

Space engineering

**ECSS Secretariat**

**ESA-ESTEC**

**Requirements & Standards Section**

**Noordwijk, The Netherlands**

Adoption Notice of CCSDS 131.0-B-4, TM Synchronization and Channel Coding

This document is distributed to the ECSS Community for Public Review.

(Duration: 8 weeks)

Start of Public Review: 28 September 2022

**End of Public Review: 24 November 2022**

**DISCLAIMER** (for drafts)

This document is an ECSS Draft Standard. It is subject to change without any notice and may not be referred to as an ECSS Standard until published as such.

**Foreword**

This Adoption Notice is one document of the series of ECSS Standards intended to be applied together for the management, engineering, product assurance and sustainability 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 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.

**Disclaimer**

ECSS does not provide any warranty whatsoever, whether expressed, implied, or statutory, including, but not limited to, any warranty of merchantability or fitness for a particular purpose or any warranty that the contents of the item are error-free. In no respect shall ECSS incur any liability for any damages, including, but not limited to, direct, indirect, special, or consequential damages arising out of, resulting from, or in any way connected to the use of this document, whether or not based upon warranty, business agreement, tort, or otherwise; whether or not injury was sustained by persons or property or otherwise; and whether or not loss was sustained from, or arose out of, the results of, the item, or any services that may be provided by ECSS.

Published by: ESA Requirements and Standards Section

 ESTEC, P.O. Box 299,

 2200 AG Noordwijk

 The Netherlands

Copyright: 2022© by the European Space Agency for the members of ECSS

Change log

|  |  |
| --- | --- |
| Previous steps |  |
| ECSS-E-AS-50-21C-Rev.1\_Draft1(18May2022)\_ias | Draft received from WG submitted for Parallel Assessment  |
| Current Step |  |
|  | Public Review 28 October – 24 November 2022 |
| Next steps |  |
| DIR + impl. DRRs | Draft with implemented DRRs |
| DIR + impl. DRRs | DRR Feedback |
| DIA | TA Vote for publication |
| DIA | Preparation of document for publication (including DOORS transfer for Standards) |
|  | Publication |
|  | Change log of document |
| ECSS-E-AS-50-21C1 March 2021 | First issueNOTE: 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 DIR118 May 2022 | First issue, Revision 1Changes 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: * adds support for the Unified Space Data Link Protocol
* adds support for ground-to-space communications links.
 |

Table of contents

[Change log 3](#_Toc65596375)

[1 Scope 5](#_Toc65596376)

[2 Context information 6](#_Toc65596377)

[3 Abbreviated terms 7](#_Toc65596378)

[4 Application requirements 8](#_Toc65596379)

[Bibliography 12](#_Toc65596380)

**Tables**

[Table 4‑1: Applicability table for CCSDS 131.0-B-4 8](#_Toc103759602)

# Scope

This document identifies the clauses and requirements modified with respect to the standard CCSDS 131.0-B-4, *TM Synchronization and Channel Coding*, Issue 4, April 2022 for application in ECSS.

# Context information

The standard CCSDS 131.0-B-4, *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-4 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-4 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-50-01C31 July 2008 | ECSS-E-AS-50-21 | CCSDS 131.0-B-x |
| ECSS-E-ST-50-03C31 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-50-04C31 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. |

# Abbreviated terms

|  |  |
| --- | --- |
| Abbreviation | Meaning |
| PSK | phase-shift keying |
| 4D-8PSK-TCM | 4-dimensional 8PSK trellis-coded modulation |

# Application requirements

CCSDS 131.0-B-4, TM Synchronization and Channel Coding, Issue 4 (April 2022) shall apply as written with the following amendments listed in Table 4‑1.

Table 4‑1: Applicability table for CCSDS 131.0-B-4

| 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 shall be used for the decoder. | 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 ~~should be used whenever constraints (such as complexity of decoder) permit~~. |
| 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) When E=16, I=1, 2, 3, 4, 5, and 8.b) When E=8, I=8 | CCSDS requirement modified for Reed-Solomon codes to explain better applicability of E=16 and E=8 | The allowable values of interleaving depth ~~are~~ 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 ~~normally~~ 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 with E=16 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. |  |

1. (informative)
Differences from ECSS-E-ST-50-01C
	1. General

Clause 4 of this document contains normative amendments to CCSDS 131.0-B-4. 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.

* 1. Differences
		1. Addition of LDPC codes

CCSDS 131.0-B-4 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.

* + 1. Transfer frame lengths

Section 11 of CCSDS 131.0-B-4 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.

* + 1. Managed parameters

Section 12 of CCSDS 131.0-B-4 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.

* + 1. Ground to space

The channel codes specified in CCSDS 131.0-B-4 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.

* + 1. Specification of service interfaces

Annex A of CCSDS 131.0-B-4 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.

* + 1. Security considerations

Annex B of CCSDS 131.0-B-4 provides a discussion of security considerations related to TM Synchronization and Channel Coding. There was no equivalent in ECSS-E-ST-50-01.

* + 1. 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-4. 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.1 | Space engineering - Adoption Notice of CCSDS 131.0-B-4, 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-50-01C31 July 2008 | Space engineering - Space data links - Telemetry synchronization and channel coding |
| ECSS-E-ST-50-03C31 July 2008 | Space engineering - Space data links - Telemetry transfer frame protocol |
| ECSS-E-ST-50-04C31 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 |