
**Space data and information transfer
systems — Flexible advanced coding and
modulation scheme for high rate
telemetry applications**

*Systèmes de transfert des informations et données spatiales —
Schéma de modulation et de codage flexible avancé pour applications
en télémesure à haut débit*

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2. www.iso.org/directives

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received. www.iso.org/patents

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ISO 17854 was prepared by the Consultative Committee for Space Data Systems (CCSDS) (as CCSDS 131.2-B-1, March 2012) and was adopted (without modifications except those stated in Clause 2 of this International Standard) by Technical Committee ISO/TC 20, *Aircraft and space vehicles*, Subcommittee SC 13, *Space data and information transfer systems*. www.iso.org/standards

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Space data and information transfer systems — Flexible advanced coding and modulation scheme for high rate telemetry applications

1 Scope

This International Standard defines an efficient and comprehensive coding and modulation solution able to support a wide range of spectral efficiency values and data rates. The main target is given by high data rate telemetry applications, i.e. Earth Exploration Satellite Service (EESS) telemetry payload, where the increase of the system throughput by means of advanced adaptive techniques is deemed essential in order to fulfil the requirements imposed by future missions.

This International Standard presents a turbo-like coding/modulation scheme based on one possible realization of a Serial Concatenated Convolutional Code (SCCC). This scheme makes use of a set of a large variety of modulation techniques (including QPSK, 8PSK, 16APSK, 32APSK, and 64APSK) and a wide range of coding rates. The number of different modulation schemes available, combined with a properly selected coding rate, allows the overall system to make efficient use of the available bandwidth, adapting itself to the variable conditions of the link. The proposed scheme can implement Variable Coding and Modulation (VCM) mode, which varies the transmission scheme to the channel conditions following a predetermined schedule (for example, as a function of the elevation angle). When a channel is available to provide feedback (e.g. via Telecommand), the transmission scheme can be dynamically adjusted using the Adaptive Coding and Modulation (ACM) mode. The proposed coding scheme is easily adapted to any of the available modulation formats thanks to the pragmatic approach adopted: the outputs of the binary encoders are mapped to the considered modulation scheme, after being interleaved. In other words, a bit-interleaved coded modulation scheme is proposed (reference [F1]).

The use of SCCC is intended mainly for high data rate applications. The Forward Error Correction (FEC) scheme is based on the concatenation of two simple four-state encoder structures. The SCCC scheme implies a Physical Layer frame of constant length, with pilots inserted in fixed positions. This architecture simplifies the synchronization procedure, thus further allowing fast and efficient acquisition at very high rates for the receiver.

This International Standard describes a technique incorporating multiple modulation formats paired with a flexible coding and synchronization method in a tightly integrated fashion. In particular, this International Standard provides a series of recommended formats where each format pairs a modulation technique with a tailored implementation of the coding and synchronization method. However, where these modulations and/or codes are recommended in other CCSDS documents, this International Standard does not limit the choice of modulations and/or codes consistent with those recommendations.

The scope and field of application are furthermore detailed in subclause 1.3 of the enclosed CCSDS publication.

2 Requirements

Requirements are the technical recommendations made in the following publication (reproduced on the following pages), which is adopted as an International Standard:

CCSDS 131.2-B-1, March 2012, Flexible advanced coding and modulation scheme for high rate telemetry applications.

ISO 17854:2013(E)

For the purposes of international standardization, the modifications outlined below shall apply to the specific clauses and paragraphs of publication CCSDS 131.2-B-1.

Pages i to v

This part is information which is relevant to the CCSDS publication only.

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Add the following information to the reference indicated:

- [1] Document CCSDS 131.0-B-2, August 2011, is equivalent to ISO 22641:2012.
- [2] Document CCSDS 132.0-B-1, September 2003, is equivalent to ISO 22645:2005.
- [3] Document CCSDS 732.0-B-2, July 2006, is equivalent to ISO 22666:2007.

3 Revision of publication CCSDS 131.2-B-1

It has been agreed with the Consultative Committee for Space Data Systems that Subcommittee ISO/TC 20/SC 13 will be consulted in the event of any revision or amendment of publication CCSDS 131.2-B-1. To this end, NASA will act as a liaison body between CCSDS and ISO.

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Recommendation for Space Data System Standards

**FLEXIBLE ADVANCED
CODING AND MODULATION
SCHEME FOR HIGH RATE
TELEMETRY APPLICATIONS**

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RECOMMENDED STANDARD

CCSDS 131.2-B-1

BLUE BOOK

March 2012

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This document has been approved for publication by the Management Council of the Consultative Committee for Space Data Systems (CCSDS) and represents the consensus technical agreement of the participating CCSDS Member Agencies. The procedure for review and authorization of CCSDS documents is detailed in *Organization and Processes for the Consultative Committee for Space Data Systems*, and the record of Agency participation in the authorization of this document can be obtained from the CCSDS Secretariat at the address below.

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CCSDS RECOMMENDED STANDARD FOR FLEXIBLE ADVANCED CODING AND
MODULATION SCHEME FOR HIGH RATE TELEMETRY APPLICATIONS

STATEMENT OF INTENT

The Consultative Committee for Space Data Systems (CCSDS) is an organization officially established by the management of its members. The Committee meets periodically to address data systems problems that are common to all participants, and to formulate sound technical solutions to these problems. Inasmuch as participation in the CCSDS is completely voluntary, the results of Committee actions are termed **Recommended Standards** and are not considered binding on any Agency.

This **Recommended Standard** is issued by, and represents the consensus of, the CCSDS members. Endorsement of this **Recommendation** is entirely voluntary. Endorsement, however, indicates the following understandings:

- o Whenever a member establishes a CCSDS-related **standard**, this **standard** will be in accord with the relevant **Recommended Standard**. Establishing such a **standard** does not preclude other provisions which a member may develop.
- o Whenever a member establishes a CCSDS-related **standard**, that member will provide other CCSDS members with the following information:
 - The **standard** itself.
 - The anticipated date of initial operational capability.
 - The anticipated duration of operational service.
- o Specific service arrangements shall be made via memoranda of agreement. Neither this **Recommended Standard** nor any ensuing **standard** is a substitute for a memorandum of agreement.

No later than three years from its date of issuance, this **Recommended Standard** will be reviewed by the CCSDS to determine whether it should: (1) remain in effect without change; (2) be changed to reflect the impact of new technologies, new requirements, or new directions; or (3) be retired or canceled.

In those instances when a new version of a **Recommended Standard** is issued, existing CCSDS-related member standards and implementations are not negated or deemed to be non-CCSDS compatible. It is the responsibility of each member to determine when such standards or implementations are to be modified. Each member is, however, strongly encouraged to direct planning for its new standards and implementations towards the later version of the Recommended Standard.

FOREWORD

This document describes a Serially Concatenated Convolutional turbo Coding (SCCC) scheme for telemetry applications. The flexibility, performance, and proper architecture of the proposed coding scheme together with a new frame structure make the scheme suitable for achieving a significantly high spectral and power efficiency while maintaining compatibility with the existing data layer protocols.

The proposed coding scheme and its associated frame structure are specifically designed to support reconfiguration of the downlink channel (variable or adaptive coding and modulation) and to provide means for reliable synchronization at the Physical Layer and the Data Link Layer.

Through the process of normal evolution, it is expected that expansion, deletion, or modification of this document may occur. This Recommended Standard is therefore subject to CCSDS document management and change control procedures, which are defined in the *Procedures Manual for the Consultative Committee for Space Data Systems*. Current versions of CCSDS documents are maintained at the CCSDS Web site:

<http://www.ccsds.org/>

Questions relating to the contents or status of this document should be addressed to the CCSDS Secretariat at the address indicated on page i.

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