INTERNATIONAL STANDARD

ISO 13541

Second edition
2021-06

Space data and information transfer systems — Attitude data messages

Systèmes de transfert des informations et données spatiales — Messages de données d'attitude

Reference number
ISO 13541:2021(E)

© ISO 2021



COPYRIGHT PROTECTED DOCUMENT

© ISO 2021

All rights reserved. Unless otherwise specified, or required in the context of its implementation, no part of this publication may be reproduced or utilized otherwise in any form or by any means, electronic or mechanical, including photocopying, or posting on the internet or an intranet, without prior written permission. Permission can be requested from either ISO at the address below or ISO's member body in the country of the requester.

ISO copyright office
CP 401 • Ch. de Blandonnet 8
CH-1214 Vernier, Geneva
Phone: +41 22 749 01 11
Email: copyright@iso.org
Website: www.iso.org

Published in Switzerland

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

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 (see 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 (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by the Consultative Committee for Space Data Systems (CCSDS) (as CCSDS 504.0-B-1 Cor.1, July 2015) and was adopted (without modifications) by Technical Committee ISO/TC 20, *Space vehicles,* Subcommittee SC 13, *Space data and information transfer systems*.

This second edition cancels and replaces the first edition (ISO 13541:2010), which has been technically revised.

The main changes compared to the previous edition are as follows:

— adds clarifying text to 1.3, Conventions and Definitions.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

© ISO 2021 – All rights reserved

CONTENTS

Section Page

1 INTRODUCTION 1-1

1.1 PURPOSE 1-1
1.2 SCOPE AND APPLICABILITY 1-1
1.3 CONVENTIONS AND DEFINITIONS 1-2
1.4 STRUCTURE OF THIS DOCUMENT 1-2
1.5 REFERENCES 1-3

2 OVERVIEW 2-1

2.1 ATTITUDE DATA MESSAGE TYPES 2-1
2.2 ATTITUDE PARAMETER MESSAGE (APM) 2-1
2.3 ATTITUDE EPHEMERIS MESSAGE (AEM) 2-2
2.4 EXCHANGE OF MULTIPLE MESSAGES 2-2
2.5 DEFINITIONS 2-2

3 ATTITUDE PARAMETER MESSAGE (APM) 3-1

3.1 OVERVIEW 3-1
3.2 APM CONTENT 3-1
3.3 APM EXAMPLES 3-10

4 ATTITUDE EPHEMERIS MESSAGE (AEM) 4-1

4.1 OVERVIEW 4-1
4.2 AEM CONTENT 4-1
4.3 AEM EXAMPLE 4-12

5 ADM SYNTAX 5-1

5.1 INTRODUCTION 5-1
5.2 LINES 5-1
5.3 KEYWORDS 5-1
5.4 VALUES 5-2
5.5 UNITS 5-4
5.6 COMMENTS 5-4

6 SECURITY 6-1

6.1 INTRODUCTION 6-1

© ISO 2021 – All rights reserved

CONTENTS (continued)

Section Page

6.2 SECURITY CONCERNS WITH RESPECT TO THIS RECOMMENDED STANDARD 6-1
6.3 POTENTIAL THREATS AND ATTACK SCENARIOS 6-2
6.4 CONSEQUENCES OF NOT APPLYING STATED SECURITY TO THE TECHNOLOGY 6-2
6.5 DATA SECURITY IMPLEMENTATION SPECIFICS 6-2

ANNEX A VALUES FOR SELECTED KEYWORDS (NORMATIVE) A-1
ANNEX B RATIONALE FOR ATTITUDE DATA MESSAGES (INFORMATIVE) B-1
ANNEX C ITEMS FOR AN INTERFACE CONTROL DOCUMENT (INFORMATIVE) C-1
ANNEX D ABBREVIATIONS AND ACRONYMS (INFORMATIVE) D-1
ANNEX E INFORMATIVE REFERENCES (INFORMATIVE) E-1

Figure Page

3-1 APM File Example Using Comments to Denote Updates 3-10
3-2 APM File Example Using Frame of Another Spacecraft 3-11
3-3 APM File Example Describing Sensor Frame to Body Frame Transform 3-11
3-4 APM File Example Describing Orientation of Instrument 3-12
3-5 APM File Example with Euler Angle Rates 3-12
3-6 APM File Example with Euler Angle Rates (Repeated Axis) 3-13
3-7 APM File Example with Mission Elapsed Time 3-14
3-8 APM File Example with Optional Euler Elements and One Maneuver 3-15
4-1 AEM Example 4-12
4-2 AEM Spinner Example 4-13

Table

3-1 APM Header 3-2
3-2 APM Metadata 3-3
3-3 APM Data 3-4
4-1 AEM File Layout Specifications 4-2
4-2 AEM Header 4-3
4-3 AEM Metadata 4-4
4-4 Types of Attitude Ephemeris Data Lines 4-8
B-1 Primary Requirements B-2
B-2 Heritage Requirements B-3

© ISO 2021 – All rights reserved

CONTENTS (continued)

Table Page

B-3 Desirable Characteristics B-3
B-4 Applicability of the Criteria to Attitude Data Messages B-4
B-5 Services Available with Attitude Data Messages B-4
C-1 Items Recommended for an ICD C-1

© ISO 2021 – All rights reserved

1 INTRODUCTION

1.1 PURPOSE

1.1.1 This Attitude Data Message (ADM) Recommended Standard specifies two standard message formats for use in transferring spacecraft attitude information between space agencies: the Attitude Parameter Message (APM) and the Attitude Ephemeris Message (AEM). Such exchanges are used for:

- preflight planning for tracking or attitude estimation support;
- scheduling attitude and data processing support;
- carrying out attitude operations;
- performing attitude comparisons;
- carrying out attitude propagations and/or sensor predictions;
- testing to initialize sub-system simulators (communications, power, etc.).

1.1.2 This Recommended Standard includes sets of requirements and criteria that the message formats have been designed to meet. For exchanges where these requirements do not capture the needs of the participating agencies, another mechanism may be selected.

1.2 SCOPE AND APPLICABILITY

1.2.1 This document contains two attitude data messages designed for applications involving data interchange in space data systems. The rationale behind the design of each message is described in annex B and may help the application engineer to select a suitable message. Definition of the attitude accuracy underlying a particular attitude message is outside of the scope of this Recommended Standard and should be specified via Interface Control Document (ICD) between data exchange participants. Applicability information specific to each Attitude Data Message format appears in sections 3 and 4, as well as in annex subsection B3.

1.2.2 This Recommended Standard is applicable only to the message format and content, but not to its transmission. The transmission of the message between agencies is outside the scope of this document and should be specified in an ICD or by following a CCSDS standard on transmission.

1.2.3 Description of the message formats based on the use of the eXtensible Markup Language (XML) will be available. An XML schema is defined by the CCSDS Recommended Standard titled ‘XML Specification for Navigation Data Messages’ (reference [5]). Agencies should specify, via ICD, the ASCII file format to be exchanged (Keyword Value Notation [KVN] or XML).

© ISO 2021 – All rights reserved

1.3 CONVENTIONS AND DEFINITIONS

The following conventions apply throughout this Recommended Standard:

a) the words ‘shall’ and ‘must’ imply a binding and verifiable specification;

b) the word ‘should’ implies an optional, but desirable, specification;

c) the word ‘may’ implies an optional specification; and

d) the words ‘is’, ‘are’, and ‘will’ imply statements of fact.

As in some attitude dynamics references, in this document the term ‘nutation’ is used to mean the motion of the spin axis of a body about an inertial axis. In many other references this motion is called ‘precession’.

Cor. 1

1.4 STRUCTURE OF THIS DOCUMENT

1.4.1 Section 2 provides a brief overview of the CCSDS-recommended Attitude Data Message types, the Attitude Parameter Message (APM) and Attitude Ephemeris Message (AEM).

1.4.2 Section 3 provides details about the structure and content of the APM.

1.4.3 Section 4 provides details about the structure and content of the AEM.

1.4.4 Section 5 provides details regarding syntax of the APM and AEM messages.

1.4.5 Section 6 provides information regarding security concerns related to the access and transmission of the Attitude Data Messages.

1.4.6 Annex B provides a list of approved values for selected keywords in the ADM Metadata sections.

1.4.7 Annex B lists a set of requirements that were taken into consideration in the design of the APM and AEM, along with tables and discussion regarding the applicability of the two message types to various attitude estimation tasks and functions.

1.4.8 Annex C lists a number of items that should be covered in ICDs prior to exchanging ADMs on a regular basis. There are several statements throughout the document that refer to the desirability or necessity of such a document; this annex lists all the suggested ICD items in a single place in the document.

1.4.9 Annex D is a list of abbreviations and acronyms applicable to the ADM.

1.4.10 Annex E is a list of informative references.

© ISO 2021 – All rights reserved