondary Header in octets minus one, represented as a binary number.

NOTE   When a Transfer Frame Secondary Header is present, this length can be used to compute the location of the start of the Transfer Frame Data Field.

d.   The value of the Transfer Frame Secondary Header Length shall be static within a specific master channel or a specific virtual channel throughout a mission phase.

5.3.3   Transfer Frame Secondary Header Data Field

a.   The Transfer Frame Secondary Header Data Field shall always be present in a Transfer Frame Secondary Header.

b.   The Transfer Frame Secondary Header Data Field shall follow, without gap, the Transfer Frame Secondary Header Identification Field.

c.   The Transfer Frame Secondary Header Data Field shall contain the Transfer Frame Secondary Header data.

5.3.4   Extended virtual channel frame count

5.3.4.1   Overview

The Transfer Frame Secondary Header may provide an extended virtual channel frame count. The following requirements apply in when the extended virtual channel frame count is used.

5.3.4.2   Using the extended count

a.   The length of the Transfer Frame Secondary Header shall be 32 bits.

NOTE   The Transfer Frame Secondary Header has a length of 4 octets, so the Transfer Frame Secondary Header Length contains the value 3.

b.   The Transfer Frame Secondary Header Data Field shall contain the 24-bit extension to the virtual channel frame count.

c.   The extension to the virtual channel frame count shall be a binary count of the roll-overs of the 8-bit value contained in the Virtual Channel Frame Count in the Transfer Frame Primary Header.

NOTE   This provides a 32-bit count, with the most significant 24 bits in the Transfer Frame Secondary Header Data Field and the least significant 8 bits in the Virtual Channel Frame Count.

d.   The use of the extended virtual channel frame count shall be associated with either a master channel or a virtual channel.

NOTE 1   If the extended virtual channel frame count is associated with a master channel, then the Transfer Frame Secondary Header of every frame on the master channel contains the extended count. However, the value of the extended count in a given frame is the value for the virtual channel to which the frame belongs.

NOTE 2   If the extended virtual channel frame count is associated with a virtual channel, then the Transfer Frame Secondary Headers of other virtual channels can be absent or used for other purposes.

e.   The use of the extended virtual channel frame count shall be static in the associated master channel or in the associated virtual channel throughout a mission phase.

5.4   Transfer Frame Data Field

5.4.1   Overview

As specified in subclause 5.1, the length of a TM Transfer Frame is static throughout a mission phase. The lengths of the optional parts of the frame (Transfer Frame Secondary Header, Operational Control Field and Frame Error Control Field) are static in the associated virtual channel, master channel or physical channel throughout a mission phase. As a result, the length of the Transfer Frame Data Field for a virtual channel is static throughout a mission phase.

In general, the Transfer Frame Data Field contains data to be transmitted over the space link on behalf of higher layers.

For TM Transfer Frames where the Synchronization Flag (subclause 5.2.7.3) is set to '0', the Transfer Frame Data Field carries packets in the manner specified in subclause 5.4.3.

This Standard does not specify the data carried in the Transfer Frame Data Field for TM Transfer Frames where the Synchronization Flag is set to '1'. The data can consist of packets or any other data units.

Subclause 5.4.4 specifies an optional use of the Transfer Frame Data Field to carry asynchronously inserted data. The specification in subclause 5.4.4 does not restrict the use of the Transfer Frame Data Field of frames where the Synchronization Flag is set to '1'.

5.4.2   General

a.   The Transfer Frame Data Field shall always be present in a TM Transfer Frame.

b.   The Transfer Frame Data Field shall follow, without gap, one of the following:

  1.   If a Transfer Frame Secondary Header is present, the Transfer Frame Secondary .

  2.   If a Transfer Frame Secondary Header is not present, the Transfer Frame Primary.

c.   The length of the Transfer Frame Data Field shall be an integral number of octets and be constrained by the length of the total TM Transfer Frame.

  NOTE   The constraints on the length of a TM Transfer Frame are specified in subclause 5.1.

5.4.3   Packet processing and extraction functions

5.4.3.1   Overview

For TM Transfer Frames where the Synchronization Flag is set to '0', the Transfer Frame Data Field carries packets. Subclauses 5.4.3.3, 5.4.3.4 and 5.4.3.5 apply in this case.

The First Header Pointer (subclause 5.2.7.6) indicates the position of the first packet which starts in the Transfer Frame Data Field.

The functions for processing the packets depend on knowledge of the position, size and meaning of certain fields in the standard packet headers. Subclause 5.4.3.3 specifies some of the properties of the packets.

Subclause 5.4.3.4 specifies the packet processing function at the sending end, which places the packets into the Transfer Frame Data Fields in a sequence of TM Transfer Frames for a virtual channel. Subclause 5.4.3.5 specifies the function at the receiving end which extracts the packets from the Transfer Frame Data Fields.

5.4.3.2   Meeting timing conditions

In a system which transmits TM Transfer Frames at a constant rate, there are timing conditions on the rate at which frames are generated at the sending end:

- If no data is available for insertion into a Transfer Frame Data Field at release time for a frame, a Transfer Frame Data Field containing idle data can be created. Subclause 5.2.7.6 defines a special value for the First Header Pointer in this case. If the Transfer Frame Data Field contains only idle data, the frame is sometimes referred to as an only idle data transfer frame. However, such a frame can transmit valid data carried in the Transfer Frame Secondary Header and the Operational Control Field.

- If insufficient data is available for insertion into a Transfer Frame Data Field at release time for a frame, then one or more idle packets can be created to occupy space in a Transfer Frame Data Field. Subclause 5.4.3.3 defines these idle packets.

5.4.3.3   Packet properties

a.   A packet handled by the packet processing and extraction functions shall have a defined Packet Version Number as specified in CCSDS 135.0-B-3 subclause 7.6, and conform to the definition of the related data structure specified in the same subclause.

> NOTE 1   The Packet Version Number occupies the first three bits of the packet header.

> NOTE 2   CCSDS 135.0-B-3 subclause 7.6 contains a list of the defined Packet Version Numbers that are also referred to as authorized Packet Version Numbers. It provides a list of references to the documents which specify the related packet data structures.

> NOTE 3   For a mission that uses the packet processing and extraction functions, it is the responsibility of the mission designer to verify the availability of support by the telemetry transfer services for each defined Packet Version Number that is used by the mission.

b.   An idle packet shall be either:

1.   an idle space packet as specified in CCSDS 133.0-B-1 subclause 4.1, or

2.   a fill encapsulation packet as specified in CCSDS 133.1-B-1 subclause 4.2.

> NOTE 1   Because an idle space packet has a minimum length of seven octets, it can spill over into a subsequent frame.

NOTE 2   The option for a different type of idle packet, in addition to the idle space packet, is being evaluated at the time of publication of this Standard.

5.4.3.4   Packet processing function at the sending end

a.   The packet processing function shall be applied independently for each virtual channel.

NOTE   While a long packet is being transmitted, other packets for the same virtual channel can be delayed. Therefore, a mission can set maximum lengths for the packets to be used by the mission.

b.   The packet processing function shall place packets contiguously into the Transfer Frame Data Field.

c.   If the length of a packet exceeds the available space in the Transfer Frame Data Field, the packet processing function shall place the remainder of the packet into the Transfer Frame Data Fields of one or more subsequent TM Transfer Frames for the same virtual channel.

NOTE 1   Typically, the last packet in the Transfer Frame Data Field of a frame spills over into the Transfer Frame Data Field of a subsequent frame of the same virtual channel.

NOTE 2   Within a virtual channel, one or more frames containing idle data (see item f below) can be transmitted between two frames carrying parts of a given packet.

NOTE 3   When a long packet is being processed, there can be frames which carry part of the packet, but where no packet starts within the Transfer Frame Data Field. In this case the First Header Pointer is set as defined in 5.2.7.6 f.

d.   The packet processing function shall set the First Header Pointer as specified in 5.2.7.6.

e.   Packets with different Packet Version Numbers may be transmitted within a virtual channel.

f.   A Transfer Frame Data Field containing only idle data may be created.

NOTE 1   In this case the First Header Pointer is set as defined in 5.2.7.6 g.

NOTE 2   The bit pattern of idle data is not specified. See D.2.8.

g.   One or more idle packets may be created to fill space in a Transfer Frame Data Field.

NOTE 1   In many cases, the idle packet or packets fill all the remaining space in the Transfer Frame Data Field. However, an idle packet or packets can be followed by one or more non-idle packets within the same Transfer Frame Data Field.

NOTE 2   If many idle packets are created in a Transfer Frame Data Field, they can increase the packet rate at the receiving end. Conversely, the creation of a single idle packet to fill the remaining space in the Transfer Frame Data Field reduces the number of packets to be processed by the packet extraction function.

5.4.3.5 Packet extraction function at the receiving end

a. The packet extraction function shall be applied independently for each virtual channel.

b. The packet extraction function shall extract the packets from a Transfer Frame Data Field using the value of the First Header Pointer together with the values contained in the length fields of the packet headers.

c. A Transfer Frame Data Field containing idle data shall be discarded.

d. Any idle packets extracted from Transfer Frame Data Fields shall be discarded.

5.4.4 Asynchronously inserted data

5.4.4.1 Overview

For legacy reasons, this subclause provides a description of the requirements which apply if asynchronously inserted data is used.

The asynchronously inserted data consists of TM Transfer Frames that are recorded in an on-board memory device, such as a magnetic tape recorder. The recorded TM Transfer Frames are played back, later at a convenient time, and placed in real-time TM Transfer Frames for transmission.

5.4.4.2 Using asynchronously inserted data

a. The stored data shall be in the form of standard TM Transfer Frames.

> NOTE 1 Typically, they are the TM Transfer Frames of the real-time physical channel at the time of recording with their attached synchronization markers.

> NOTE 2 For ease of retrieval, each recorded TM Transfer Frame is tagged with a large count number. This can be achieved, for each virtual channel, with the extended virtual channel frame count defined in 5.3.4.

b. At playback time, the recorded TM Transfer Frames shall be placed into the Transfer Frame Data Field of real-time TM Transfer Frames with the Synchronization Flag set to '1'.

c. The asynchronous insertion may be made in either the forward or the reverse mode.

d. If forward insertion mode is used, then any recorded attached synchronization markers shall use the alternative synchronization marker pattern of hexadecimal 352EF853.

> NOTE Otherwise, the presence of forward-justified attached synchronization markers in the data fields of the real-time TM Transfer Frames can cause disruptions to the frame synchronization process at the receiving end, particularly during acquisition.

e. A dedicated virtual channel shall be used for the playback data.

f. At the receiving end, the real-time virtual channel used for the playback data shall be processed and its contents stored for later off-line processing.

g. In the later off-line processing, the recorded TM Transfer Frames shall be retrieved in the correct, forward-justified direction and processed as for a real-time physical channel.

h.   Any Communications Link Control Word (see 5.5.3) extracted from the Operational Control Field of a recorded TM Transfer Frame shall not be processed by the real-time telecommand system.

5.5   Operational Control Field

5.5.1   General

a.   If present, the Operational Control Field shall occupy the four octets following, without gap, the Transfer Frame Data Field.

b.   The presence or absence of the Operational Control Field shall be signalled by the Operational Control Field Flag in the Transfer Frame Primary Header (see 5.2.4).

c.   The Operational Control Field shall be associated with a master channel or a virtual channel.

   NOTE   Support at the receiving end for retrieving the Operational Control Field can be limited. In some cases, the receiving end can only support retrieval of the Operational Control Field associated with a master channel.

d.   The Operational Control Field shall be present in every TM Transfer Frame transmitted through the associated master channel or virtual channel throughout a mission phase.

e.   Bit 0 of the Operational Control Field shall contain a Type Flag which indicates the contents of the field.

   NOTE   The purpose of the Operational Control Field is to provide a standardized mechanism for reporting a small number of real-time functions.

5.5.2   Type Flag

a.   The Type Flag shall always be present in an Operational Control Field.

b.   The Type Flag shall be contained in bit 0 of the Operational Control Field.

c.   The Type Flag shall be set as follows:

   •   '0' if the Operational Control Field holds a Type-1-Report (see 5.5.3);

   •   '1' if the Operational Control Field holds a Type-2-Report (see 5.5.4).

d.   The Type Flag may vary between TM Transfer Frames on the same virtual channel.

5.5.3   Type-1-Report

a.   If the Type Flag is '0', the Operational Control Field shall contain a Type-1-Report.

b.   A Type-1-Report shall contain a Communications Link Control Word, the content of which is defined in ECSS-E-50-04A, subclause 6.3.

   NOTE   The Communications Link Control Word is used to control the operation of a telecommand space link.

5.5.4 Type-2-Report

a. If the Type Flag is '1', the Operational Control Field shall contain a Type-2-Report.

b. The value of the first bit of a Type-2-Report (i.e. bit 1 of the Operational Control Field) shall indicate the use of the report as follows:

- '0', the contents of the report are project-specific;

- '1', the contents of the report are reserved for future application.

NOTE   This Standard does not define the use of Type-2-Reports; however, it accommodates the possibility to do so in future issues by restricting the use of the first bit.

c. The value of the first bit of a Type-2-Report may vary between TM Transfer Frames on the same virtual channel.

5.6 Frame Error Control Field

5.6.1 General

a. If present, the Frame Error Control Field shall occupy the two octets following, without gap, one of the following:

1. If an Operational Control Field is present, the Operational Control Field.

2. If an Operational Control Field is not present, the Transfer Frame Data Field.

b. The Frame Error Control Field shall be present in a TM Transfer Frame if the TM Transfer Frame is not Reed-Solomon encoded.

NOTE   The Frame Error Control Field is optional if the TM Transfer Frame is contained within the data space of a Reed-Solomon code block.

c. If present, the Frame Error Control Field shall occur within every TM Transfer Frame transmitted within the same physical channel throughout a mission phase.

NOTE 1 The purpose of this field is to provide a capability for detecting errors which can be introduced into the frame during the transmission and data handling process.

NOTE 2 When applied to an encoded block of less than 32 768 bits (4096 octets), the code has the following capabilities:

- *   All error sequences composed of an odd number of bit errors are detected.
- *   All error sequences containing at most two bit errors anywhere in the encoded block are detected.
- *   If a random error sequence containing an even number of bit errors (greater than or equal to 4) occurs within the block, the probability that the error is undetected is approximately 2^{-15} (or 3×10^{-5}).
- *   All single error bursts spanning 16 bits or less are detected provided no other errors occur within the block.

5.6.2 Frame Error Control Field encoding procedure

The encoding procedure shall be as follows:

a. The encoding procedure accepts an (n-16)-bit TM Transfer Frame, excluding the Frame Error Control Field, and generates a systematic binary (n,n-16) block code by appending a 16-bit Frame Error Control Field as the final 16 bits of the codeblock.

b. The equation for the contents of the Frame Error Control Field is:

$$FECF = [(X^{16} \cdot M(X)) + (X^{(n-16)} \cdot L(X))] \text{ modulo } G(X)$$

where

- all arithmetic is modulo 2;

- FECF is the 16-bit Frame Error Control Field and the first bit transferred is the most significant bit, taken as the coefficient of the highest power of X;

- n is the number of bits in the encoded message;

- M(X) is the (n-16)-bit information message to be encoded expressed as a polynomial with binary coefficients, and the first bit transferred is the most significant bit, M_0, taken as the coefficient of the highest power of X;

- L(X) is the presetting polynomial given by

$$L(X) = \sum_{i=0}^{15} X^i$$

- G(X) is the generating polynomial given by:

$$G(X) = X^{16} + X^{12} + X^5 + 1.$$

NOTE 1   The $X^{(n-16)} \cdot L(X)$ term has the effect of presetting the shift register to all '1' state prior to encoding.

NOTE 2   A sample implementation of an encoder is described in Annex A.

5.6.3 Frame Error Control Field decoding procedure

a. The decoding procedure shall use an error detection syndrome, S(X), given by

$$S(X) = [(X^{16} \cdot C^*(X)) + (X^n \cdot L(X))] \text{ modulo } G(X)$$

where

- C*(X) is the received block, including the Frame Error Control Field, in polynomial form, with the first bit transferred being the most significant bit C_0 taken as the coefficient of the highest power of X;

- S(X) is the syndrome polynomial which is zero if no error is detected and non-zero if an error is detected, with the most significant bit S_0 taken as the coefficient of the highest power of X.

NOTE   A sample implementation of a decoder is described in Annex A.

b. The Frame Error Control Field shall not be used for error correction.

NOTE   The code is intended for error detection purposes only.

Annex A (informative)
Frame error control

A.1 General

This annex describes sample implementations of the encoding and decoding procedures for the cyclic redundancy code in the Frame Error Control Field defined in 5.6.

The bit numbering convention specified in subclause 3.3.1 applies.

A.2 Encoding

Figure A-1 shows an arrangement for an encoder to generate the Frame Error Control Field value, FECF, as given in the equation in 5.6.2.

For the 16-bit FECF value, the first bit transferred is the most significant bit, P_0, taken as the coefficient of the highest power of X.

The encoder uses a shift register and each small rectangle in the figure represents a bit in the shift register. For each frame, the shift register bits are initialized to "1" before the encoding.

For encoding, the position of the ganged switch is as follows:

- 1 when the (n-16) information bits are being transferred;

- 2 when the encoder outputs the 16 bits of FECF.
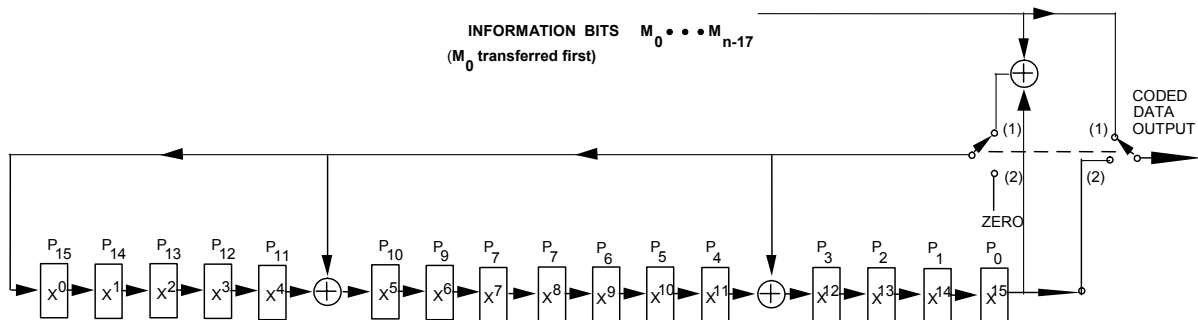

Figure A-1: Encoder

A.3   Decoding

Figure A-2 shows an arrangement for a decoder to generate the syndrome polynomial, S(X), as given in the equation in 5.6.3.

The decoder uses a shift register and each small rectangle in the figure represents a bit in the shift register. For each frame, the shift register bits are initialized to "1" before the decoding.

The frame contains n bits, which consist of the (n-16) information message bits followed by the 16 bits, FECF, of the Frame Error Control Field.

To decode:

•   All the n bits of the frame are clocked into the input.

•   The contents of the shift register are then examined. For an error-free frame, all bits in the shift register are zero. A non-zero content indicates an erroneous frame.
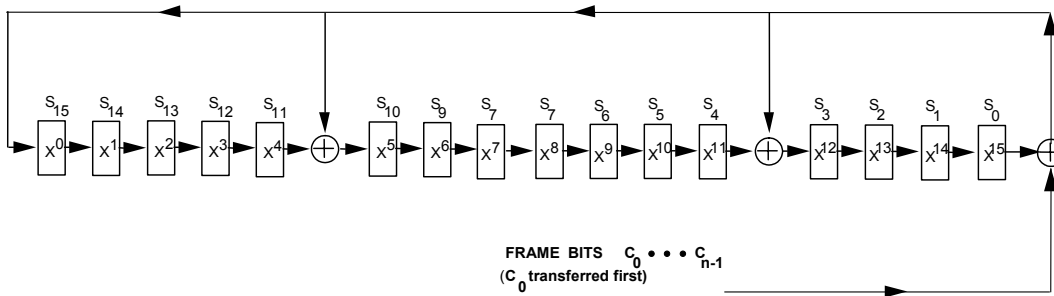
Figure A-2: Decoder

Annex B (informative)
Changes from PSS-04-106

B.1   General

This annex describes some of the technical differences between this Standard and PSS-04-106, ESA Packet Telemetry Standard, Issue 1, January 1988.

The main purpose of the annex is to assist in verifying the compatibility of existing systems.

The list of differences in this annex provides an indication of the differences in technical content between this Standard and PSS-04-106. However, it is not the purpose of this annex to provide a complete list or to provide full details on each item in the list nor to describe the consequences of each item in the list. Refer to the relevant clauses of this Standard and to the PSS documents for further details.

PSS-04-106 has a wider scope than this Standard. This annex only includes differences that are within the scope of this Standard.

B.2   Technical changes

a.   In this Standard, packets with any Packet Version Number can be transferred as packets over the telemetry space data link, as long as their Packet Version Number is defined by CCSDS in CCSDS 135.0-B-3. This includes packets that are not included in PSS-04-106.

b.   PSS-04-106 specifies the following Telemetry Transfer Frame lengths:

- 892, 1115 or 1784 octets if Reed-Solomon coding is used, or

- any number of octets between 128 and 2040 if Reed-Solomon coding is not used.

This Standard specifies a maximum frame length of 2048 octets and that the length is consistent with the specifications contained in the standard for telemetry channel coding, ECSS-E-50-01.

c.   In PSS-04-106, the Telemetry Transfer Frame length is fixed for the duration of the mission.

This Standard specifies that the length is constant for a mission phase.

d.   In this Standard, a physical channel can have multiple master channels. Each master channel has a different value in the Spacecraft Identifier field of its frames.

PSS-04-106 makes no distinction between a physical channel and a master channel.

e.   In PSS-04-106, if the Operational Control Field is used, then it is in every frame of the physical channel.

In this Standard, Operational Control Field use can be related to a master channel or to virtual channel(s).

NOTE   The master channel and physical channel are less clearly distinguished in PSS-04-106 than in this Standard.

f.   In PSS-04-106, if the Transfer Frame Secondary Header is used, then it is in every frame of the physical channel.

In this Standard, Transfer Frame Secondary Header use can be related to a master channel or to virtual channels. Similarly, in this Standard, if the Transfer Frame Secondary Header is used for an Extended Virtual Channel Frame Count, this use can be related to a master channel or to virtual channels.

g.   PSS-04-106 only defines one length (32 bits) for the Transfer Frame Secondary Header.

In this Standard other lengths from 16 to 512 bits can be used.

h.   An Operational Control Field with Type Flag (bit 0) set to 1 is a Type-2 report. In PSS-04-106 all use of Type-2 reports is reserved for future application.

In this Standard, Type-2 reports are defined as follows:

- if bit 1 of the Operational Control Field is '0', the contents of the report are project-specific;

- if bit 1 of the Operational Control Field is '1', the contents of the report are reserved for future application.

i.   In this Standard, if the Synchronization Flag in a Telemetry Transfer Frame is set to '1', the First Header Pointer is undefined.

PSS-04-106 states that in this case the First Header Pointer is set to all "1".

j.   The differences in the names of fields and of groups of fields in a Telemetry Transfer Frame are shown in Table B-1.

Table B-1: Differences in names from PSS-04-106 for fields in a Telemetry Transfer Frame

Name in PSS-04-106	Name in this Standard
Frame Identification	(not used)
(not used)	Master Channel Identifier
Version Number	Transfer Frame Version Number
Frame Data Field Status	Transfer Frame Data Field Status
Secondary Header Flag	Transfer Frame Secondary Header Flag
Secondary Header Identifica-tion	Transfer Frame Secondary Header Identi-fication
Secondary Header Version Number	Transfer Frame Secondary Header Version Number
Secondary Header Data	Transfer Frame Secondary Header Data
Secondary Header Length	Transfer Frame Secondary Header Length
Frame Error Control Word	Frame Error Control Field

Annex C (informative)
Differences from CCSDS recommendations

C.1 General

This annex describes the technical differences between this Standard and the related CCSDS recommendations defined in CCSDS 132.0-B-1.

This annex lists the differences of technical content between this Standard and the CCSDS recommendations indicated. However, it is not the purpose of this annex to provide complete details on each item in the list or to describe the consequences of each item in the list. Refer to the relevant clauses of this Standard and to the CCSDS recommendations for further details.

The given CCSDS recommendations have a wider scope than this Standard. This annex only includes the differences that are within the scope of this Standard.

C.2 Differences

a. This Standard defines the use of the Transfer Frame Secondary Header for extending the Virtual Channel Frame Count.

   The extended count is not specified in the CCSDS recommendations.

b. In CCSDS 132.0-B-1, a telemetry transfer frame with its First Header Pointer set to '11111111110' is called an OID Transfer Frame, meaning that it has Only Idle Data in its Transfer Frame Data Field.

   In this Standard the term OID Transfer Frame is not used but the meaning of the First Header Pointer value is the same.

Annex D (informative)
Mission configuration parameters

D.1 General

This annex provides a summary of the mission configuration parameters within the scope of this Standard.

This annex lists the options and values that can be taken by the parameters as specified in this Standard. Mission designers are responsible for verifying the availability of support for the options and values selected for their mission.

D.2 Parameters of a physical channel

D.2.1 Overview

This subclause describes the mission configuration parameters of a physical channel that carries TM Transfer Frames.

D.2.2 Length of the TM Transfer Frame

The length of the TM Transfer Frame is an integer number of octets, up to 2048 octets. The length can be limited by the channel coding schemes specified in ECSS-E-50-01.

The length is constant throughout a mission phase. The length is a configuration parameter for each mission phase.

D.2.3 Transfer Frame Version Number

The Transfer Frame Version Number is a mission configuration parameter.

For the TM Transfer Frames specified in this Standard it is set to '00', indicating a version-1 transfer frame. The value is constant for all frames of the physical channel. The value applies to all master channels and all virtual channels of the physical channel.

For a physical channel where the frames have any other value in the Transfer Frame Version Number is not within the scope of this Standard.

D.2.4 Spacecraft Identifiers

A physical channel uses one or more integer values for the Spacecraft Identifier field of the TM Transfer Frames.

Each Spacecraft Identifier value corresponds to a specific master channel.

The list of Spacecraft Identifier values is a mission configuration parameter. See also NOTE 1 of subclause 5.2.2.3.

D.2.5   Frame Error Control Field

If the physical link uses Reed-Solomon encoding, the presence of the Frame Error Control Field is optional. Otherwise, the field is present in all frames.

The presence or absence of the Frame Error Control Field is constant for all frames throughout a mission phase. It is a configuration parameter for each mission phase.

D.2.6   Handling of frames containing detected errors

The handling of TM Transfer Frames containing detected errors is mission dependent and is specified for each mission or mission phase.

Faulty frames can be delivered or discarded.

D.2.7   Multiplexing parameters

Issues concerning the multiplexing of master channels onto a physical channel, and the multiplexing of virtual channels onto a master channel, are not within the scope of this Standard.

Algorithms, priorities and other related parameters are mission dependent.

D.2.8   Pattern of idle data

For a Transfer Frame Data Field containing only idle data, as specified in subclause 5.4.3.4 f, this Standard does not specify the pattern of the idle data.

The pattern of the idle data is a mission configuration parameter.

D.3   Parameters of a master channel

D.3.1   Overview

This subclause describes the mission configuration parameters for a master channel.

D.3.2   Spacecraft Identifier

A master channel has a specific value for the Spacecraft Identifier field of the TM Transfer Frame. The Transfer Frame Version Number for the master channel is described in D.2.3 above.

D.3.3   Virtual Channel Identifiers

A master channel consists of between one and eight virtual channels. Therefore, a master channel uses up to eight integer values for the Virtual Channel Identifier field of the TM Transfer Frames. The values are mission configuration parameters. Each Virtual Channel Identifier value corresponds to a distinct virtual channel of the master channel.

D.3.4   Transfer Frame Secondary Header

The presence and use of the Transfer Frame Secondary Header is a mission configuration parameter for each mission phase. If the Transfer Frame Secondary Header is associated with a master channel in a mission phase, then the following apply:

- The length of the Transfer Frame Secondary Header is a mission configuration parameter of the master channel for the mission phase.

- The values of the Transfer Frame Secondary Header Flag and the Transfer Frame Secondary Header Length are constant for the mission phase in all frames of the master channel.

- The application of the Transfer Frame Secondary Header is a mission configuration parameter of the master channel for the mission phase. The Transfer Frame Secondary Header can optionally be used for the extended virtual channel frame count specified in subclause 5.3.4.

  NOTE   If the Transfer Frame Secondary Header is associated with a master channel, then the Transfer Frame Secondary Header cannot at the same time be associated with any of the virtual channels of the master channel.

D.3.5   Operational Control Field

The presence of the Operational Control Field is a mission configuration parameter for each mission phase. If the Operational Control Field is associated with a master channel in a mission phase, then the value of the Operational Control Field Flag is a mission configuration parameter of the master channel for the mission phase.

  NOTE   If the Operational Control Field is associated with a master channel, then the Operational Control Field cannot at the same time be associated with any of the virtual channels of the master channel.

D.4   Parameters of a virtual channel

D.4.1   Overview

This subclause describes the mission configuration parameters of a virtual channel.

D.4.2   Spacecraft Identifier and Virtual Channel Identifier

A virtual channel has specific values for the Spacecraft Identifier and the Virtual Channel Identifier of the TM Transfer Frame. The Transfer Frame Version Number for the virtual channel is described in D.2.3 above.

D.4.3   Transfer Frame Secondary Header

The presence and use of the Transfer Frame Secondary Header is a mission configuration parameter for each mission phase. If the Transfer Frame Secondary Header is associated with a virtual channel in a mission phase, then:

- The length of the Transfer Frame Secondary Header is a mission configuration parameter of the virtual channel for the mission phase.

- The values of the Transfer Frame Secondary Header Flag and of the Transfer Frame Secondary Header Length are constant for the mission phase in all frames of the virtual channel.

- The application of the Transfer Frame Secondary Header is a mission configuration parameter of the virtual channel for the mission phase. The Transfer Frame Secondary Header can optionally be used for the extended virtual channel frame count specified in subclause 5.3.4.

D.4.4 Synchronization Flag

Setting the Synchronization Flag is a mission configuration parameter for a virtual channel. The value of the flag is constant for a mission phase in all frames of the virtual channel. The flag indicates the formatting of the Transfer Frame Data Field.

When the Synchronization Flag is '0', then the Transfer Frame Data Field carries packets as specified in subclause 5.4.3. The additional mission configuration parameters in this case are described in D.5 below.

When the Synchronization Flag is '1', this Standard does not specify the contents of the Transfer Frame Data Field. The use and formatting of the field in this case are mission configuration parameters for the virtual channel.

Subclause 5.4.4 describes the optional use of the field to carry asynchronously inserted data.

D.4.5 Operational Control Field

The presence of the Operational Control Field is a mission configuration parameter for each mission phase. If the Operational Control Field is associated with a virtual channel in a mission phase, then the value of the Operational Control Field Flag is a mission configuration parameter for the virtual channel for the mission phase.

D.5 Additional parameters when Synchronization Flag is '0'

D.5.1 Overview

This subclause describes the additional mission configuration parameters for a virtual channel that has the Synchronization Flag set to '0'. The additional parameters concern the packets carried in the Transfer Frame Data Field.

D.5.2 Valid packet version numbers

The list of valid values for the Packet Version Number is a mission configuration parameter for the virtual channel.

D.5.3 Maximum packet length

The maximum packet length is a mission configuration parameter for the virtual channel.

D.5.4 Handling of incomplete packets

The handling of incomplete packets at the receiving end is a mission configuration parameter. Incomplete packets can be delivered or discarded.

Bibliography

ECSS-E-50B[1]	Space engineering - Communications general requirements
ECSS-E-HB-50A[1]	Space engineering - Communications guidelines
CCSDS 132.0-B-1	TM Space Data Link Protocol – Blue Book, Issue 1, September 2003
CCSDS 320.0-B-4	CCSDS Global Spacecraft Identification Field Code Assignment Control Procedures – Blue Book, Issue 4, January 2006
CCSDS 350.0-G-2	The Application of CCSDS Protocols to Secure Systems – Green Book, Issue 2, January 2006
PSS-04-106	ESA Packet Telemetry Standard, Issue 1, January 1988

[1] To be published

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