



CCSDS

The Consultative Committee for Space Data Systems

CONJUNCTION DATA MESSAGE TEST PLAN/REPORT

CCSDS RECORD

CCSDS 508.0-Y-1.4

YELLOW BOOK

July 2025

FOREWORD

This document records the plans for prototype testing and results of that testing for the Conjunction Data Message, CCSDS 508.0-P-1.2, Pink Book. As a record of prototype testing, it is expected that expansion, deletion, or modification of this document will **not** occur. This document is subject to CCSDS document management and change control procedures, which are defined in the *Organization and Processes for the Consultative Committee for Space Data Systems*. Current versions of CCSDS documents are maintained at the CCSDS Web site:

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1 INTRODUCTION

1.1 PURPOSE

The purpose of this document is to describe the prototype testing conducted on the CCSDS Conjunction Data Message (CDM), CCSDS 508.0-P-1.2 (reference [2]).

1.2 SCOPE

The scope of this document is testing of the Conjunction Data Message. The CDM is part of the technical program of the CCSDS Navigation Working Group. The CDM document completed a CCSDS Agency Review in May 2024, with revisions following this initial review to apply RIDs from the review and proofreading changes; this process is described in reference [1].

1.3 APPLICABILITY

This document applies to the prototype testing required to advance the CDM from Pink Book to Blue Book status.

1.4 RATIONALE

The CCSDS Procedures Manual states that for a Recommendation to become a Blue Book, the draft standard must be tested in an operational manner. The following requirements for an implementation exercise were excerpted from reference [1]:

“At least two independent and interoperable prototypes or implementations must have been developed and demonstrated in an operationally relevant environment, either real or simulated.”

This document outlines the Navigation Working Group’s approach to meeting this requirement for the CDM 508.0 Pink Book.

1.5 DOCUMENT STRUCTURE

The first sections of this document describe the Test Plan for the prototyping activity; the last sections of the document provide a Test Report of the realized plan. Acronyms are provided in Annex A.

1.6 REFERENCES

The following documents are referenced in this document. At the time of publication, the editions indicated were valid. All documents are subject to revision, and users of this document are encouraged to investigate the possibility of applying the most recent editions of the documents indicated below. The CCSDS Secretariat maintains a register of currently valid CCSDS documents.

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- [1] *Organization and Processes for the Consultative Committee for Space Data Systems.* CCSDS A02.1-Y-4. Yellow Book. Issue 4. Washington, D.C.: CCSDS, April 2014.
- [2] *Conjunction Data Message.* Recommendation for Space Data System Standards, CCSDS 508.0-P-1.2. Pink Book, Washington, D.C.: CCSDS, December 2024.

2 CONCLUSION/RECOMMENDATION

The test plan and test reports documented herein substantiate that the organizations participating in the CCSDS Navigation Working Group have successfully conducted prototype testing of the Conjunction Data Message (CDM) document (references [2], [3]). During the testing, CDMs were produced by 4 independent organizations, and the ability to correctly read the messages and utilize the information in analyses was demonstrated by 4 different organizations.

Based on the diversity of organizations able to read/write the messages, and the positive test results, the Navigation Working Group recommends that the CDM Pink Book document be promoted to a Blue Book CCSDS Recommended Standard.

*** NOTE: The above is the Conclusion the team hopes to reach at the conclusion of the testing described in this document. ***

3 CONJUNCTION DATA MESSAGE (CDM) TESTING GOALS

The test of the CDM described in Section 4 and Section 5 of this plan will be conducted in order to meet the CCSDS requirements described in Section 2. In Section 6 and Section 7, the results of the testing are presented.

3.1 CDM OVERVIEW

The CDM is an ASCII file in “keyword=value notation” (KVN) formatted message as well as an Extensible Markup Language (XML) formatted message. It specifies a standard message format for use in exchanging spacecraft conjunction information between originators of conjunction assessment (CA) data, satellite owner/operators and other authorized parties. The file is organized into 5 sections: a header section, a relative metadata/data section, a metadata section, a data section, and an optional user defined parameter section. The header section contains identification information (version, creation date, originator, etc.). The relative metadata/data section contains metadata/data describing relative relationships between the two conjuncting objects. The metadata section contains information regarding the objects to which the conjunction assessment information applies, operator contact information, applicable reference frames, etc.. The data section contains the Cartesian state vector for the conjuncting objects at the time of closest approach (obligatory), a 6x6 position/velocity covariance matrix (obligatory) for both objects, the 7, 8 and 9 terms for a 9x9 covariance matrix (optional) for both objects, needed for propagation of the covariance to another time point, and information describing the orbit determination used for each object in producing the state vectors and covariance. The final optional user defined parameter section allows users to define implementation specific parameters which are not catered for in the main body of the CDM standard, if used, the keywords and their meanings should be detailed in an Interface Control Document (ICD).

4 TEST PLAN OVERVIEW

4.1 TEST ORGANIZATION

Prototyping of the CDM will be performed as shown in the following table, which lists the Test Number, participating member agencies of the Navigation Working Group, and direction of message transfer. All CDM optional elements will be exercised in the test cases. In the event of discrepancies, troubleshooting will be conducted by the participants in the test.

Test#	From	To
1	CNES	NASA JSC
2	DLR	ESA/ESOC
3	TraCSS	NASA CARA
4	Messages from Tests 1, 2, & 3	NASA JPL

4.2 TEST CASE ELEMENTS

For the purposes of testing there are considered to be two types of keyword within the CDM. These being independent keywords which do not have complex conditions which can be tested in a single test, and conditional keywords which require two tests to test their functionality. These will be referred to as independent keywords and dependent keywords. All new or modified keywords associated with CDM V2 are listed below to indicate which type they are considered to be. Dependent keywords will include the two states, referred to as cases, which need to be tested.

4.2.1 INDEPENDENT KEYWORDS

The following keywords are considered independent and therefore do not require multiple tests to test their functionality:

General keywords:

- CLASSIFICATION
- CONJUNCTION_ID
- MAHALANOBIS_DISTANCE
- APPROACH_ANGLE
- EFFECTIVE_COMBINED_HBR
- PREVIOUS_MESSAGE_ID
- PREVIOUS_MESSAGE_EPOCH
- NEXT_MESSAGE_EPOCH
- OPS_STATUS
- ODM_MSG_LINK
- ADM_MSG_LINK
- OBS_BEFORE_NEXT_MESSAGE
- COVARIANCE_SOURCE
- OD_EPOCH

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- MIN_MEDIAN_MAX_UPDATE_INTERVAL
- AREA_PC_MIN
- AREA_PC_MAX
- HBR
- MIN_DV
- MAX_DV
- LEAD_TIME_REQD_BEFORE_TCA
- APOAPSIS_ALTITUDE
- PERIAPSIS_ALTITUDE
- INCLINATION
- DENSITY_FORECAST_UNCERTAINTY
- SCREENING_DATA_SOURCE
- DCP_SENSITIVITY_VECTOR_POSITION
- DCP_SENSITIVITY_VECTOR_VELOCITY

Collision probability keywords:

- COLLISION_MAX_PROBABILITY
- COLLISION_MAX_PC_METHOD

Space environment burden keywords:

- SEB_FACTOR
- SEB_MODEL

RCS keywords:

- RCS
- RCS_MIN
- RCS_MAX

Visual magnitude keywords:

- VM_ABSOLUTE
- VM_APPARENT_MIN
- VM_APPARENT
- VM_APPARENT_MAX
- REFLECTANCE

Covariance confidence keywords:

- COV_CONFIDENCE
- COV_CONFIDENCE_METHOD

Covariance scale factor keywords:

- CSCALE_FACTOR_MIN
- CSCALE_FACTOR
- CSCALE_FACTOR_MAX

User defined parameters:

- USER_DEFINED_x

4.2.2 DEPENDENT KEYWORDS

The following keywords are considered dependent and therefore require multiple tests to test their functionality. In each instance the keyword details the cases that require testing.

Collision percentile keywords:

- COLLISION_PERCENTILE
- COLLISION_PROBABILITY

Two cases will be performed as follows:

- Case #1: This test will contain the COLLISION_PERCENTILE keyword with 5 elements, this will mean that the COLLISION_PROBABILITY keyword shall also contain 5 corresponding elements.
- Case #2: This test will not contain the COLLISION_PERCENTILE keyword, this will mean that the COLLISION_PROBABILITY keyword will just contain one value.

Screening parameter keywords:

- SCREEN_TYPE
- SCREEN_VOLUME_SHAPE
- SCREEN_VOLUME_RADIUS
- SCREEN_PC_THRESHOLD

Two cases will be performed as follows.

- Case #1: This test will contain SCREEN_TYPE set to SHAPE. This will mean that SCREEN_VOLUME_SHAPE must be present and shall be set to SPHERE, and keyword SCREEN_VOLUME_RADIUS must be present and set accordingly.
- Case #2: This test will contain SCREEN_TYPE set to PC. This will mean that SCREEN_PC_THRESHOLD must be present and set accordingly.

Optimally enclosing box keywords:

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- OEB_PARENT_FRAME
- OEB_PARENT_FRAME_EPOCH
- OEB_Q1
- OEB_Q2
- OEB_Q3
- OEB_QC
- OEB_MAX
- OEB_INT
- OEB_MIN
- AREA_ALONG_OEB_MAX
- AREA_ALONG_OEB_INT
- AREA_ALONG_OEB_MIN

Two cases will be performed as follows.

- Case #1: OEB_PARENT_FRAME set to UNKNOWN. This will mean that all other OEB keywords shall not be present.
- Case #2: OEB_PARENT_FRAME set to a value from the SANA registry (https://sanaregistry.org/r/orbit_relative_reference_frames/). This will mean that all other OEB keywords shall be present.

Alternate covariance keywords:

- ALT_COV_TYPE
- ALT_COV_REF_FRAME
- CX_X
- CY_X
- CY_Y
- CZ_X
- CZ_Y
- CZ_Z
- CXDOT_X
- CXDOT_Y
- CXDOT_Z
- CXDOT_XDOT
- CYDOT_X
- CYDOT_Y
- CYDOT_Z
- CYDOT_XDOT
- CYDOT_YDOT
- CZDOT_X
- CZDOT_Y

- CZDOT_Z
- CZDOT_XDOT
- CZDOT_YDOT
- CZDOT_ZDOT
- CDRG_X
- CDRG_Y
- CDRG_Z
- CDRG_XDOT
- CDRG_YDOT
- CDRG_ZDOT
- CDRG_DRG
- CSRP_X
- CSRP_Y
- CSRP_Z
- CSRP_XDOT
- CSRP_YDOT
- CSRP_ZDOT
- CSRP_DRG
- CSRP_SRP
- CTHR_X
- CTHR_Y
- CTHR_Z
- CTHR_XDOT
- CTHR_YDOT
- CTHR_ZDOT
- CTHR_DRG
- CTHR_SRP
- CTHR_THR
- CSIG3EIGVEC3 (C on ALT_COV_TYPE)

Two cases will be performed as follows.

- Case #1: ALT_COV_TYPE set to XYZ. This will mean that all alternate covariance keywords shall be present except CSIG3EIGVEC3.
- Case #2: ALT_COV_TYPE set to CSIG3EIGVEC3. This will mean only ALT_COV_FRAME and CSIG3EIGVEC3 shall be present.

4.3 TEST CASE CONSTRUCTION

The tests detailed in this document shall be constructed to test all of the parameters detailed in Section 4.2 and CDM functionality.

Test 1 will be constructed to test that CDM V2 is backwards compatible with CDM V1 from a Keyword perspective. It should be noted that the only discrepancy acceptable may be that if

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a CDM V1 reader checks the CCSDS_CDM_VERS keyword, it may not accept a value of 2.0. This is something that can be overridden if an organization does not chose to update their readers. A list of compatible CDM V1 keywords is provided in Annex B.

Test 2 shall be constructed to test all or a subset of the independent keywords detailed in Section 4.2 along with all dependent keywords using their Case #1 configurations.

Test 3 shall be constructed to test all or a subset or all of the independent keywords detailed in Section 4.2 along with all dependent keywords using their Case #2 configurations.

Test 2 and Test 3 shall be constructed such that, if each test contains a subset of independent keywords, combined they shall test all independent keywords in across both test.

Test 4 shall test that the CDM messages used for tests 1, 2, and 3 in this document, when converted to XML, validate against the CDM XML schema.

5 TEST PLAN DETAILS

5.1 TEST CASE #1: CDM BACKWARDS COMPATABILITY

5.1.1 TEST PURPOSE

This tests the ability of CDM V2 to support CDM messages containing just CDM V1 keywords. The assignments to "Organisation1" and "Organisation2" are as indicated in Section 4.1 above.

5.1.2 TEST DESCRIPTION

For this test, Organisation1 will send a CDM using just CDM V1 keywords to Organisation2. Organisation2 will ingest this message and determine if the message was correctly processed. A list of compatible CDM V1 keywords is provided in Annex B.

5.1.3 EXPECTED RESULTS

It is anticipated that Organisation1 will successfully write a CDM message containing just CDM V1 keywords and that Organisation2 will successfully read the CDM message. Assuming that these criteria are met, the test will be considered successful. In the event of discrepancies, troubleshooting will be conducted by the participants in the test.

NOTE: The message should specify that "CCSDS_CDM_VERS = 2.0", this could cause an error in the receiver's processing that would need to be addressed by the receiver.

5.2 TEST CASE #2: INDEPENDENT KEYWORD AND CASE #1 DEPENDENCIES

5.2.1 TEST PURPOSE

This test demonstrates the processing of a CDM message containing optional keywords which have conditional dependencies.

5.2.2 TEST DESCRIPTION

For this test Organisation1 will write the CDM test message including all or a subset of independent keywords plus dependent keywords in Case #1 configuration as defined in Section 4.2. Organisation2 will read the provided message and determine if the message was successfully processed.

5.2.3 EXPECTED RESULTS

It is anticipated that Organisation1 will successfully write a CDM message and that Organisation2 will successfully read the CDM message. Assuming that these criteria are met, the test will be considered successful. In the event of discrepancies, troubleshooting will be conducted by the participants in the test.

5.3 TEST CASE #3: INDEPENDENT KEYWORD AND CASE #2 DEPENDENCIES

5.3.1 TEST PURPOSE

This test demonstrates the processing of a CDM message containing optional keywords which have conditional dependencies.

5.3.2 TEST DESCRIPTION

For this test Organisation1 will write the CDM test message including all or a subset of independent keywords plus dependent keywords in Case #2 configuration as defined in Section 4.2. Organisation2 will read the provided message and determine if the message was successfully processed.

5.3.3 EXPECTED RESULTS

It is anticipated that Organisation1 will successfully write a CDM message and that Organisation2 will successfully read the CDM message. Assuming that these criteria are met, the test will be considered successful. In the event of discrepancies, troubleshooting will be conducted by the participants in the test.

5.4 TEST CASE #4: XML SCHEMA

5.4.1 TEST PURPOSE

This test demonstrates that the CDM messages used for tests 1, 2, and 3 in this document, when converted to XML, validate correctly against the CDM V2 XML schema.

5.4.2 TEST DESCRIPTION

For this test this test messages written for test 1, 2, and 3 will be converted to XML and validated against the CDM V2 XML schema.

5.4.3 EXPECTED RESULTS

If the test messages validate correctly against the CDM V2 XML schema, the test will be considered successful. In the event of discrepancies, troubleshooting will be conducted by the participants in the test.

6 TEST REPORT OVERVIEW

CDM participants will prepare test data sheets as applicable, and send them to the Navigation Working Group via email.

The test report details will be consolidated in Section 7 of this document. A summarization of the test process and the recommendation of the NavWG may be found in Section 2 of the report. The report will be submitted to the CCSDS Engineering Steering Group (CESG) and CCSDS Management Council (CMC), along with results of the agency reviews. At that time, a formal request will be submitted to the CMC for progression of the CDM to CCSDS Blue Book status.

The next page contains a format for the test data sheets that will be used to report the results of individual tests. The form includes sections for the originator of the message and the recipient of the message as well as sections to document the test results.

SAMPLE



Conjunction Data Message (CDM) Prototype Test Data Sheet

1	Report Date:	
2	Program Under Test:	Conjunction Data Message (CDM) Prototype
3	Test Case Number:	
4	Agencies Participating in this Test Case:	
5	Agency Responsible for Producing Test Message	
6	Producing Test Engineer:	
7	Agency Responsible for Consuming Test Message	
8	Consuming Test Engineer:	
9	Spacecraft:	
10	Results (Pass, Partial Pass, Fail):	
11	Variances from Expected Result:	
12	Comments:	

7 TEST REPORT DETAILS

7.1 TEST CASE #1 CDM BACKWARDS COMPATABILITY

7.2 TEST CASE #2: INDEPENDENT KEYWORD AND CASE #1 DEPENDENCIES

7.3 TEST CASE #3: INDEPENDENT KEYWORD AND CASE #2 DEPENDENCIES

7.4 TEST CASE #4: XML SCHEMA

ANNEX A

ABBREVIATIONS AND ACRONYMS (INFORMATIVE)

ASCII	American Standard Code for Information Interchange
CA	Conjunction Assessment
CCSDS	Consultative Committee for Space Data Systems
CDM	Conjunction Data Message
CNES	Centre National d'Etudes Spatiales
CSM	Conjunction Summary Message
DLR/GSOC	Deutsches Zentrum für Luft und Raumfahrt (German Aerospace Center)/German Space Operations Center
ESA/ESOC	European Space Agency/European Space Operations Center
ITRF	International Terrestrial Reference Frame
JAXA	Japan Aerospace Exploration Agency
KVN	Keyword = Value Notation
NASA/GSFC	National Aeronautics and Space Administration/Goddard Space Flight Center
NASA/JPL	National Aeronautics and Space Administration/Jet Propulsion Laboratory
NASA/JSC	National Aeronautics and Space Administration/Johnson Space Flight Center
NavWG	CCSDS Navigation Working Group
OCM	Orbit Conjunction Message
SANA	Space Assigned Numbers Authority
TCA	Time of Closest Approach
XML	Extensible Markup Language

ANNEX B

CONJUNCTION DATA MESSAGE V1 KEYWORDS (INFORMATIVE)

This Annex lists all keywords included in CDM V1.

Header:

- CCSDS_CDM_VERS
- CREATION_DATE
- ORIGINATOR
- MESSAGE_FOR
- MESSAGE_ID

Relative Metadata:

- TCA
- MISS_DISTANCE
- RELATIVE_SPEED
- RELATIVE_POSITION_R
- RELATIVE_POSITION_T
- RELATIVE_POSITION_N
- RELATIVE_VELOCITY_R
- RELATIVE_VELOCITY_T
- RELATIVE_VELOCITY_N
- START_SCREEN_PERIOD
- STOP_SCREEN_PERIOD
- SCREEN_VOLUME_FRAME
- SCREEN_VOLUME_SHAPE
- SCREEN_VOLUME_X
- SCREEN_VOLUME_Y
- SCREEN_VOLUME_Z
- SCREEN_ENTRY_TIME
- SCREEN_EXIT_TIME
- COLLISION_PROBABILITY
- COLLISION_PROBABILITY_METHOD

Object Metadata:

- OBJECT
- OBJECT_DESIGNATOR
- CATALOG_NAME

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- OBJECT_NAME
- INTERNATIONAL_DESIGNATOR
- OBJECT_TYPE
- OPERATOR_CONTACT_POSITION
- OPERATOR_ORGANIZATION
- OPERATOR_PHONE
- OPERATOR_EMAIL
- EPHEMERIS_NAME
- COVARIANCE_METHOD
- MANEUVERABLE
- ORBIT_CENTER
- REF_FRAME
- GRAVITY_MODEL
- ATMOSPHERIC_MODEL
- N_BODY_PERTURBATIONS
- SOLAR_RAD_PRESSURE
- EARTH_TIDES
- INTRACK_THRUST

Object Data:

- TIME_LASTOB_START
- TIME_LASTOB_END
- RECOMMENDED_OD_SPAN
- ACTUAL_OD_SPAN
- OBS_AVAILABLE
- OBS_USED
- TRACKS_AVAILABLE
- TRACKS_USED
- RESIDUALS_ACCEPTED
- WEIGHTED_RMS
- AREA_PC
- AREA_DRG
- AREA_SRP
- MASS
- CD_AREA_OVER_MASS
- CR_AREA_OVER_MASS
- THRUST_ACCELERATION
- SEDR
- X
- Y
- Z
- X_DOT
- Y_DOT

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- Z_DOT
- CR_R
- CT_R
- CT_T
- CN_R
- CN_T
- CN_N
- CRDOT_R
- CRDOT_T
- CRDOT_N
- CRDOT_RDOT
- CTDOT_R
- CTDOT_T
- CTDOT_N
- CTDOT_RDOT
- CTDOT_TDOT
- CNDOT_R
- CNDOT_T
- CNDOT_N
- CNDOT_RDOT
- CNDOT_TDOT
- CNDOT_NDOT
- CDRG_R
- CDRG_T
- CDRG_N
- CDRG_RDOT
- CDRG_TDOT
- CDRG_NDOT
- CDRG_DRG
- CSRP_R
- CSRP_T
- CSRP_N
- CSRP_RDOT
- CSRP_TDOT
- CSRP_NDOT
- CSRP_DRG
- CSRP_SRP
- CTHR_R
- CTHR_T
- CTHR_N
- CTHR_RDOT
- CTHR_TDOT
- CTHR_NDOT
- CTHR_DRG

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- CTHR_SRP
- CTHR_THR