



# Space engineering

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## Adoption Notice of CCSDS 131.0-B-5, TM Synchronization and Channel Coding

ECSS Secretariat  
ESA-ESTEC  
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Noordwijk, The Netherlands

## Foreword

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 shall 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.

This Adoption Notice has been prepared by the ECSS Space Communications Working Group, reviewed by the ECSS Executive Secretariat and approved by the ECSS Technical Authority.

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## Change log

ECSS-E-AS-50-21C 1 March 2021	First issue NOTE: This document supersedes ECSS-E-ST-50-01 “Space data links – Telemetry synchronization and channel coding” (31 July 2008).
ECSS-E-AS-50-21C Rev.1 13 January 2023	First issue, Revision 1 Changes with respect to ECSS-E-AS-50-21C (1 March 2021) are: Update of the ECSS Adoption Notice with respect to the new version of CCSDS Standard. This version: <ul style="list-style-type: none"><li>• adds support for the Unified Space Data Link Protocol</li><li>• adds support for ground-to-space communications links.</li></ul>
ECSS-E-AS-50-21C Rev. 2 5 December 2024	First issue, Revision 2 Changes with respect to ECSS-E-AS-50-21C Rev.1 (13 January 2023) are: <ul style="list-style-type: none"><li>• Update of the ECSS Adoption Notice with respect to the new version of CCSDS Standard, that includes a revised pseudo-randomizer, for the purpose of obviating spectral spikes in high-data-rate links.</li><li>• Addition of differences from ECSS-E-ST-50-01C concerning USLP, turbo code rates, and ASM bit patterns, that were missed in previous versions of the ECSS Adoption Notice.</li></ul>

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# Table of contents

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<b>Change log</b> .....	<b>3</b>
<b>1 Scope</b> .....	<b>5</b>
<b>2 Context information</b> .....	<b>6</b>
<b>3 Abbreviated terms</b> .....	<b>7</b>
<b>4 Application requirements</b> .....	<b>8</b>
<b>Annex A (informative) Differences from ECSS-E-ST-50-01C</b> .....	<b>10</b>
<b>Bibliography</b> .....	<b>12</b>
 <b>Tables</b>	
Table 4-1: Applicability table for CCSDS 131.0-B-5.....	8

# 1 Scope

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This document identifies the clauses and requirements modified with respect to the standard [CCSDS 131.0-B-5, TM Synchronization and Channel Coding, Issue 5, September 2023](#) for application in ECSS.

## 2

# Context information

The standard [CCSDS 131.0-B-5](#), *TM Synchronization and Channel Coding*, has been developed by CCSDS for use in developing synchronization and channel coding systems.

With this Adoption Notice ECSS is adopting and applying [CCSDS 131.0-B-5](#) with a minimum set of modifications, identified in the present document, to allow for reference and for a consistent integration in the ECSS system of standards.

[CCSDS 131.0-B-5](#) is similar to the ECSS standard ECSS-E-ST-50-01C *Space data links - Telemetry synchronization and channel coding* (31 July 2008), that is superseded by ECSS-E-AS-50-21 (latest version).

Differences between these standards that are not covered by the normative modifications in clause 4 are described in the informative Annex A.

Mapping of superseded ECSS-E-50-xx Standards w.r.t. ECSS Adoption Notice versus CCSDS Standards.

Superseded ECSS	ECSS Adopted Notice	Based on CCSDS
ECSS-E-ST-50-01C 31 July 2008	ECSS-E-AS-50-21	CCSDS 131.0-B-x
ECSS-E-ST-50-03C 31 July 2008	ECSS-E-AS-50-22	CCSDS 132.0-B-x
	ECSS-E-AS-50-23	CCSDS 732.0-B-x
ECSS-E-ST-50-04C 31 July 2008	ECSS-E-AS-50-24	CCSDS 231.0-B-x
	ECSS-E-AS-50-25	CCSDS 232.0-B-x
	ECSS-E-AS-50-26	CCSDS 232.1-B-x
NOTE: The applicable CCSDS Standard referred to by the ECSS Adoption Notice is stated per latest version of the ECSS Adoption Notice.		

### 3

## Abbreviated terms

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<b>Abbreviation</b>	<b>Meaning</b>
AOS	advanced orbiting system
ASM	attached synch marker
PSK	phase-shift keying
USLP	unified space data link protocol
4D-8PSK-TCM	4-dimensional 8PSK trellis-coded modulation

# 4

## Application requirements

ECSS-E-AS-50-21\_1520001

- a. [CCSDS 131.0-B-5](#), TM Synchronization and Channel Coding, Issue 5 (September 2023) shall apply as written with the following amendments listed in [Table 4-1](#).

ECSS-E-AS-50-21\_1520002

**Table 4-1: Applicability table for [CCSDS 131.0-B-5](#)**

Clause or requirement number	Applicability	Applicable text for ECSS (the new/added text is underlined)	Comments	Text as in the original CCSDS document (deleted text with strikethrough)
3.2.4	Modified	Soft bit decisions with at least three-bit quantization <u>shall be used for the decoder</u> .	CCSDS requirement modified: for convolutional codes. Words “should be used whenever constraints (such as complexity of decoder) permit” deleted and replaced by words “shall be used for the decoder”	Soft bit decisions with at least three-bit quantization <del>should be used whenever constraints (such as complexity of decoder) permit</del> .



Clause or requirement number	Applicability	Applicable text for ECSS (the new/added text is underlined)	Comments	Text as in the original CCSDS document (deleted text with strikethrough)
4.3.1c.	New requirement	E=8 shall not be used unless the modulation scheme is 4-dimensional 8PSK trellis-coded modulation (4D-8PSK-TCM).	New requirement added: restricted use of Reed-Solomon codes with E=8	
4.3.5.1	Modified	The allowable values of interleaving depth shall be: a) <u>When E=16, I=1, 2, 3, 4, 5, and 8.</u> b) <u>When E=8, I=8</u>	CCSDS requirement modified for Reed-Solomon codes to explain better applicability of E=16 and E=8	The allowable values of interleaving depth <del>are</del> I=1, 2, 3, 4, 5, and 8.
4.3.5.2	Modified	The interleaving depth shall be fixed on a Physical Channel for a Mission Phase.	CCSDS requirement modified for Reed-Solomon codes: word “normally” deleted.	The interleaving depth shall <del>normally</del> be fixed on a Physical Channel for a Mission Phase.
5.1	Modified	Concatenated codes shall consist of a combination of a Reed-Solomon code <u>with E=16</u> defined in section 4 with one of the convolutional codes defined in section 3.	CCSDS requirement modified for restricted use of Reed-Solomon codes: the original requirement was applicable to both E=8 and E=16, the new requirement applies only to E=16	Concatenated codes shall consist of a combination of a Reed-Solomon code defined in section 4 with one of the convolutional codes defined in section 3.
5.1	New NOTE	NOTE - Reed-Solomon code with E=8 is not concatenated with one of the convolutional codes.	New NOTE added.	

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# Annex A (informative)

## Differences from ECSS-E-ST-50-01C

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### A.1 General

Clause 4 of this document contains normative amendments to [CCSDS 131.0-B-5](#). This Annex describes some additional differences, with respect to the superseded ECSS-E-ST-50-01C Standard, that are not covered by Clause 4.

This Annex lists the differences of technical content, but 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.

### A.2 Differences

#### A.2.1 Addition of LDPC codes

[CCSDS 131.0-B-5](#) specifies a number of low-density parity-check (LDPC) codes for the coding of either a Transfer Frame or a stream of Sync-Marked Transfer Frames (SMTFs). ECSS-E-ST-50-01 did not include any LDPC codes.

#### A.2.2 Addition of turbo code rates

[CCSDS 131.0-B-5](#) specifies turbo codes with rates  $1/2$ ,  $1/3$ ,  $1/4$ , and  $1/6$ . ECSS-E-ST-50-01 instead specified only Turbo codes with rate  $1/2$  and  $1/4$ .

#### A.2.3 ASM bit patterns

[CCSDS 131.0-B-5](#) specifies dedicated ASM bit patterns for LDPC codes and Turbo codes, depending on the code rates. Since some of these codes and rates were not part of ECSS-E-ST-50-01, the associated ASM bit patterns were also not included.

#### A.2.4 Pseudo-randomizer

Section 10 of [CCSDS 131.0-B-5](#) specifies a pseudo-randomizer with 131071 bits in length, for avoiding spectral spikes in high-data-rate links. The 131071-bits pseudo-randomizer replaces the 255-bit randomizer of ECSS-E-ST-50-01, unless it is required for backward compatibility with legacy systems.

## A.2.5 Transfer frame lengths

Section 11 of [CCSDS 131.0-B-5](#) has a normative specification of the transfer frame lengths that can be used with each of the channel codes. Annex C of ECSS-E-ST-50-01 had an informative specification of the lengths.

## A.2.6 USLP transfer frame

CCSDS 131.0-B-5 has normative specifications for supporting three Space Data Link Protocols: TM and AOS Space Data Link protocols and the Unified Space Data Link (USLP, CCSDS 732.1-B-3). ECSS-E-ST-50-01 did not include any reference to USLP.

## A.2.7 Managed parameters

Section 12 of [CCSDS 131.0-B-5](#) has a normative specification of the managed parameters used by synchronization and channel coding. Annex G of ECSS-E-ST-50-01 had an informative specification, and referred to the parameters as mission configuration parameters.

## A.2.8 Ground to space

The channel codes specified in [CCSDS 131.0-B-5](#) can be used as well on ground-to-space and space-to-space links. Section 13 has a normative specification for ground-to-space and space-to-space links. ECSS-E-ST-50-01 did not include such use.

## A.2.9 Specification of service interfaces

Annex A of [CCSDS 131.0-B-5](#) provides a formal abstract specification of the service interfaces, including service primitives and parameters, provided by TM Synchronization and Channel Coding. There was no equivalent in ECSS-E-ST-50-01.

## A.2.10 Security considerations

Annex B of [CCSDS 131.0-B-5](#) provides a discussion of security considerations related to TM Synchronization and Channel Coding. There was no equivalent in ECSS-E-ST-50-01.

## A.2.11 Application profiles

Annex D of ECSS-E-ST-50-01 provided guidelines for choosing a coding scheme and included some information on coding scheme performance. There is no equivalent in [CCSDS 131.0-B-5](#). The CCSDS Historical Document, CCSDS 131.4-M-1-S also provided guidance to users in the choice of coding scheme for a telemetry link. The CCSDS informational report, CCSDS 130.1-G-3, includes performance information related to TM synchronization and channel coding.

## Bibliography

ECSS-E-AS-50-21C Rev.2	Space engineering - Adoption Notice of CCSDS 131.0-B-5, TM Synchronization and Channel Coding
ECSS-E-AS-50-22C Rev.1	Space engineering - Adoption Notice of CCSDS 132.0-B-3, TM Space Data Link Protocol
ECSS-E-AS-50-23C Rev.1	Space engineering - Adoption Notice of CCSDS 732.0-B-4, AOS Space Data Link Protocol
ECSS-E-AS-50-24C Rev.1	Space engineering - Adoption Notice of CCSDS 231.0-B-4, TC Synchronization and Channel Coding
ECSS-E-AS-50-25C Rev.1	Space engineering - Adoption Notice of CCSDS 232.0-B-4, TC Space Data Link Protocol
ECSS-E-AS-50-26C	Space engineering - Adoption Notice of CCSDS 232.1-B-2, Communications Operation Procedure-1
ECSS-E-ST-50-01C 31 July 2008	Space engineering - Space data links - Telemetry synchronization and channel coding
ECSS-E-ST-50-03C 31 July 2008	Space engineering - Space data links - Telemetry transfer frame protocol
ECSS-E-ST-50-04C 31 July 2008	Space engineering - Space data links - Telecommand protocols synchronization and channel coding
CCSDS 130.1-G-3	TM Synchronization and Channel Coding, Summary of Concept and Rationale – Green Book, Issue 3, June 2020
CCSDS 131.4-M-1-S	TM Channel Coding Profiles – Silver Book, Issue 1, July 2011
CCSDS 230.1-G-3	TC Synchronization and Channel Coding, Summary of Concept and Rationale – Green Book, Issue 3, October 2021
CCSDS 732.1-B-3	Unified Space Data Link Protocol – Blue Book, Issue 3, June 2024

NOTE      When using CCSDS document, be informed that CCSDS Technical Corrigenda are updates to blue books (e.g. for minor technical changes) without changing the issue number.