SAE Aerospace
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AEROSPACE STANDARD

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Platform/Subsystem Common Interface Control Document Format

RATIONALE

The well adopted AS5609 Aircraft/Store Common Interface Control Document Format Standard leveraged the desire for a general avionics/platform to subsystem interface control document format. This facilitates an easier control and comparison of the products from different suppliers from the integrator or main contractor point of view and allows the generation of one ICD for different customers from the suppliers point of view.

FOREWORD

The Platform/Subsystem Common Interface Control Document Format is a standard that defines a common document format for platform/subsystem logical, physical, and environmental interfaces. Its purpose is to assist and harmonize platform-subsystem interface standardization and to provide a common document format for the development and comparison of platform/subsystem interface control documents (ICDs).

This document was prepared by the AS-1C1 Avionics CICD Task Group, under the jurisdiction of the AS-1C Subcommittee, Avionic Subsystems, of the SAE AS-1 Committee, Platform Systems and System Integration.

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1. SCOPE

This SAE Aerospace Standard (AS) defines the editorial format and policies necessary for the publication of platform/subsystem Interface Control documents. The Common Interface Control Document Format Standard defines a common format for platform to subsystem interface documents to facilitate subsystem integration.

This aerospace standard specifies the common technical data sections for the Common Interface Control Document Format down to the third header level for the majority of sub-sections. The Common Interface Control Document Format Aerospace Standard provides a structured document format in appendixes supported by example paragraphs, drawings, etc.

1.1 Purpose

The Platform/Subsystem Common Interface Control Document Format standardizes the document format to be utilized to define and document platform/subsystem interfaces. A common document format is desired to facilitate subsystem integration in new or already existing platforms.

1.2 Field of Application

This standard applies to new Platform/Subsystem Interface Control Documents, and may be applied to existing subsystem ICDs when they are being revised.

2. REFERENCES

2.1 Applicable Documents

The following publications form a part of this document to the extent specified herein. The latest issue of SAE publications shall apply. The applicable issue of other publications shall be the issue in effect on the date of the purchase order. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or 724-776-4970 (outside USA), www.sae.org.

AS5609 Aircraft/Store Common Interface Control Document Format Standard

AS5506 Architecture Analysis and Design Language (AADL)

2.1.2 ANSI Publications

Available from American National Standards Institute, 25 West 43rd Street, New York, NY 10036-8002, Tel: 212-642-4900, www.ansi.org.

ASCII American Standard Code for Information Interchange

2.1.3 Object Management Group Publications

Available from the Object Management Group (www.omg.org)

UML Unified Modeling Language

SysML System Modeling Language

2.1.4 U.S. Government Publications

Available from the Document Automation and Production Service (DAPS), Building 4D, 700 Robbins Avenue, Philadelphia, PA 19111-5094, Tel: 215-697-6257, http://assist.daps.dla.mil/quicksearch/.

MIL-STD-1472 Human Engineering

MIL.-STD-130 Identification Marking of US Military Property

MIL-STD-1553B Notice 4 Digital Time Division Command/Response Multiplex Data Bus NOTE: Revision B Notice 4 is specifically required.

MIL-HDBK-1553A Notice 1 Multiplex Applications Handbook

DoDAF Department of Defense Architecture Framework – see http://www.architectureframework.com/dodaf/

2.2 Applicable References

None

2.3 Definitions

PLATFORM: In the context of this standard a platform is regarded as any vehicle designed to be supported by air, being borne up either by the dynamic action of the air upon the surfaces of the vehicle, or by its own buoyancy. The term includes fixed and movable wing airplanes, helicopters, gliders, and airships, with or without on-board operator, but excludes air-launched missiles, target drones, and flying bombs.

SUBSYSTEM: Any equipment intended for internal carriage and installed in a platform.

2.3.1 Terminology

SHALL: This Term in the Platform/Subsystem Common Interface Control Document Format is to be used wherever the criterion for conformance with the specific recommendation requires that there be no deviation.

SHOULD: This Term in the Platform/Subsystem Common Interface Control Document Format is to be used wherever the criterion for conformance with the specific recommendation is to meet a system objective. Failure to meet a “Should” statement shall be justified

MUST: This Term in the Platform/Subsystem Common Interface Control Document Format is used for a legislative or regulatory requirement (e.g. health and safety) with which the customer, the platform company and the subsystem company shall comply. It is not used to express a requirement of the specification.

WILL: This Term in the Platform/Subsystem Common Interface Control Document Format is used for the future tense. It does not express a requirement of the specification.

MAY: This Term in the Platform/Subsystem Common Interface Control Document Format expresses a permissible practice or action. It does not express a requirement of the specification.

3. PLATFORM/SUBSYSTEM COMMON INTERFACE CONTROL DOCUMENT FORMAT REQUIREMENTS

3.1 Background

The SAE generated AS5609 – Aircraft/Store Common Interface Control Document Format. This standard has been adopted by the military platform industry and demanded the generation of a comparable standard for platform to subsystem interfaces. Currently each supplier of subsystems either uses its own format for the subsystem interface or is required to use the format of the subsystem integrator i.e. the platform manufacturer. This standard facilitates the subsystem integration through easy identification of technical information in similar document locations and allows the generation of a single subsystem ICD for different manufacturers/platforms. Additionally, this standard can support the handling of a complex interface through the provision of a complete guideline of considerable points relevant in a subsystem integration.

3.2 Application Areas and Format Utilization

3.2.1 Application Areas

The Platform/Subsystem Common Interface Control Document Format is intended for use in all areas and combinations of platform to subsystem integration for all kinds of subsystems (including equipment and pods) of any origin (legacy or new products).

3.2.2 Utilization and Basic Considerations

There exists just one interface from the subsystem point of view, which shall be described within one Interface Control Document. That is the direct interface between the platform and the subsystem logically, mechanically and electrically directly connected (no intermediary system) together. All other platform subsystems interfacing with the subsystem subject to integration are regarded as the platform itself.

3.3 Basic Structure and Generation Rules

The Platform/Subsystem Common Interface Control Document is split into two volumes. Volume 1 covers mostly hardware aspects such as the mechanical or electrical interface, whilst Volume 2 specifies the logical part and provides the Signal Format Sheets.

For simple interfaces, the two volume approach may be unnecessary. Dependent on the size and intent of the interface control document, the author may retain a single volume approach, but shall keep to the same section/paragraph sequence defined in the Platform/Subsystem Common Interface Control Document Format for that document. For example, if the subsystem has no logical interface requirements with the platform, the author may drop Volume 2 and only write a Volume 1 document, but the entire format must be utilized. Parts that are not applicable can be simply marked as "Not Applicable" but they must not be deleted.

However, all parts of the Platform/Subsystem Common Interface Control Document Format may be tailored to the author's needs. This may be necessary to cope with special requirements or needs of a subsystems integration project, where test assets or subsystem prototypes (development models) may be necessary during the development phase. This may require a separate ICD to cover e.g. specific flight test instrumentation connections and recording capability.

Prior to commencing the writing of a platform/subsystem ICD it is necessary to understand the data that is required to be captured in the document. A checklist aligned against the section numbers in the two main volumes of the ICD can assist an ICD author in gathering the relevant data. The checklist identifies the relevant section numbers and titles and provides check columns for the author to record if specific information is required in the ICD or not. Some sections are mandatory so these will already be checked in the list. The final column of the checklist then gives a brief outline of the type of data that is required to populate each section of the ICD or where blank, acts as a working sheet for the ICD author to compile notes of project-specific information that needs to be gathered.

If possible, reference to existing standards and definitions shall be given to avoid multiple specifications. Deviations shall be clearly identified.

Whenever possible, favorably in the logical sections, modern system design languages (e.g. UML, SysML, AADL) and system architecture description methods (DoDAF) shall be used.

3.4 Volume 1 Overview

Volume 1 covers mostly hardware aspects such as the mechanical or electrical interface. The heading level 1 structure for Volume 1 is shown in FIGURE 1. Examples for each paragraph of the Volume 1 template are provided in Appendix A.

1	Introduction
2	Applicable Documents
3	Mechanical Interface
4	Electrical Interface
5	Aerodynamics Interface
6	Safety
7	Environmental Consderations
8	Pilot Vehicle Interface
9	Wireless Communication
10	Support/ Maintenance Interface

FIGURE 1 – CICD FORMAT STRUCTURE VOLUME 1 LEVEL 1

3.4.1 Volume 1 Section 1 Introduction

This section shall cover the introduction to the Volume 1 of the interface control document. An overview of the volume content and detailed information concerning updates shall be given. The use of terms within the interface control document shall be defined. In the general description subsection, the purpose of the subsystem, platform or the combination shall be identified. FIGURE 2 provides an outline of this section.

1	Introduction
1.1	Scope
1.2	Updating
1.3	Information Accuracy
1.4	Definition of Terms
1.5	General Description
1.6	Commonality Considerations

FIGURE 2 – CICD FORMAT STRUCTURE FOR VOLUME 1, SECTION 1

3.4.2 Volume 1 Section 2 Applicable Documents

This section lists the referenced and considered documents relevant for Volume 1 of the interface control document and defines the order of precedence if any. All documents referenced elsewhere in Volume 1 of the interface control document and which are fundamental for the interface shall be listed in this section. The listing shall include the relevant document issue used during document generation to prevent invalidating the interface control document after an update of the referenced document. FIGURE 3 provides an outline of this section.

2	Applicable Documents
2.1	SAE Publications
2.2	ANSI Publications
2.3	U.S. Government Publications
2.4	Applicable References
2.5	Project Specific Documents
2.6	Precedence
2.7	Definitions
2.7.1	Terminology
2.7.2	Abbreviations and Acronyms

FIGURE 3 – CICD FORMAT STRUCTURE FOR VOLUME 1, SECTION 2

3.4.3 Volume 1 Section 3 Mechanical Interface

The mechanical interface shall be defined within this section. This section specifies physical characteristics such as moments of inertia or center of gravity, any physical clearance issues, hardware locations or alignment as well as loads, stiffness and loading considerations. A definition of units of measurement, scaling and scaling factors to facilitate interoperability and common understanding shall be included. FIGURE 4 provides an outline of this section.

3	Mechanical Interface
3.1	General
3.2	Physical Characteristics
3.2.1	Dimensional Envelope
3.2.2	Mass
3.2.3	Centre of Gravity
3.2.4	Moments of Inertia
3.2.5	Natural Frequencies
3.2.6	Connector Interfaces
3.2.7	Mounting Details
3.2.8	Clearances
3.3	Alignment
3.4	Loads
3.4.1	Loads (Air and Ground)
3.4.2	Subsystem Unique Loads
3.5	Subsystem Stiffness
3.6	Installation Considerations
3.7	Additional Mechanical Interface Considerations

FIGURE 4 – CICD FORMAT STRUCTURE FOR VOLUME 1, SECTION 3

3.4.4 Volume 1 Section 4 Electrical Interface

This section shall define all ICD relevant electrical, electromagnetic, and optical signals that are contained in the interface between the platform and the subsystem. The layout of this section specifies the connection first (i.e. connector description including connector layout and contact assignment as well as details information about the used contact types) and is followed by a general description of the signals separated between power lines, state signals and information signals including signal definition sheets. The section comprises the harness design and layout and bonding and grounding requirements. FIGURE 5 provides an outline of this section.

4	Electrical Interface
4.1	General
4.2	Interface Connection
4.2.1	Connector Descriptions
4.2.2	Contact Assignment and Contact Description
4.3	Contact Types
4.3.1	Power Lines
4.3.2	State Signals
4.3.3	Information Signals
4.4	Harness Design/ Layout
4.5	Bonding/ Grounding

FIGURE 5 – CICD FORMAT STRUCTURE FOR VOLUME 1, SECTION 4

3.4.5 Volume 1 Section 5 Aerodynamics Interface

This section shall define all aerodynamic aspects of the installed subsystem. Although not common for equipment, some structures like e.g. antennae or pods protruding the platform structure may have an effect on the systems aerodynamic behavior and thus need to be considered. FIGURE 6 provides an outline of this section.

5	Aerodynamics Interface
5.1	Configuration
5.2	Drag Data

FIGURE 6 – CICD FORMAT STRUCTURE FOR VOLUME 1, SECTION 5

3.4.6 Volume 1 Section 6 System Safety

This section shall specify all safety issues for ground operations of the subsystem including radiation, dangerous areas, special handling procedures and FOD. FIGURE 7 provides an outline of this section.

6	Safety
6.1	System Safety & Mission Criticality
6.1.1	Installation
6.1.2	Radiation
6.1.3	Dangerous Areas
6.1.4	Special Handling Procedures
6.1.5	Foreign Object Debris/Damage (FOD)
6.2	Special Considerations

FIGURE 7 – CICD FORMAT STRUCTURE FOR VOLUME 1, SECTION 6

3.4.7 Volume 1 Section 7 Environmental Considerations

This section shall address interface relevant influences caused by environmental impact.

Environmental requirements evolve during the subsystem development and integration with the platform. This section of the ICD will also evolve during this process. It starts out defining the environmental conditions specified for the subsystem and/or platform standalone and eventually evolves to the definition for the subsystem/platform combination. At the conclusion of the integration program it shall define the environmental conditions the platform and subsystem combination can withstand. In addition, the level of definition is predefined as follows to cope with the severity of the environmental influence, for the platform/subsystem combination:

remain safe in a specific environment, means that the system will not endanger personnel, platform or subsystem when exposed to the specified environment, or subsequently during any handling and disposal. The system is not required to operate either during or after exposure to the environment,

operate means that the system will survive exposure to, and function correctly within its performance limits during exposure to the specified environment and

survive a specific environment means that the subsystem/platform combination in addition to staying safe throughout and following exposure to the environment, will subsequently be capable of operating satisfactorily within its performance limits after exposure to the environment.

FIGURE 8 provides an outline of this section.

7	Environmental Considerations
7.1	Introduction
7.2	Environmental Condition
7.2.1	General
7.2.2	Altitude and Ambient Pressure
7.2.3	Dynamic Pressure Change
7.2.4	Temperatures
7.2.5	Humidity
7.2.6	Solar Radiation
7.2.7	Fungus Resistance
7.2.8	Salt Fog
7.2.9	Rain - Rain Erosion
7.2.10	Hail (for external carriage or subsystems mounted on the external surface)
7.2.11	Drip
7.2.12	Sand and Dust
7.2.13	Icing/Freezing Rain
7.2.14	Climatic Zones
7,2,15	Vibration
7.2.16	Gunfire Vibration
7.2.17	Mechanical Shock
7.2.18	Acoustic Noise
7.2.19	Linear Acceleration
7.2.20	Angular Motion, Acceleration and Angular Rates
7.2.21	Radiation (nuclear)
7.2.22	X-Ray Emissions
7.2.23	Explosive Atmosphere
7.2.24	Contamination
7.2.25	Bio and Chemical Hardening
7.2.26	TEMPEST
7,2,27	Nuclear Biological Chemical (NBC) De-contamination
7.3	Electromagnetic Environmental Effects (E3)
7.3.1	Conducted Emissions, Power Lines
7.3.2	Conducted Emissions, Control and Signal Lines
7.3.3	Exported Spikes and Transients
7.3.4	Radiated Emissions, Electric Field
7.3.5	Conducted Susceptibilities, Power Leads
7.3.6	Bulk Current Injection Test
7.3.7	Imported Spikes and Transients
7.3.8	Radiated Susceptibility, Magnetic Induction Field
7.3.9	Radiated Susceptibility, Electric Field
7.3.10	DC Magnetic Field Environment
7.3.11	Compass Safe Distance
7.3.12	EMP
7.3.13	Conducted Emissions, Antenna Terminal
7.3.14	Spurious and Harmonic Emissions
7.3.15	Inter-Modulation
7.3.16	Rejection of Unwanted Signals
7.3.17	Cross-Modulation
7.3.18	Electrostatic Discharge
7.3.19	Lightning Protection
7.3.20	Tables for E3 Subsection
7.4	Subsystem Life Constraints

FIGURE 8 – CICD FORMAT STRUCTURE FOR VOLUME 1, SECTION 7

3.4.8 Volume 1 Section 8 Pilot Vehicle Interface

This section considers the design and relationship regarding the function and physical aspects of the subsystem in relation to the operator of the platform. It includes display design and layout, seating of the operator, optical line of sight and audio requirements. FIGURE 9 provides an outline of this section.

8	Pilot Vehicle Interface

FIGURE 9 – CICD FORMAT STRUCTURE FOR VOLUME 1, SECTION 8

3.4.9 Volume 1 Section 9 Wireless Communication

This section specifies the wireless communication interface used to e.g. initiate functions in the subsystem without the need to rely on a wired interface. It may be used to update subsystem information or simply to communicate with the subsystem for data evaluation, sensor data retrieval, etc. While this section shall address the electrical part of the wireless communication, the logical description shall be part of the functional section of Volume 2, whilst the description of the wireless communication protocol is located in Section 5 of Volume 2 and the signal content structure/information shall be described in Volume 2 Section 7. FIGURE 10 provides an outline of this section.

9	Wireless Communication
9.1	Overview
9.2	Reception/Transmission
9.3	Other interface considerations

FIGURE 10 – CICD FORMAT STRUCTURE FOR VOLUME 1, SECTION 9

3.4.10 Volume 1 Section 10 Support/Maintenance Interface

The support interface shall describe all supporting measures for the installation, handling, loading, labeling and marking relevant during and after the integration of the subsystem. Whenever possible reference to an existing standard shall be made. It encompasses ground operation issues such as ground equipment (STE), item identification (e.g. RFID method) and OFP loading. FIGURE 11 provides an outline of this section.

10	Support/ Maintenance Interface
10.1	Installation and Handling
10.1.1	Platform Installation Provisions (e.g. fixtures for installation)
10.1.2	Handling of the Subsystem
10.2	Maintenance Interface
10.3	Design of equipment for remote handling
10.4	Marking/ Labeling
10.5	Item identification
10.6	Memory Load/Verify (MLV)
10.7	ID Tagging

FIGURE 11 – CICD FORMAT STRUCTURE FOR VOLUME 1, SECTION 10

3.5 Volume 2 Overview

Volume two covers mostly software aspects of the interface such as the functional requirements, specific communication requirements (e.g. protocol options), logical signal sheets, timelines and sequences. The heading level 1 structure for Volume two is shown in FIGURE 12. Examples for each paragraph of the Volume two templates are provided in Appendix B.

1	Introduction
2	Applicable Documents
3	Functional Interface
4	Communication Interface
5	Wireless Communication Interface
6	Information Sheets
7	Wireless Communication Information Sheets

FIGURE 12 – CICD FORMAT STRUCTURE VOLUME 2 LEVEL 1

3.5.1 Volume 2 Section 1 Introduction

This section shall cover the introduction to the Volume 2 of the ICD. An overview of the volume content and detailed information concerning updates shall be given. The use of terms within the ICD shall be defined. FIGURE 13 provides an outline of this section.

1	Introduction
1.1	Scope
1.2	Updating
1.2.1.	Information Accuracy
1.2.2	Definition of Terms
1.3	General Description

FIGURE 13 – CICD FORMAT STRUCTURE FOR VOLUME 2, SECTION 1

3.5.2 Volume 2 Section 2 Applicable Documents

The section lists the used and considered documents relevant for Volume 2 of the ICD and defines the order of precedence if any. FIGURE 14 provides an outline of this section.

2	Applicable Documents
2.1	SAE Publications
2.2	ANSI Publications
2.3	U.S. Government Publications
2.4	Applicable References
2.5	Project Specific Documents
2.6	Precedence
2.7	Definitions
2.7.1	Terminology
2.7.2	Abbreviations and Acronyms

FIGURE 14 – CICD FORMAT STRUCTURE FOR VOLUME 2, SECTION 2

3.5.3 Volume 2 Section 3 Functional Interface

The functional interface is the core of Volume 2. The operation of a subsystem as a system of systems shall be described in conjunction with the platform operation. Co-ordinate systems and parameter definition is included. Relevant system states and modes shall be specified and coarse and detailed timelines are defined. It is suggested to use UML/SysML nomenclature or applicable DoDAF system views for the descriptions in this section. In principle the functional requirements for each bit specified in the signal format sheets, unless defined elsewhere, shall be described in the functional section. FIGURE 15 provides an outline of this section.

A detailed structure is proposed with examples in appendix B, which highlights the different points of view – from platform and subsystem - for a specific function.

3	Functional Interface
3.1	General
3.2	Basic Mission Data and Definitions
3.2.1	Mission Data Overview
3.2.2	Axis Systems and Parameter Definitions
3.3	States and Modes of Operation
3.4	Sequence of Events
3.5	Event Description

FIGURE 15 – CICD FORMAT STRUCTURE FOR VOLUME 2, SECTION 3

3.5.4 Volume 2 Section 4 Communication Interface

The communication interface section shall specify the implemented protocols, restrictions to standard protocols and optional capabilities of a protocol that are used. Important parts of standards shall be referenced and deviations shall be specified. Formal message representation, word and bit content and sequencing, etc. shall be defined.

The subsection "Subsystem Programming" shall be used to address possible subsystem program changes or may be changes to the operational program or changes to the data files. The section includes the data structure of the OFP and detailed programming requirements. FIGURE 16 provides an outline of this section.

4	Communication Interface
4.1	Introduction
4.2	Protocol Options Implemented
4.3	Data Structure and Sequence
4.4	Subsytem Programming

FIGURE 16 – CICD FORMAT STRUCTURE FOR VOLUME 2, SECTION 4

3.5.5 Volume 2 Section 5 Wireless Communication Interface

The wireless communication interface section shall specify the implemented protocols and any restrictions or optional capabilities used in the wireless communication. Formal message representation, word and bit content and sequencing, etc. shall be defined. To get a more holistic view of all aspects of wireless interface, section 9 of Volume 1 and Sections 3, 5 and 7 of Volume 2 have to be considered together. FIGURE 17 provides an outline of Section 5.

5	Wireless Communication Interface
5.1	Introduction
5.2	Wireless Interface Information Structure

FIGURE 17 – CICD FORMAT STRUCTURE FOR VOLUME 2, SECTION 5

3.5.6 Volume 2 Section 6 Information Format Sheets

This section contains information format sheets for the onboard interface. FIGURE 18 provides an outline of this section.

6	Information Format Sheets

FIGURE 18 – CICD FORMAT STRUCTURE FOR VOLUME 2, SECTION 6

3.5.7 Volume 2 Section 7 Wireless Information Format Sheets

This section contains the information format sheets for the wireless interface. FIGURE 19 provides an outline of this section.

7	Wireless Interface Information Format Sheets

FIGURE 19 – CICD FORMAT STRUCTURE FOR VOLUME 2, SECTION 7

3.6 Rules for the Interface Control Document Generation Using This Format

3.6.1 Introduction

The Platform/Subsystem Common Interface Control Document Format structure can be tailored to the project's needs. This means that for simple ICDs where a two-volume approach may not be necessary, the document could be covered with a single volume that maintains the defined section structure. The same applies for the decision whether a single two volume document should cover all subsystem variants used during development, low rate production, integration and test (including the operational subsystems) or whether separate documents will be required.

3.6.2 General

As of the release date of this Aerospace Standard, this Platform/Subsystem Common Interface Control Document Format standard can be regarded as complete to the required level. To provide some growth, and to cover future developments, the writer of an Interface Control Document using this format shall establish all sections down to the 3rd heading level (example: 2.1.2) as defined herein. It is anticipated that the top-level structure will rarely change. Although the standard format in Appendices A and B have sections below the third level, the structure below heading level 3 can be regarded as an example.

If explicitly outlined in the text of Appendix A or B or identified through a colored headline, even a higher-level structure (above heading level 4) may be regarded as an example. The higher-level example (above level 4) is required in areas, where this particular part of an Interface Control Document is still evolving, the description is too detailed or generally the structure is regarded at the authors' discretion.

In contradiction to a higher-level example, a lower level structure (below heading level 3) may be required when the substructure is regarded mandatory for the Platform/Subsystem Common Interface Control Document Format layout.

An interface control process is established to define the rules for changing or updating the interface control document, including the maintenance of the correct relationship between the contents of Volume 1 and Volume 2. It is essential that each volume identify explicitly the related issue status of the other volume.

Commonly, the release of a new issue occurs more often in the early phases of an interface design when frequent changes require a new release. When the design is mature, interface changes can be distributed between new issues. A new release is only required after some major changes have been identified and when the project is close to completion.

3.6.3 Design and Layout Rules

Where the interface control document is used to define interface requirements, the requirements for the subsystem or platform shall be uniquely identifiable throughout the ICD. TABLE 1: Tracking Identifiers provides a suggested tracking identifier that should be followed by sequential numbering of the requirement type. To facilitate identification and to enable traceability, a table containing all requirements should be generated.

TABLE 1 – TRACKING IDENTIFIERS

FIRST CHARACTER – INTERFACE ELEMENT AFFECTED		SECOND CHARACTER – REQUIREMENT TYPE	
P	PLATFORM	SL	SHALL
SS	SUBSYSTEM	M	MAY
E	EQUIPMENT	T	MUST
NN	ANY CHARACTER TO DESCRIBE A PARTICULAR SUBSYSTEM/EQUIPMENT	D	SHOULD
EXAMPLES: {PS-001} WOULD BE PLATFORM SHALL NUMBER 1, {ET-004} WOULD BE SUBSYSTEM MUST NUMBER 4			

Each table or figure shall be mentioned in the text. The position of a figure in the text is at the authors' discretion, i.e. either interspersed with the text or at the end of a section or subsection. The examples in the Appendix A and B cover both possibilities.

A table of content shall be generated for each volume.

An abbreviations list shall be generated. A definition of symbols or a glossary is optional.

The applicable documents shall be listed by title and alphanumeric descriptor. References to these documents in the content of the ICD shall be by the descriptor rather than the document title.

3.6.4 Use of the Formats in Appendix A and B

As required above, the interface control document author is required to keep the structure down to level 3. Exceptions are possible due to tailoring or a single volume approach. However, to comply with the Platform/Subsystem Common Interface Control Document Format standard, the parts of the sections in the Appendices A and B that are not marked as described below are required.

The beginning of an example in Appendices A and B are marked and identified with the line: "---------- Begin Example", and end with "---------- End Example".

Whenever possible, metric units shall be used.

3.6.5 Classified Information

An ICD may contain classified information. The author has three approaches, first classify the whole ICD, second refer to the classified material in a reference document, and third place the classified material in a separate annex to the ICD. The approach selected will depend upon the proportion of classified material, level of classification and national security policies

4. NOTES

4.1 A change bar (|) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

4.2 Intended Use

The Platform/Subsystem Common Interface Control Document Format standard is intended to be used for but not limited to airborne military applications for platform to subsystem integration. ICDs written in compliance with this standard may define requirements for platform and subsystems in any combination of legacy and new products. The term "platform" includes manned, remotely controlled and autonomous systems.

4.2.1 Implementation

Implementation and application of the standard is the responsibility of each military service, with technical guidance and direction provided by appropriate service program offices.

In civil/commercial subsystem integration tasks, the application of this standard is the responsibility of the integrating entity.

4.3 Tailoring Guidance

This Platform/Subsystem Common Interface Control Document Format standard defines a format for an Interface Control Document between subsystems and platform(s). The usefulness of the standard is dependent on tailoring, therefore, tailoring of the Platform/Subsystem Common Interface Control Document Format should be kept to a minimum. However, to facilitate the acceptance of the format, tailoring may be accepted in areas such as the incorporation of test assets/pre-production models and a single volume approach for simple interfaces.

APPENDIX A - VOLUME 1 – PLATFORM/SUBSYSTEM INTERFACE CONTROL DOCUMENT

1. INTRODUCTION

The introduction of the CICD shall give an overview of the document. Scope, updating rules, used terms and a general description are included. The whole ICD comprises 2 Volumes, Volume 1 – this volume – contains the more stable parts of the integration process while volume 2 covers the logical and functional interface, which changes more often in the course of an integration. The introduction can be regarded as unique for both volumes, or, like in this example, for each volume separately. The introduction of the CICD volume 1 shall clearly define the subject interface, with a description of how related interfaces are being managed.

Besides an overview of the ICD, this section shall give an insight in the position of the ICD with respect to the project documentation.

---------- Begin Example

The following document tree in FIGURE 1 is provided for information only and to assist the readers understanding. It shows the posítion of the ICD in the context of the project document set.

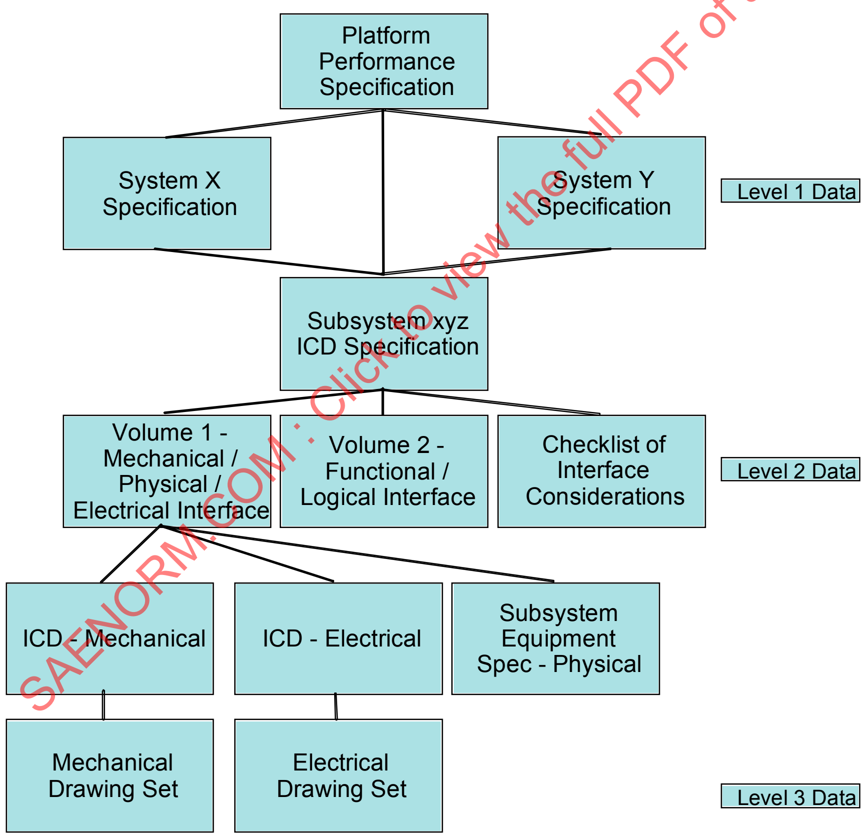


FIGURE 1 – DOCUMENT TREE

---------- End Example

1.1 Scope

This SAE Aerospace Standard (AS) defines the editorial format and policies necessary for the publication of Interface Control documents. The Platform Subsystem Interface Control Document Format defines a common format for platform subsystem interface documents to foster increased interoperability and consistent interface definition. It is designed with the versatility to serve differing "ICD" philosophies and organizations.

This aerospace standard defines the common technical data sections for the Platform Subsystem Interface Control Document Format down to the third header level for the majority of sub-sections. The Platform Subsystem Interface Control Document Format Aerospace Standard provides a structured document format in appendixes supported by example paragraphs, drawings, etc.

---------- Begin Example

Section 3 addresses the mechanical interface between the subsystem xyz and the host platform abc.

Section 4 addresses the electrical interface between the subsystem xyz and the host platform abc.

Section 5 contains requirements for the aerodynamics interface like drag data, etc.

Section 6 addresses safety issues relevant to the interface.

Section 7 lists environmental conditions and marginal conditions to be considered. This section includes also Electromagnetic Environmental Effects requirements.

Section 8 specifies the pilot vehicle interface.

Section 9 comprises the hardware relevant requirements for a wireless interface.

Section 10 applies to support measure like installation, handling and marking of the subsystem.

---------- End Example

1.2 Updating

This section is used to document the update procedures of this volume e.g. applied change procedures, or the section shall be used to establish the change process.

---------- Begin Example

The ICD shall be updated on the design responsible authority's discretion. The information about and the reception of any updates are under the responsibility of the user. The update procedure shall be control by the established Interface Control Process as defined in document xyz.

---------- End Example

1.3 Information Accuracy

This section records information concerning handling of values during the generation process of the ICD e.g. marking of currently unconfirmed values, uncertain statements or uncertain definitions.

---------- Begin Example

Throughout this document and unless otherwise stated, when a value is quoted which is still unconfirmed, a ´TBC´ rating follows the quoted value.

A star rating as follows grades this TBC rating system:

TBC* detailed calculations but not yet finalized

TBC** simple calculations and/or previous experience

TBC*** best estimate

---------- End Example

1.4 Definition of Terms

This section records the rules to specify use of wording in the document like “may”, “shall” etc.

---------- Begin Example

1.4.1 Utilization of Common Terms

The word "shall" in the text expresses a mandatory requirement of the specification. Departure from such a requirement is not permissible without formal agreement between customer and the aircraft company.

The word "should" in the text expresses a recommendation or advice on implementing a requirement of the specification. The customer expects such recommendation or advice to be followed unless good reasons are stated for not doing so.

The word "must" in the text is used for a legislative or regulatory requirement (e.g. health and safety) with which both the customer and the aircraft company shall comply. It is not used to express a requirement of the specification

The word "will" in the text is used for the future tense. It does not express a requirement of the specification.

The word "may" in the text expresses a permissible practice or action. It does not express a requirement of the specification.

Plain text (i.e. text not containing the above key words) is used to state facts and to describe existing capabilities or features. Such text does not express a requirement of the specification.

1.4.2 Non-common Terms

Terms not specified in 1.4.1 are of informal nature and are not authoritative.

---------- End Example

1.5 General Description:

The system controlled by this interface shall be described. Subject to deletion if already covered by 1.1.

The subsystem controlled and affected by this interface shall be described.

---------- Begin Example

The subsystem ´xyz´ is an active RF sensor subsystem:

- Capable of providing SAR imagery with a resolution of xxx.
- Integrated laser for tracking and designation of specific target(s).
- Integrated with the platform main computer and the subsystem and associated subsystem processor to perform its designated function.
- The platform ´abc´ is a low observable, agile all-weather super-sonic strike fighter aircraft:
- Wireless capability including high bandwidth video transmission and reception.

---------- End Example

1.6 Commonality Considerations

Subsystem commonality means for use of subsystems on different platforms.

---------- Begin Example

The subsystem is to be used on all platforms equipped with a fibre channel interface and all related standards therein.

---------- End Example

2. APPLICABLE DOCUMENTS

2.1 SAE Publications

This section shall give an overview of the content of the applicable documents

---------- Begin Example

The following documents, of the exact issue shown, form a part of this document to the extent specified herein. In the event of conflict between the document referenced herein and the contents of this document, see 2.6, Precedence.

AS5643-IEEE-1394b Interface Requirements for Military and Aerospace Vehicle Applications

---------- End Example

2.2 ANSI Publications

Platform or subsystem related ANSI specifications relevant to the interface shall be listed in this section.

---------- Begin Example

Equipment Specification subsystem box xxx-yyy-zzz

System Specification for integration of subsystem xyz SS-123

System Software Requirement Specification SSRS-123

---------- End Example

2.3 U.S. Government Publications

Platform or subsystem related US government publications relevant to the interface shall be listed in this section.

---------- Begin Example

STANAG 4586 (NATO Standardization Agreement) Leading the Way to NATO UAV Systems Interoperability

---------- End Example

2.4 Applicable References

Supplier Documents, Plans, Configuration Procedures, Drawings

---------- Begin Example

Drawing x

Drawing y

---------- End Example

2.5 Project Specific Documents

Project handbooks, project specific and interface relevant technical notes shall be listed here.

---------- Begin Example

MIL-HDBK-xyz

---------- End Example

2.6 Precedence

Defines the sequencing of documents including this ICD and which documents control the others, etc.

---------- Begin Example

In the event of conflict between requirements specified in this and referenced documents, the following order of precedence applies:

Document 1

Document 2

Document 3

---------- End Example

2.7 Definitions

2.7.1 Terminology

The terminology section provides a definition of any terminology used in this ICD.

2.7.2 Abbreviations and Acronyms

The abbreviations and acronyms section provides a definition for all abbreviations and acronyms used in this ICD.

3. MECHANICAL INTERFACE

3.1 General

Subsystem mechanical interface aspects are dealt with in the following with the aim to standardize the kind of related information as well as the way the information is represented.

As far as is applicable, the aspects of interface are separately considered from subsystem and platform perspective, in an attempt to differentiate those parameters which are different or commonly needed by the two communities (platform design authority and subsystem design authority) to carry out the interface analysis task.

Note 1: Any required data has to be inserted in the ICD only if relevant to the subsystem – platform interface.

Note 2: If a drawing is translated from Imperial to metric or vice-versa, a precautionary note has to be inserted, warning that the drawing has been translated from a different system and this should be taken into proper consideration in any assembly, tolerance or installation analysis.

Conversion methods will be clearly stated.

3.2 Physical Characteristics

3.2.1 Dimensional Envelope

Dimensions will be expressed in mm.

Tolerances (and their applicable unit of measure) will be indicated. Drawings and pictures should be presented in scales coherent with a representation on "A4" or "US letter" format pages. Two recommended scales should be adopted: for drawings included in the text: one (i.e. 1/100) for large images, such as platform, and another one (i.e. 1/20 or 1/25) for smaller images, such as subsystems. Full scale drawings or detailed graphical data can be dealt with as separate documents, which will be referred to in the applicable paragraphs together with suitable instruction in order to allow the exchange/download in electronic format (IGES or STEP formats to be preferred).

Ideally, dimensions provided here should allow:

- The platform design authority to create a simplified 3D model of the subsystem itself
- The subsystem design authority to gather the necessary information for a first fit trial analysis (platform location, mounting geometry, etc).

Two kinds of dimensions will be provided:

a) Absolute dimensions

   Overall dimensions that allows the physical volume containing the subsystem to be drawn.

---------- Begin Example

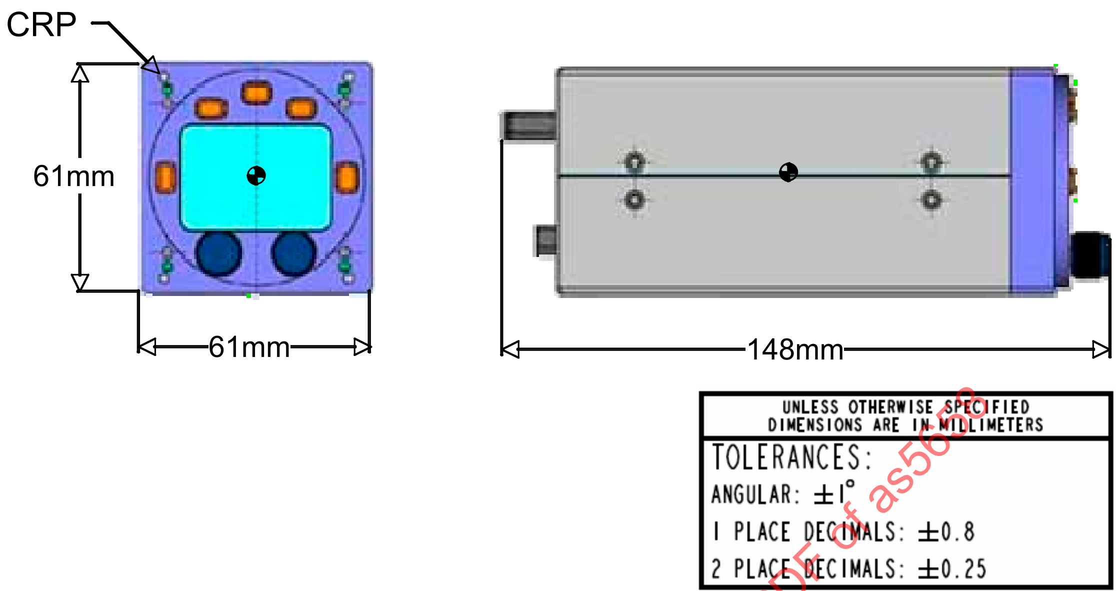


FIGURE 2 – ABSOLUTE SUBSYSTEM DIMENSIONS

---------- End Example

b) Relative dimensions

Dimensions that allow the reciprocal positioning of the parts of the subsystem, which are significant from the interface perspective (access panels, air intakes, wave guides, etc.) shall be specified.

---------- Begin Example

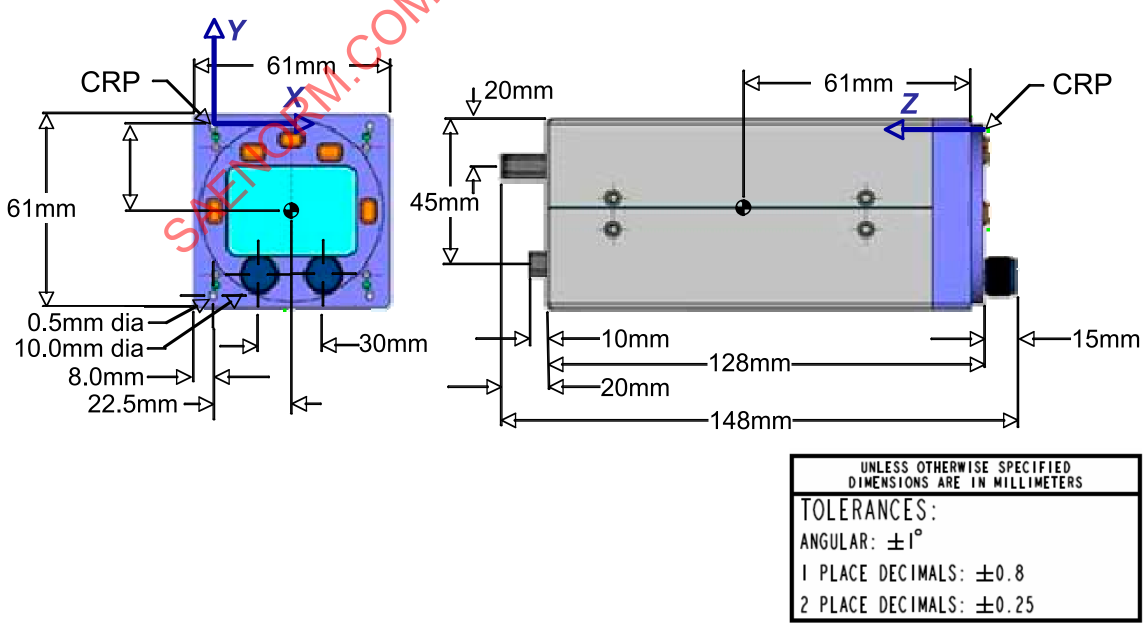


FIGURE 3 – RELATIVE SUBSYSTEM DIMENSIONS

---------- End Example

The relevant interface dimensions will be referred to a common reference point (CRP).

It is proposed to locate the CRP at a selected attachment point.

Details of the subsystem attachment geometry and the relevant position of CRP will be referred to in the paragraph where geometry of attachment elements is given (attachment bracket, mounting hole, mounting slides, etc.).

The use of subsystem or platform subsystems (i.e. STA 1245) should be avoided whenever possible in order to avoid the need to perform equivalence computations necessary to translate subsystem dimensions to platform dimensions and vice versa.

In those cases where the subsystem configurations for installation, maintenance or removal present different envelopes, these should be dealt with separately. (Example: access panels locally enlarge the installation envelope. Subsystem panels open during normal operation for dispensing, etc).

3.2.2 Mass

Mass unit of measure will be kg

<u>Subsystem Side</u>

Subsystem mass will be provided for each subsystem configuration e.g countermeasures subsystems with/without countermeasures, coolant systems with/without coolant, etc.

If necessary, variations of mass that could occur as a result of subsystem functions (e.g. use of coolant for a sensor system, use of countermeasures, etc.), will be defined.

A subsystem mass distribution graph will be provided in cases of significant unevenness in mass distribution.

---------- Begin Example

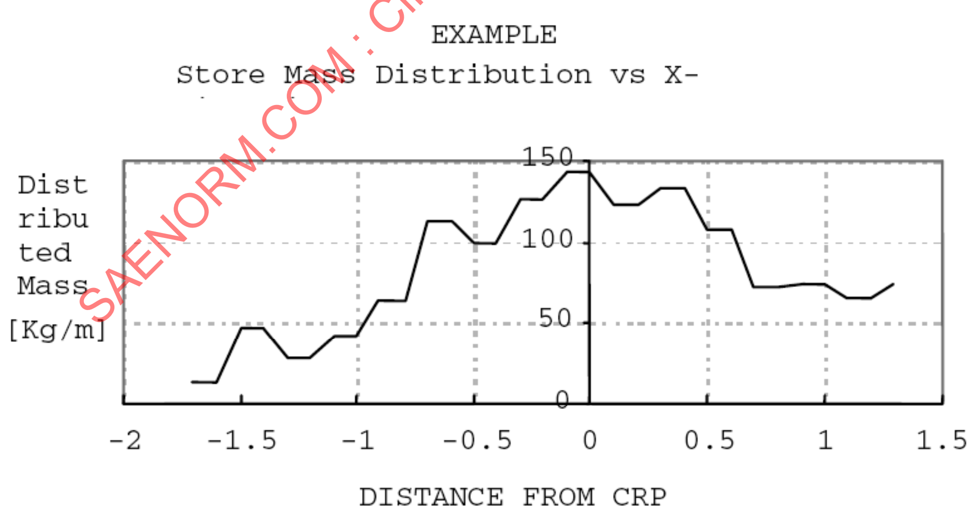


FIGURE 4 – SUBSYSTEM MASS DISTRIBUTION GRAPH

---------- End Example

<u>Platform Side</u>

If applicable, the subsystem mass limitation will be given for each candidate subsystem.

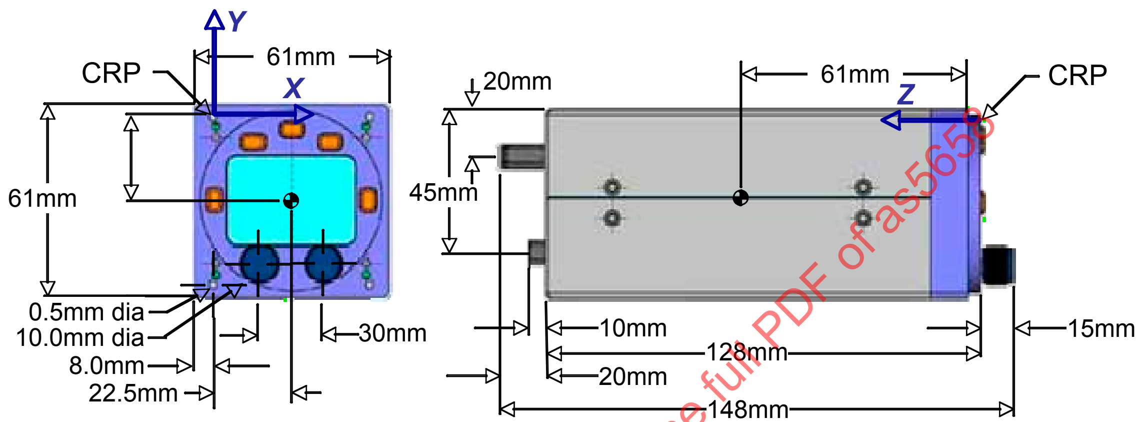
3.2.3 Centre of Gravity

It must be ensured that the variations that could occur simply as a measure of the tolerances associated with the agreed mass figures are addressed.

Subsystem Side

Position of centre of gravity will be provided for each subsystem configuration and referred to the CRP.

---------- Begin Example



CG Location (mm)	X	Y	Z
Subsystem A	22.5	22.5	61

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN MILLIMETERS
TOLERANCES:
ANGULAR: ±1°
1 PLACE DECIMALS: ±0.8
2 PLACE DECIMALS: ±0.25

FIGURE 5 – CENTRE OF GRAVITY LOCATION

---------- End Example

Platform Side

If applicable, the subsystem center of gravity limitations will be given for each candidate mounting location and referenced with respect to the CRP.

---------- Begin Example

The subsystem shall maintain its center of gravity location where X = 22.5+/-5mm, Y = 22.5+/-5mm, and Z = 64+/-5mm from the common reference point.

---------- End Example

3.2.4 Moments of Inertia

Moments of Inertia will be expressed in kgm2.

It must be ensured that the variations that could occur simply as a measure of the tolerances associated with the agreed mass figures are addressed.

Subsystem Side

Moments of inertia in pitch, yaw, and roll will be provided for each subsystem configuration/status/combination.

Platform Side

Either "Not Applicable" or eventual limitations to Moment of Inertia for defined platform subsystems will be highlighted.

---------- Begin Example

The subsystem shall maintain its moments of inertia within 10% of those shown in TABLE 1.

TABLE 1 – MOMENTS OF INERTIA

IXX (kg-m2)	IYY (kg-m2)	IZZ (kg-m2)	IXY (kg-m2)	IYZ (kg-m2)	IXZ (kg-m2)
0.92969E-01	3.37349E+00	3.28890E+00	-0.81329E-02	-0.33602E-04	-1.19118E-03

---------- End Example

3.2.5 Natural Frequencies

The natural harmonic frequencies of the system are defined herein.

Subsystem Side

Relevant subsystem vibration modes shall be provided here.

Platform Side

Relevant platform vibration modes shall be provided here (for example: number of rotor blades and rotation velocities).

3.2.6 Connector Interfaces

The connector interface provides harness connector locations, orientation and clearances (e.g. primary and auxiliary interface connections, specific grounding connectors).

Subsystem Side

Location, height above subsystem surface, identification and orientation of subsystem connectors shall be specified.

Specific mating and de-mating requirements will be detailed (blind or bayonet mating, connection forces, torques, travel, shearing or tearing forces, etc.)

Care will be given to ensure that all information leading to complete identification of the geometry of the connector(s) and its mating condition(s) are provided.

Note: Shielding properties and bonding features of electrical connectors will be covered in the proper paragraph of the electrical interface section

---------- Begin Example

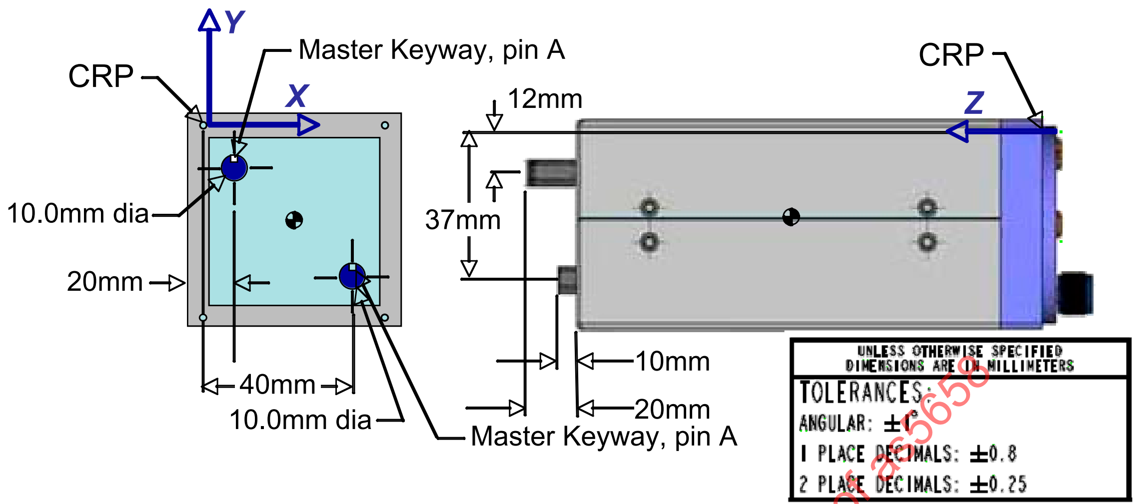


FIGURE 6 – SUBSYSTEM CONNECTOR INTERFACE (SUBSYSTEM SIDE)

---------- End Example

Platform Side

Location, identification and orientation of harness connectors shall be specified. Specific mating and de-mating requirements will be detailed (blind or bayonet mating, connection forces, torques, strokes, etc.).

Care will be given to ensure that all information leading to complete identification of the geometry of connector(s) and its mating condition(s) are provided.

Note: Shielding properties and bonding features of electrical connectors will be covered in the proper paragraph of the electrical interface section.

---------- Begin Example

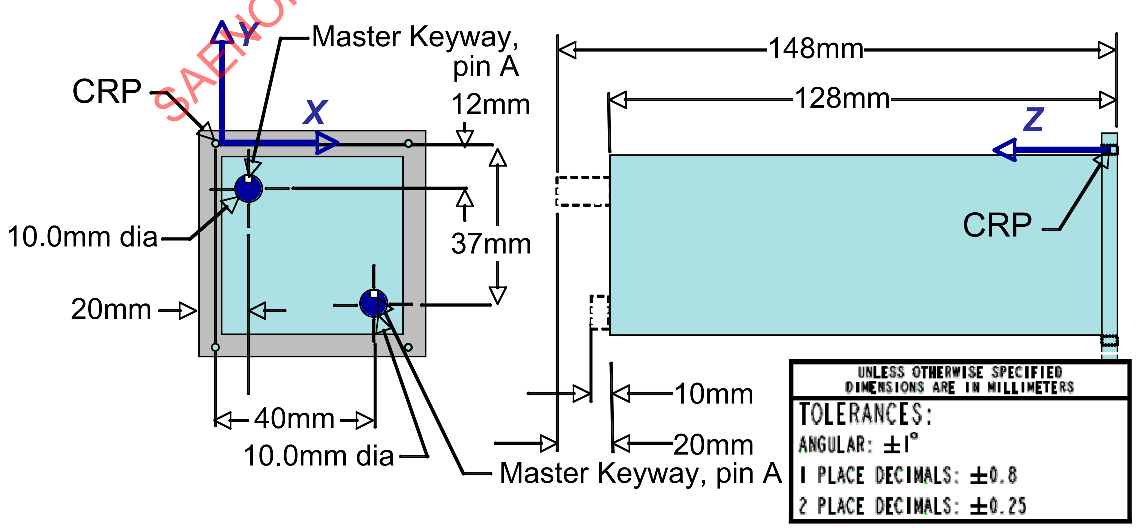


FIGURE 7 – SUBSYSTEM CONNECTOR INTERFACE (PLATFORM SIDE)

---------- End Example

3.2.7 Mounting Details

Platform Side

The subsystem mounting specifics will be identified and the detail geometry of the attachment points will be provided:

Note: The maximum allowable loads on each attachment point will be provided.

The maximum allowable and minimum required (where appropriate) crutching/supporting/snubbing loads and the associated reinforced allowable area will be provided.

Eventual limitations or precautions to be adopted will be provided.

---------- Begin Example

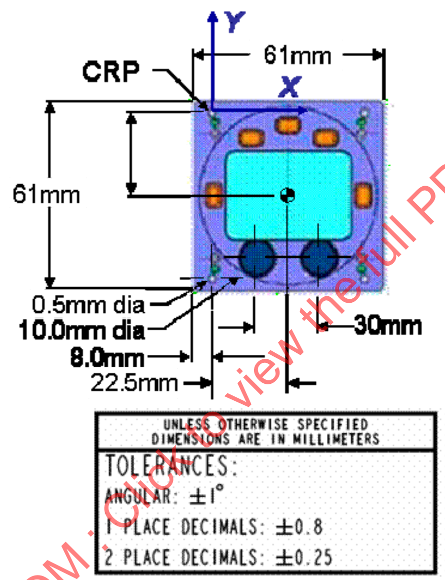


FIGURE 8 – GRAPHIC DETAIL OF SUBSYSTEM ATTACHMENT

---------- End Example

Subsystem Side

Interface data of the subsystem mounting specifics at will be provided.

Geometry of the subsystem mounting specifics will be detailed.

---------- Begin Example

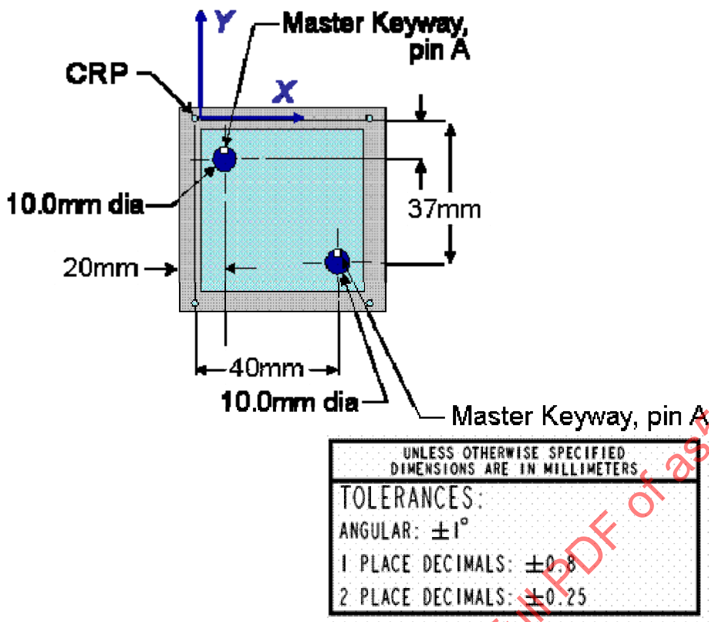


FIGURE 9 – PLATFORM SUBSYSTEM MOUNTING INTERFACE

---------- End Example

3.2.8 Clearances

This information is additional to that given with the subsystem dimensional envelopes.

It is recommended that this data is provided in a separate set of pictures/drawings in order to reduce graphical clutter and to ease the addressing of eventual issues for example a different installation procedure could be devised in case the standard procedure reveals incompatibilities or conflicts.

<u>Subsystem Side</u>

The required clearances will be divided into the following sections (where applicable):

Clearances for subsystem installation

Clearance aspects of subsystem installation devices (if required) and space envelopes to be respected during the subsystem installation will be addressed in this section.

Space needed to operate wrenches, special tools or to carry out mechanical and electrical connections will be specified.

---------- Begin Example

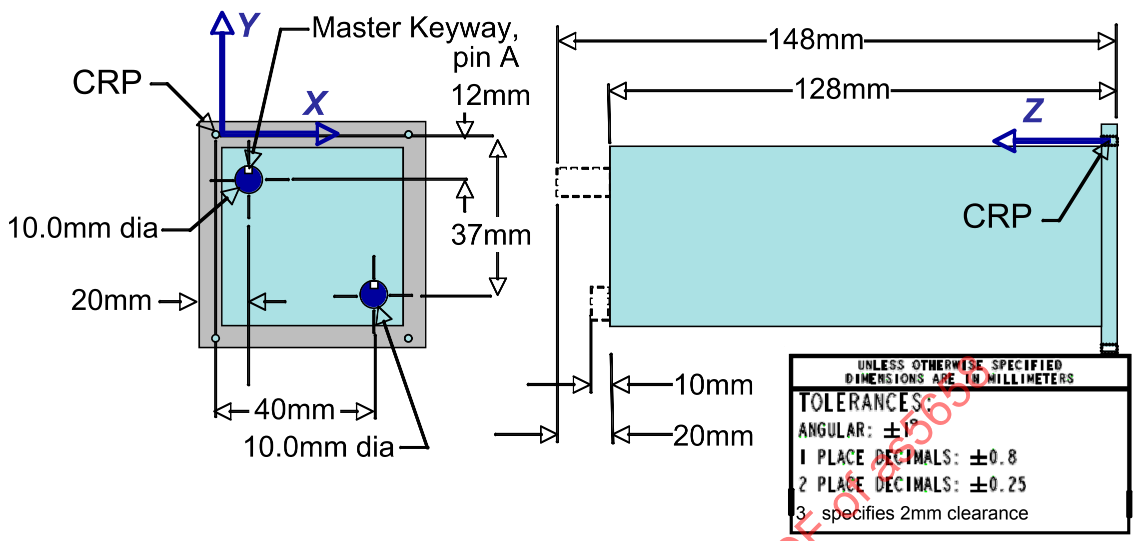


FIGURE 10 – CLEARANCE ENVELOPE FOR SUBSYSTEM INSTALLATION

---------- End Example

Clearances for subsystem preparation/setting before use (if required)

Space needed to operate 1st line functional check, setting or tuning operations, installation of checking devices, will be specified.

---------- Begin Example

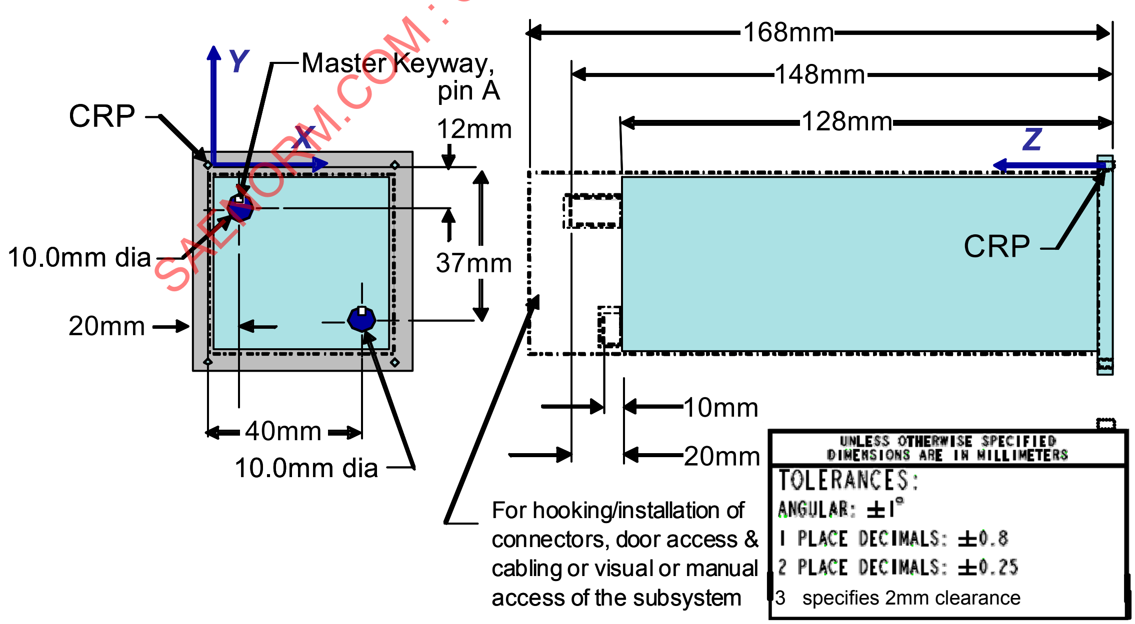


FIGURE 11 – CLEARANCE ENVELOPE FOR SUBSYSTEM PREPARATION/SETTING

---------- End Example

Clearances for subsystem

Space envelopes needed for the use of the subsystem (if already dealt with in the dimensional envelope paragraph, make a reference).

Clearances for Subsystem release of items

Space envelopes needed for the safe operation or release of any item from the subsystem. If needed, clearances will be identified for each subsystem condition/status. A figure should be included that illustrates the keep-out zone for dispensing items (hydraulic fluid, chaff, flares etc.)

Platform Side

Minimum allowed clearances versus platform structure, in proximity of the installed subsystem (flaps, slats, and ground (worst landing and take-off cases)), and near pylons, or subsystem subsystems will be provided.

This information should allow the identification of the candidate subsystem locations and combinations compatible with the candidate subsystem. A figure should be included that illustrates the subsystem keep-out zone (movable platform surfaces, access doors, and ground (worst landing and take-off cases), etc)

3.3 Alignment

Only static alignment is dealt with in this paragraph.

Dynamic alignment (during flight) during use can be gathered from Section 5 and subsystem stiffness

Note: Electronic boresighting (transfer alignment) will be addressed in the functional (Volume II) section of the ICD format.

Subsystem Side

Subsystem requirements for alignment repeatability will be provided (mrad ranges in yaw, pitch and roll).

Subsystem requirements for mechanical alignment - orientation (if applicable) will be declared.

Subsystem internal alignment adjustment capability (i.e. inertial navigation unit) will be declared and the achievable adjustment range provided.

Platform Side

For each subsystem, the subsystem line (SL) nominal orientation (in degrees) with respect to a defined platform reference axis will be provided.

The alignment repeatability of the SL guaranteed by the candidate platform subsystem will be provided (mrad ranges in yaw, pitch and roll).

If available, the SL mechanical alignment adjustments achievable on the candidate subsystem will be identified (ranges in yaw and pitch will be indicated).

If applicable (in case of interface impact) the associated procedure and tools will be described and listed.

3.4 Loads

3.4.1 Loads (Air and Ground)

Subsystem Side

This records the subsystem information needed by the platform design authority to determine the loads induced by the subsystem inertia and aerodynamic properties into the platform (candidate platform subsystem(s)).

The aerodynamic coefficients (CX, CY and CZ) of the subsystem free stream shall be provided as a function of the angle of attack and sideslip (if required).

NOTE: Subsystem inertia data has already been provided in the relevant section.

Platform Side

This records platform information needed by the subsystem design authority to determine the loads induced on the subsystem by the platform motion.

The candidate subsystem inertial loads envelope will be provided with an nz – ny graphic and the range of rotational accelerations will be provided.

To allow evaluation of aerodynamic loads, a graphic of dynamic pressure versus angle of attack and dynamic pressure vs angle of sideslip will be provided (if required).

Identification and location of the selected loads reference point (if different than CRP) will be provided.

Minimum and maximum preload forces exchanged between the platform mounting and the subsystem will be defined and provided.

Special load conditions (crash landing, platform carrier landing, barrier engagement, catapulting, etc) will be separately defined.

3.4.2 Subsystem Unique Loads

Forces, which are transferred from subsystem to platform as a result of the subsystem specific function will be identified and detailed in this section.

3.5 Subsystem Stiffness

Subsystem stiffness data shall be provided in terms of distribution along the longitudinal (X) axis of EI (the product of the modulus of elasticity by the moment of inertia of the section) for the two flexional bending modes and of GJpolar (the product of the shear modulus by the polar moment of inertia of the section) for the torsional mode.

EI and GJpolar will be expressed in Nm2.

---------- Begin Example

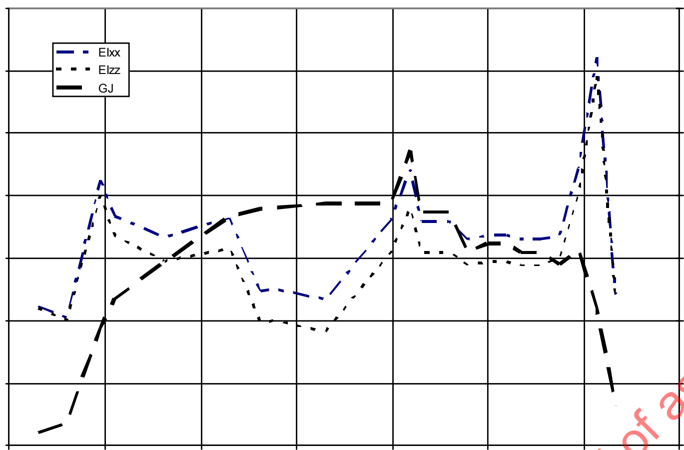


FIGURE 12 – TYPICAL SUBSYSTEM EI/GJ DIAGRAM

---------- End Example

3.6 Installation Considerations

The topic of this paragraph is to address specific installation requirements. Section 10 provides installation/removal procedural details.

Subsystem Side

Subsystem mounting points and reinforced areas, where loading forces can be applied and the eventual limitations or precautions, shall be identified.

---------- Begin Example

The subsystem shall use fatigue rated fasteners.

---------- End Example

Platform Side

Indication of platform subsystem mounting points where loading forces can be applied and the eventual limitations or precautions.

---------- Begin Example

The platform shall identify any specific installation requirements.

---------- End Example

3.7 Additional Mechanical Interface Considerations

This section shall be used to cover any mechanical issues not included previously (e.g. conductive/convective transfer surfaces, visual indicators, door access, impact to radar, infrared and visual signatures, etc.).

4. ELECTRICAL INTERFACE

4.1 General

Overview of the electrical interface part i.e. in the form “paragraph xy contains…”. In principle the whole paragraph or at least some parts could be covered by a reference to the entity of a connector related military standard (like MIL-STD-1560 including connectors together with the relevant slash-sheets) or other standards (like MIL-STD-704), provided this standard(s) applies. Some of the examples and the example structure are taken from MIL-STD-1760C. Provided that the platform or subsystem would comply with the standard, a simple reference would be sufficient rather than a repetition of the standard content.

Provided that there is logical or functional information associated with the description of the electrical interface, a reference to Volume 2, Section 3 Functional Interface or to Volume 2 Section 6 Information Format Sheets shall be made.

4.2 Interface Connection:

Describes the electrical interface connection in general i.e. gives an overview of the parts of the electrical interface like discrete lines, data and power and introduces the next two subparagraphs. In addition the different parts of the interface should be addressed inclusive harness aspects.

The system shall provide an interconnect diagram in sufficient detail to define major system components with unique identifiers. The diagram shall show all major interfaces; input/output connections, cable networks, and associated connections between major subsystem components.

---------- Begin Example

The following provides the subsystem block diagram showing the top-level interfaces required for integration. FIGURE 13 details the interface signals described in the following paragraphs.

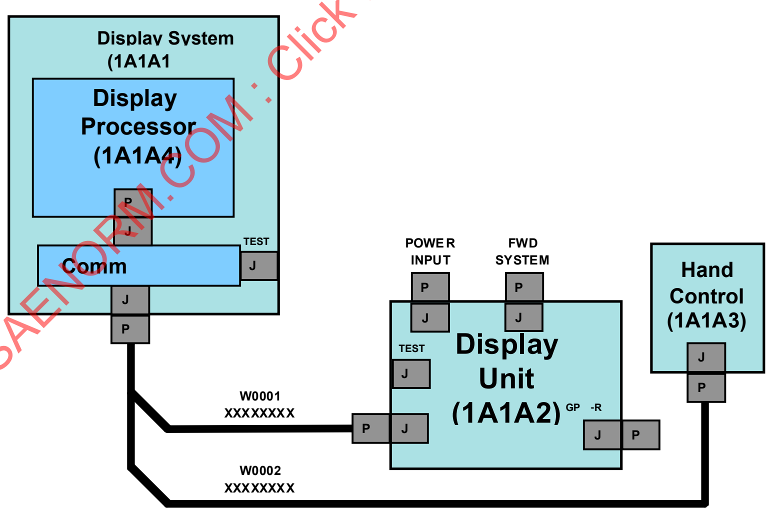


FIGURE 13 – DISPLAY SUBSYSTEM INTERCONNECTS

Interface Boundary

The interface boundary between SYSTEM X and SYSTEM Y is shown in FIGURE 14.

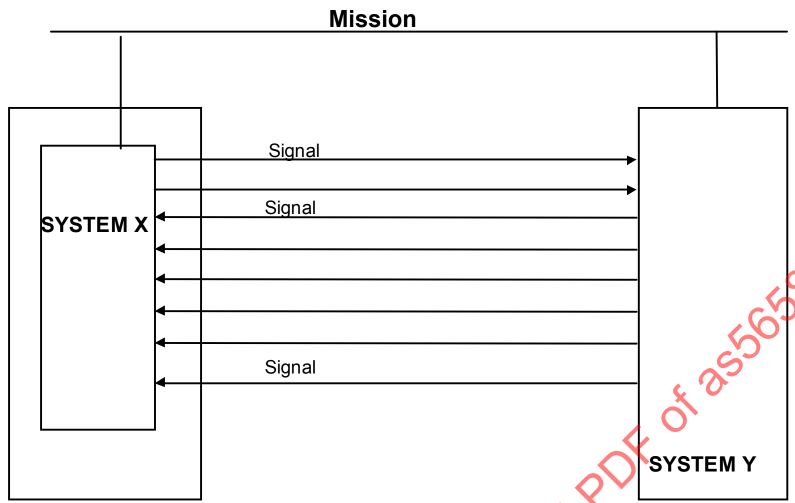


FIGURE 14 – INTERFACE BOUNDARY (SYSTEM X TO SYSTEM Y)

---------- End Example

4.2.1 Connector Description

Description of the electrical parts of the subsystem connector(s) supported by drawing(s). Keyway orientation and connector location are specified in Volume 1 Section 3 Mechanical Interface.

---------- Begin Example

The subsystem connections are defined in 4.2.2. See FIGURE 15 for reference the connector layout.

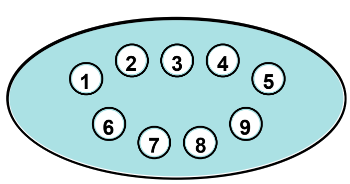


FIGURE 15 – 1A1W1 P1 CONNECTOR PIN LAYOUT – MATING SIDE

---------- End Example

4.2.2 Contact Assignment and Contact Description

Description of connector contacts and layout of the electrical interface connection supported by the appropriate drawing(s).

This is the section to contain the pin assignments for all subsystem interfaces. The signals are divided by type in 4.3. To provide a reference to this paragraph and an overview of the interface, the signal type must be listed here. A detailed description of the pins may be given in the following paragraphs.

---------- Begin Example

TABLE 2 and TABLE 3 show the subsystem interface connector details.

TABLE 2 – SIGNAL LIST FOR THE 1A1A1 P1 (MATES WITH 1A1A2 J2)

Subsystem Interface Connector Contact/Function			**Subsystem Interface Connector**
ID	**Size**	**Use/Function**	**Socket Type**
1	22	DCD / Carrier Detect	MIL-C-39029/56
2	22	RxD / Receive Detect	MIL-C-39029/56
3	22	TxD / Transmit Data	MIL-C-39029/56
4	22	DTR / Data Terminal	MIL-C-39029/56
5	22	SG / Signal Ground	MIL-C-39029/56
6	22	DSR / Data Set Ready	MIL-C-39029/56
7	22	RTS / Request to Send	MIL-C-39029/56
8	22	CTS / Clear to Send	MIL-C-39029/56
9	22	RI / Ring Indicator	MIL-C-39029/56

TABLE 3– SIGNAL LIST FOR THE 1A1A2 J2 (MATES WITH 1A1A1 P1)

Subsystem Interface Connector Contact/Function			**Subsystem Interface Connector**
ID	**Size**	**Use/Function**	**Plug Type**
1	22	DCD / Carrier Detect	MIL-C-39029/56
2	22	RxD / Receive Detect	MIL-C-39029/56
3	22	TxD / Transmit Data	MIL-C-39029/56
4	22	DTR / Data Terminal	MIL-C-39029/56
5	22	SG / Signal Ground	MIL-C-39029/56
6	22	DSR / Data Set Ready	MIL-C-39029/56
7	22	RTS / Request to Send	MIL-C-39029/56
8	22	CTS / Clear to Send	MIL-C-39029/56
9	22	RI / Ring Indicator	MIL-C-39029/56

---------- End Example

4.3 Contact Types:

The following sections contain a description of the electrical characteristics of each single connection. Commonly the basic conditions of each line are specified in other standards. In an ICD the signal restrictions or limitations with respect to the range defined in the standard are specified i.e. the true values of e.g. a transmitted signal.

4.3.1 Power Lines

General description of the electrical power interface shall be given in this section i.e. what power is applicable to drive the subsystem and its functions etc. Interface considerations for AC/DC power should address voltage levels, current capacity, overcurrent protection, off-state leakage current, stabilization time, phase rotation, load power factor, phase power imbalance, and power application.

---------- Begin Example

The interface current level is shown in FIGURE 16.

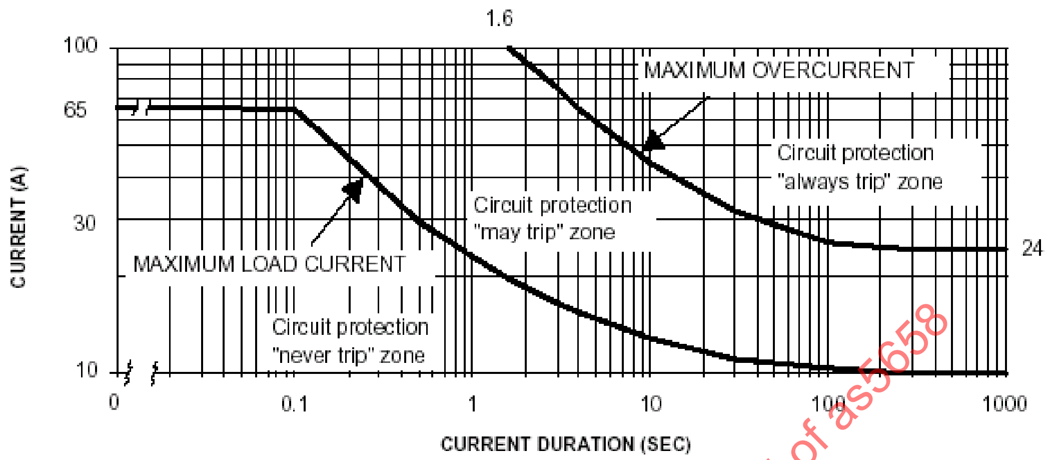


FIGURE 16 – INTERFACE CURRENT LEVEL

4.3.1.1 DC Power Levels

In the Form Sheets on Pages x to y the DC voltage levels specified are 22vdc to 29vdc which are the DC Normal Operation conditions. Whilst the SYSTEM X will provide full performance under DC Abnormal Operation conditions the SYSTEM Y full specified performance can only be assured within the DC Normal Operation limits. FIGURE 17 shows the Full Specified Performance DC power levels for the systems covered in this ICD.

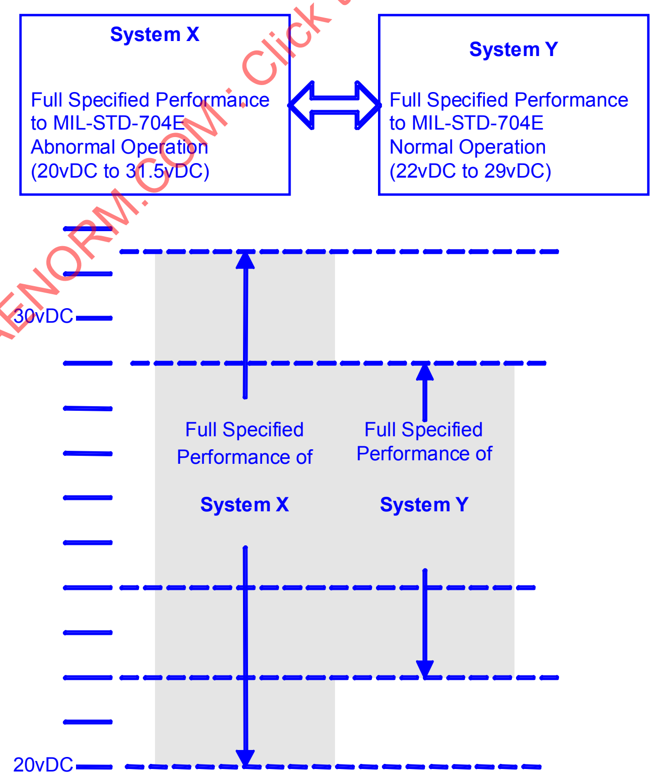


FIGURE 17 – DC POWER LEVELS

---------- End Example

4.3.2 State Signals

Should the discrete line consist of a single pin referenced to ground or shared return, the description of the signal implies the description of the pin. In the following example, this would be the case for the interlock. The description of the shared return or ground can be defined in the power line section. If the discrete connection covers the signal line and the return (in the following example for the release consent), a description of the pin may be required. However, the incorporation of the pin descriptive part in this section is on the authors´ discretion.

---------- Begin Example

4.3.2.1 Address Lines

The purpose of the address interface discrete signal lines is to provide a means for the platform to assign a unique digital multiplex data bus address to the MIL-STD-1553 compliant remote terminal. A minimum of seven discrete lines is necessary to support the interface. The seven discrete lines consist of five address discrete lines with a binary coded weighting, one address parity discrete line and one discrete line for a common return. The nominal operating modes for these lines are an open circuit for Logic 1 or a connection to the common return for logic 0 for each address line. The pin description can be found in 4.2.2.2.

4.3.2.2 Address Signal

The platform shall comply with the requirements herein when signals with the following characteristics are applied to the address interface at the ASI by the connected subsystem. The characteristics defined apply to the address bit and parity connections referenced to the address return connection.

a. Open circuit (logic 1) voltage

   (1) Minimum voltage of 3.5 V DC

   (2) Maximum voltage of 31.5 V DC

   (3) Rise and fall times of applied voltage less than 10 milliseconds

b. Logic 0 current

   (1) Minimum current of 5.0 milliamperes dc

   (2) Maximum current of 100 milliamperes dc through each address bit and parity connection

   (3) Maximum current of 600 milliamperes dc through the address return connection

   (4) Rise and fall times of applied current less than 10 milliseconds

4.3.2.2.1 Logic Thresholds

The platform shall provide the following logic states under the voltage and current conditions of this section:

a. Logic 1 state characteristics. The platform shall maintain sufficient open circuit conditions between each logic 1 set address bit (or parity) connection and the return connection such that when the voltages of 4.3.2.2.1 are applied across the connections, the current flow shall not exceed 300 microamperes.

b. Logic 0 state characteristics. The platform shall limit the voltage drop between each logic 0 set address bit (or parity) connection and return connection at the ASI to 1.0 volts maximum when the current levels specified in 4.3.2.2.1 are applied. This maximum voltage drop applies when logic 0 states exist at any or all address bit and parity connections.

4.3.2.2.2 Response Characteristics

The platform shall produce valid address characteristics at the ASI within 10 milliseconds of excitation signal application from the subsystem. The platform shall not require continuous application of the excitation signal.

4.3.2.2.3 Address Isolation

The platform shall electrically isolate all address connections (including address return) at each ASI from the address connections at all other ASIs, from power returns and from platform structure. The isolation shall be 100 kOhms minimum over the frequency range of dc to 4 kHz.

4.3.2.3 Discrete Signal 1

Parent Name:	Release Cues							Circuit:	**##**
Standard:	Discrete Interface - No applicable standard								
Description:	Discrete signal to Channel 1 of the SYSTEM X LRI 1.								
	Analogue:					**Discrete:**			
Param	Logical	Units	=	Physical	Units	Logical State	=	Physical	Units
Max:	n/a		=	n/a		True	=	> 11.45	Volts dc
Min:			=						
Accy:			=			False	=	< 10.45	Volts dc
Resl:			=						
Rate:			=						

Comment:	The Release Cue output from the SYSTEM Y to Channel 1 of the SYSTEM X will be a pulse of amplitude 28 volts (nom) and duration ## msecs (+10/ -0 msecs). The Release Cue off time should be 1 msecs minimum. At the minimum voltage of Rel Cue Supply 1, the minimum output voltage from the SYSTEM Y for the True state shall be greater than 17 vdc. Response time of the input stage is 53.84uSecs. SYSTEM X LRI 1Transition low to high >11.45v (max low level voltage) SYSTEM X LRI 1Transition high to low <10.45v (min high level voltage) Max Current = 8 mA Min Current = 4 mA

Source (X):				**Sink (Y):**			
Max Output:	=	28.0	Volts	Max Input:	=	31.5	Volts
Min Output:	=	0	Volts	Min Input:	=	0	Volts
Default Value	=	False		Default Value	=	False	
Impedance:	=	390	Ohms	Impedance:	=	3.9K	Ohms
Slew Rate:	=	n/a		Time Const:	=	113	uSecs
Signal Conditioning							

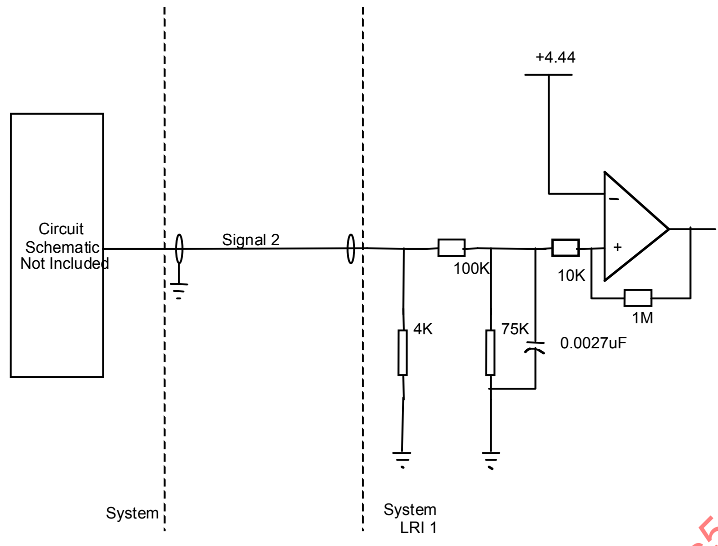


FIGURE 18 – DISCRETE SIGNAL 1 DEFINITION

---------- End Example

4.3.3 Information Signals

Signals having significant information content should be described in this section. The state signals have lower information content. Information signals encompass data networks both low speed and high speed (MIL-STD-1553, Ethernet, CANBus for example), and analogue signals (audio, video, timing, radio frequency). The distinction between analogue and digital is not used at the top level because it is becoming blurred with the advance of high speed signaling such as e.g. Quadrature Amplitude Modulation.

A few examples of analogue information signals are audio, timing pulses, radio frequency, video, seeker slaving. Analogue Signals are best described by frequency domain and in other cases by time domain template diagrams. The template diagrams illustrate the salient points of the signal along with allowable variations. In example 2 based on stereo audio a frequency domain representation is more appropriate, example 1 based on a timing pulse a time domain representation is more appropriate. Another case is video where the use of both domains is more appropriate. If possible an external standard should be referenced. The parameters listed below to describe the analogue signals should be regarded as an initial list; others may be required in a particular instance.

The amount of signal present "signal strength" can be described in a number of different ways, the most suitable depending upon the application. Power, voltage or current may describe the signal strength. Is the value quoted a RMS, peak, average, maximum, or minimum? If averages are used the type of averaging should be made clear. Is the average based upon the signal amplitude (voltage or current) or upon the power and in each case was the averaging performed on linear units (Volts, Ampere, Watt) or logarithmic units (Decibel). In the descriptions below the generic term "signal strength" is used but this should be detailed as appropriate. The input and out put impedance should be stated.

An example for a digital information signal is the common bus in accordance with MIL-STD-1553. The definition encompasses the general data bus characteristics like transmission frequency, synchronization, voltage and requirements for cable (electrical characteristics like attenuation, capacity, impedance etc) and for the terminals (input/output voltage, output waveform, overshoot and ringing, output symmetry, output noise, input impedance, noise rejection, common mode rejection). Again as stated above, the list is not complete and has to be adjusted to the actual needs. If possible refer to an external standard.

It is suggested that the signal is specified using signal definition sheets.

---------- Begin Example

4.3.3.1 Analogue Information General

- General Description
- Frequency Domain
- Time Domain
- Rates of Change
- Stability
- Harmonic Distortion
- Non-Harmonic
- Ringing Overshoot Undershoot
- Pulse Width
- Noise

4.3.3.2 Analogue Signal 1

Parent Name:	Aircraft Data In								Circuit:	**##**
Standard:	GPS-86-12320-058 NAVSTAR Phase III ICD ICD-GPS-060									
Description:	Discrete interface providing precise synchronisation of System Time, for SYSTEM X Channel 1, using a 1 Hz Precise Time and Time Interval (PTTI) pulse.									
	Analogue:					**Discrete:**				
Param	Logical	Units	=	Physical	Units	Logical State	=	Physical	Units	
Max:	n/a		=	n/a		Low	=	0±1	Volts	
Min:			=			High	=	10±1	Volts	
Accy:			=							
Resl:			=							
Rate:			=							
Comment:	This signal provides precise synchronisation to the System Time information provided to the SYSTEM X in the Aircraft Data message on the Mission Bus. The SYSTEM Y will output a 10 volts 1 Hz PTTI pulse to Channel 1 of the LRI 1 to synchronise its real time clock to the current System Time value. (Ref. GPS-86-12320-058 NAVSTAR Phase III ICD ICD-GPS-060)									

Source (X):				**Sink (Y):**			
Max Output:	=	11	Volts	Max Input:	=	11	Volts
Min Output:	=	0	Volts	Min Input:	=	0	Volts
Default Value	=	False		Default Value	=	False	
Impedance:	=	50	Ohms	Impedance:	=	50	Ohms
Slew Rate:	=	n/a		Time Const:	=	n/a	
Signal Conditioning							

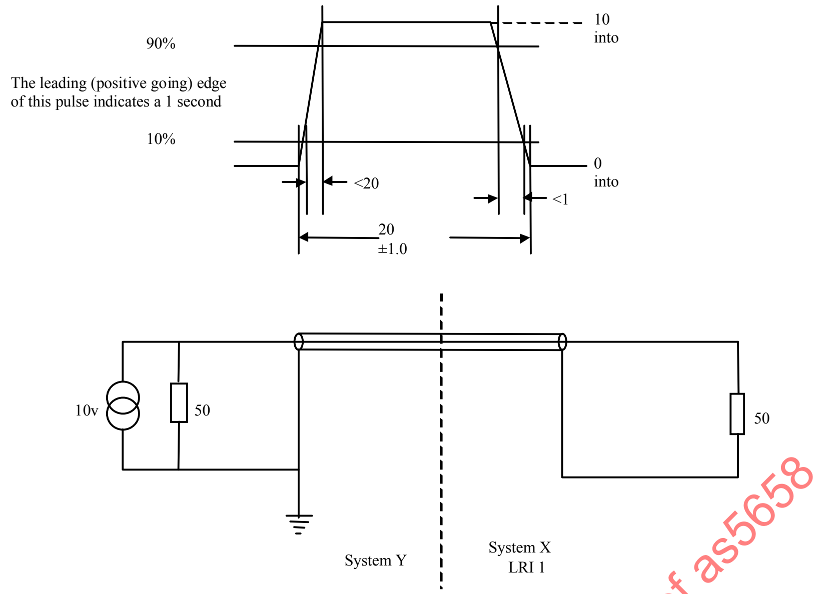


FIGURE 19 – ANALOGUE SIGNAL 1 DEFINITION

---------- Example 1:

4.3.3.3 Analogue High Bandwidth Connection

This example is a sawtooth wave where the falling edge is used for synchronization purposes.

4.3.3.3.1 General Signal Description

The signal approximates a sawtooth waveform. Timing is signified by the falling edge. Internal timers should be reset on this edge. There is background random noise. The output and input impedance is 100 kΩ.

Time Domain Template Diagram: Figure 20 illustrates the shape of the falling edge. T is the period of the sawtooth 10 μs. The times are measured from the last negative going zero crossing. The slew rate is limited to 200 V/μs.

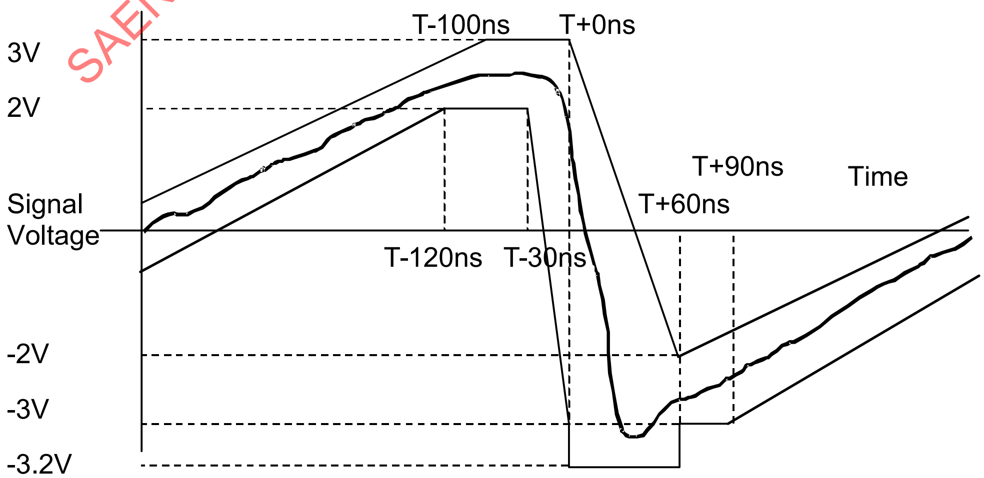


FIGURE 20 – TIME DOMAIN TEMPLATE. ONE PULSE

4.3.3.4 RF Interface

		Circuit:	##
Parent Name:	GPS RF		
Standard:	STANAG 4294 (Part 1) - Navstar Global Positioning System (GPS) Characteristics.		
Description:	This is the raw RF signal generated by the GPS antenna, which contains the encoded GPS satellite data. The C/A and P(Y) codes are centred on the D-band frequencies defined in STANAG 4294. The requirements of this interface apply over the frequency ranges L1 ± 10.23 MHz for L1_P(Y), L2 ± 10.23 MHz for L2_P(Y) and L1 ± 1.023MHz for L1_C/A. The receiver shall be compatible with the following signal power levels. L1_P(Y) -155.0 dBW (min) to -119.5 dBW (max) L2_P(Y) -160.0 dBW (min) to -122.0 dBW (max) L1_C/A -152.0 dBW (min) to -117.0 dBW (max) The receiver shall be compatible with the following minimum signal to noise ratios. L1_P(Y) -42.5 dB L2_P(Y) -45.5 dB L1_C/A -39.5 dB The maximum dc offset generated by the receiver shall not exceed ± 500 millivolts.		

	Analogue:					**Discrete:**			
Param	Logical	Units	=	Physical	Units	Logical State	=	Physical	Units
Max:	n/a		=	n/a	n/a	n/a	=	n/a	n/a
Min:	n/a		=	n/a	n/a	n/a	=	n/a	n/a
Accy:	n/a		=	n/a	n/a	n/a		n/a	n/a
Resl:	n/a		=	n/a	n/a	n/a		n/a	n/a
Rate:	n/a		=	n/a	n/a	n/a		n/a	n/a

Comment: The receiver decodes this RF signal in order to generate a navigation solution.

Source (X):				**Sink (Y):**			
Max Output:	=	-117.0	dBW	Max Input:	=	-117.0	dBW
Min Output:	=	-160.0	dBW	Min Input:	=	-160.0	dBW
Max SNR		-45.5	dB	Max SNR	=	-45.5	dB
Min SNR	=	-39.5	dB	Min SNR	=	-39.5	dB
Impedance:	=	50	Ohms	Impedance:	=	50	Ohms
VSWR	=	2:1		VSWR	=	2:1	

Signal Conditioning

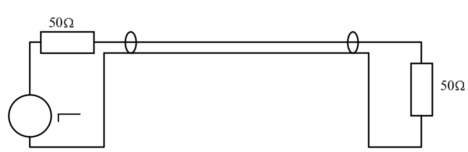


FIGURE 21 – RF INTERFACE DEFINITION

---------- Example 2:

4.3.3.5 Digital Information

This section shall cover the description of the electrical characteristic of the used digital signals like specific shielding for data lines etc. The structure of the digital information (the protocol like messages, word, bits, synchronization etc. is specified in the communications interface description in Volume 2, Section 4

For the platform there may be a situation where e.g. the Mil Bus redundancy cannot be achieved. Any provisions for special solutions or restrictions for the data interface should be included in this section.

The following information may be included in the description of a digital information signal (note: the list is not regarded complete and may vary with the nature of the digital information carrier), examples of the figures (without reference in the text) are given at the end of this section:

- Digital Information Carrier (Data Bus Characteristics)
    - Cable (type, shielding, general requirements)
    - Characteristic Impedance
    - Cable attenuation
    - Cable termination
    - Cable stub requirements
- Transformer coupled stubs
- Coupling transformer
    - Transformer input impedance
    - Transformer waveform integrity
    - Transformer common mode rejection
- Fault isolation
- Cable coupling
- Stub voltage requirements
    - Direct coupled stubs
- Fault isolation
- Cable coupling
- Stub voltage requirements
    - Wiring and cabling for EMC

4.3.3.5.1 Tables for Digital Information Signals:

Terminal Output Characteristics

- Output voltage
- Output waveform
- Overshoot and ringing
- Output symmetry
- Output Noise

Terminal Input Characteristics

- Input Voltage
- Input impedance
- Noise rejection
- Common mode rejection

4.3.3.6 Databus Signals

Parent Name: MUX Bus A — Circuit: **##**

Standard: MIL-STD-1553B + Notice 4

Description: The MUX A data bus (in conjunction with the MUX B data bus) provides the primary means of data communication between the LRI's in the mission system.

Param	Analogue: Logical	Units	=	Physical	Units	Discrete: Logical State	=	Physical	Units
Max:			=				=		
Min:			=				=		
Accy:			=						
Resl:			=						
Rate:			=						

Comment: The data interface is defined in MIL-STD-1553B + Notice 4. The data transactions across the data bus are defined in section 4 of Volume 2 of this ICD.

Source (X):				Sink (Y):			
Max Output:	=		Volts	Max Input:	=		Volts
Min Output:	=		Volts	Min Input:	=		Volts
Default Value	=			Default Value	=		
Impedance:	=		Ohms	Impedance:	=		Ohms
Slew Rate:	=			Time Const:	=		

Signal Conditioning

4.3.3.6.1 Figures for Digital Information Signals

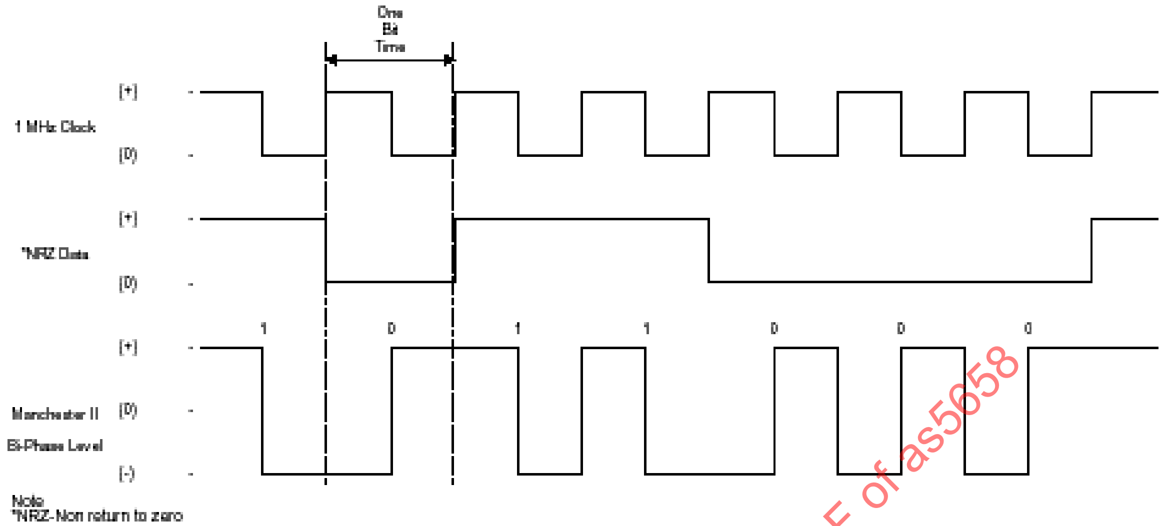


FIGURE 22 – DATA ENCODING

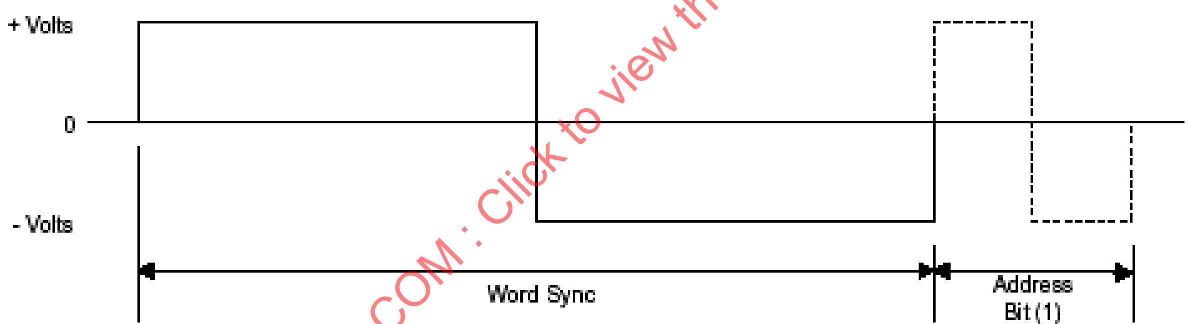


FIGURE 23 – COMMAND AND STATUS SYNC WAVEFORM

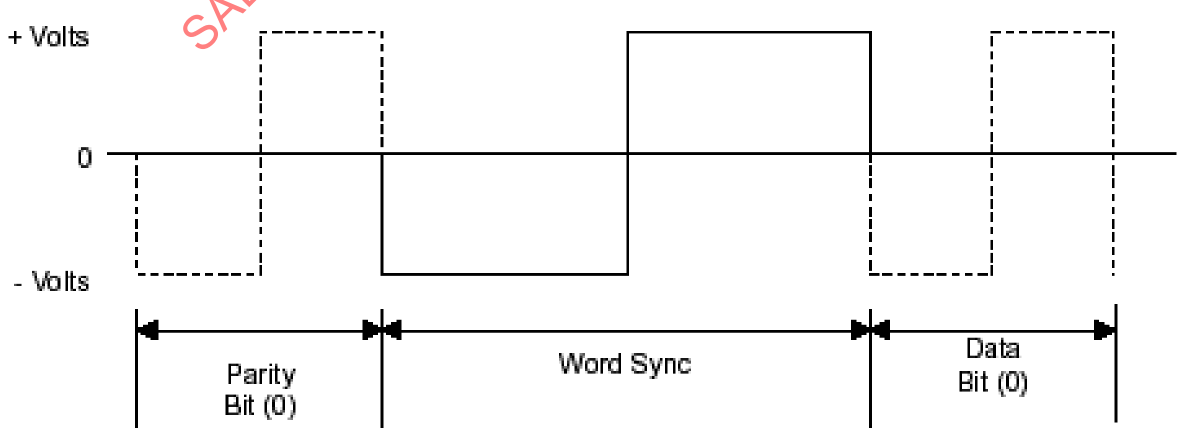


FIGURE 24 – DATA SYNC WAVEFORM

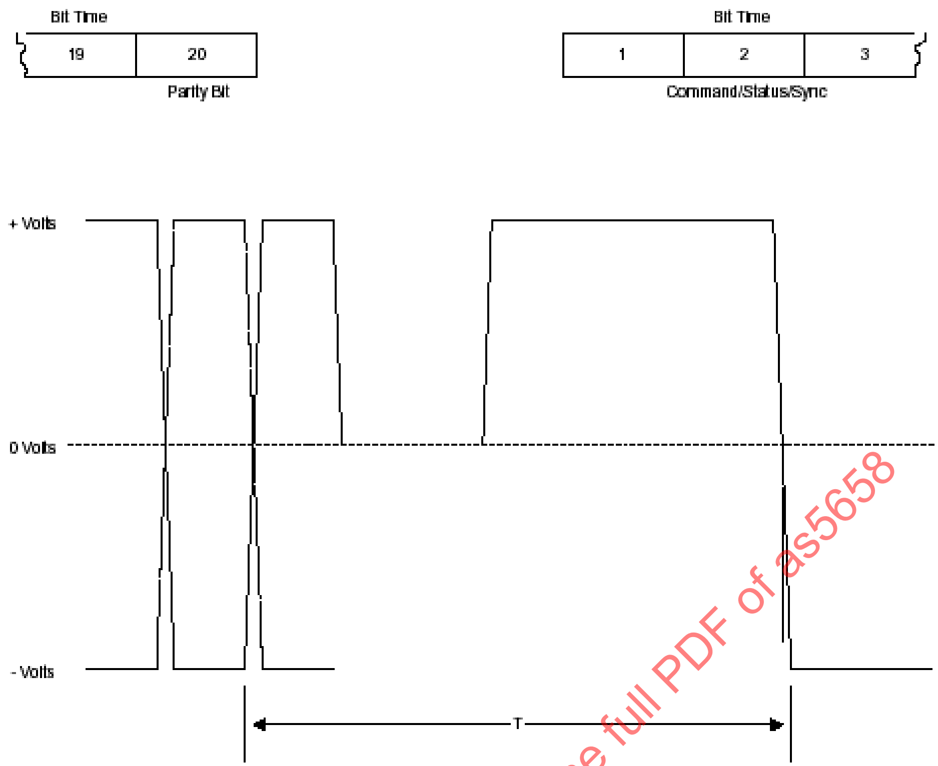


FIGURE 25 – INTERMESSAGE GAP AND RESPONSE TIME

4.3.3.7 Signal Time Line

The timing relationship between the Position, Drive, CCW Direction and Locked signals for the Dispenser is shown in FIGURE 26.

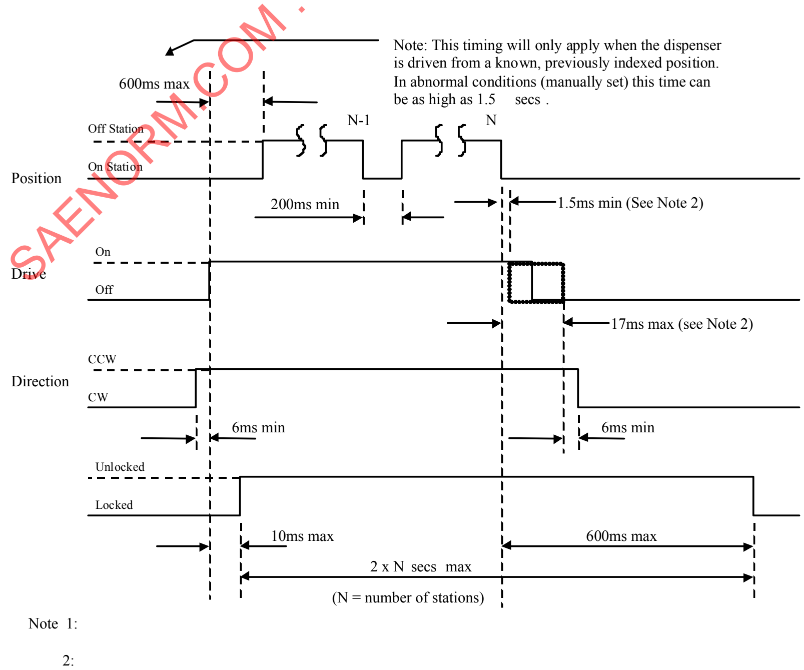


FIGURE 26 – DISPENSER SIGNAL TIMING

---------- End Example

4.4 Harness Design/ Layout

This section provides the harness design/layout description that addresses the requirements for the backshell, separation of safety/ mission critical signals from interference, separation of armament and release signals, redundancy as required, separation of grounds, harness length as a design consideration for attenuation factors, bend radius, wire gauge, insulation, derating guidelines, length, etc. This requirement may be achieved by reference to another source (document, drawings, etc).

4.5 Bonding/Grounding

This section describes the specific features of the subsystem that support bonding/Grounding with the host vehicle structure.

The section shall provide a grounding diagram in sufficient detail to showing major power, returns, and cable shielding between subsystems. All types of returns, (power, analog, digital and chassis) shall be depicted showing grounding methodology and tie points. The system should have one Single-Point Ground (hence the name) in the network to prevent ground loops and any noise sources. Peer reviews should be held with electrical subject matter experts to review the design analyzing it for possible ground loops and noise sources.

---------- Begin Example

The subsystem provides a bonding interface sufficient to meet the requirements of MIL-B-5087, Class R. The location and characteristics of this interface are shown on the Installation Drawing. FIGURE 27 shows the subsystem electrical grounding diagram.

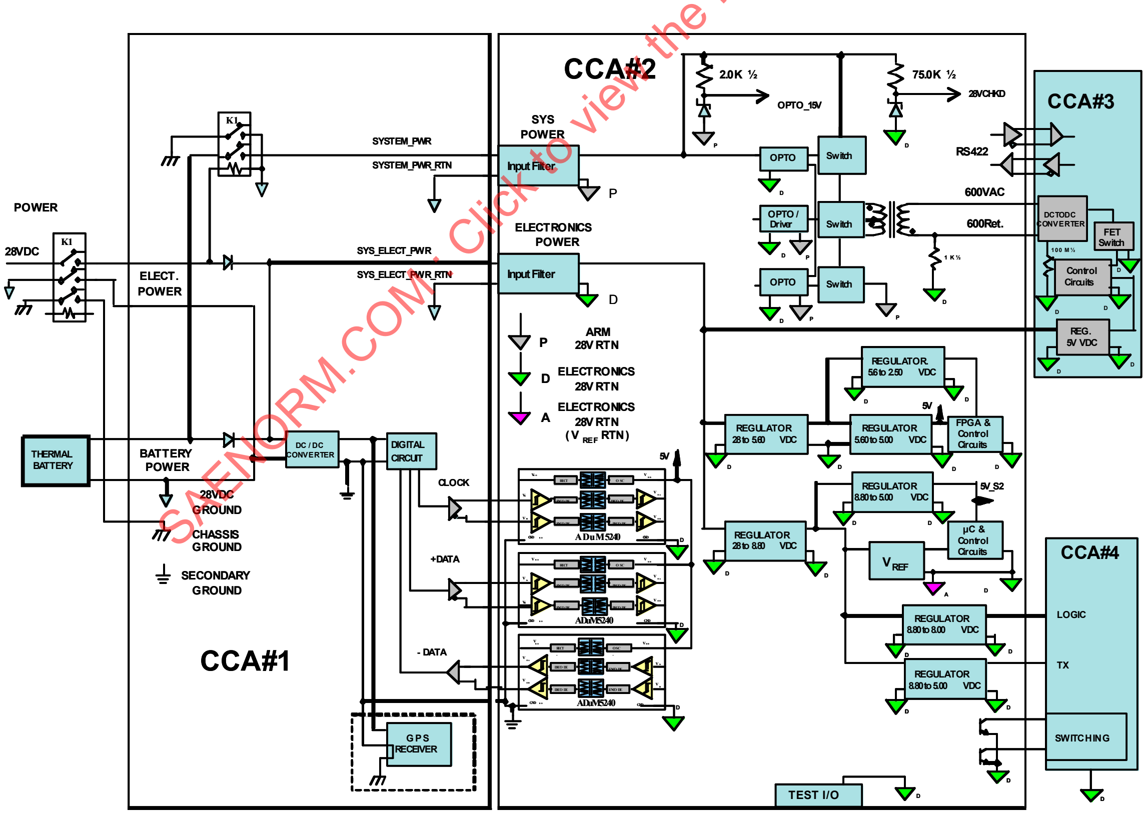


FIGURE 27 – SUBSYSTEM ELECTRICAL GROUNDING DIAGRAM

---------- End Example

5. AERODYNAMICS INTERFACE

This section shall cover all aerodynamics aspects relevant for the interface.

5.1 Configuration

This section shall define the subsystem external interface.

---------- Begin Example

The subsystem will be carried in the configuration shown in FIGURE 28.

FIGURE 28 – EXTERNAL ANTENNA

---------- End Example

5.2 Drag Data

Drag values caused by airflow shall be defined in this section.

---------- Begin Example

5.2.1 Drag Characteristics

The following FIGURE 29 shows the subsystem fluid dynamic control volume, drag variations over a range of speeds, assuming undisturbed incident airflow, whilst FIGURE 30 shows the zero lift drag vs. Mach number relation.

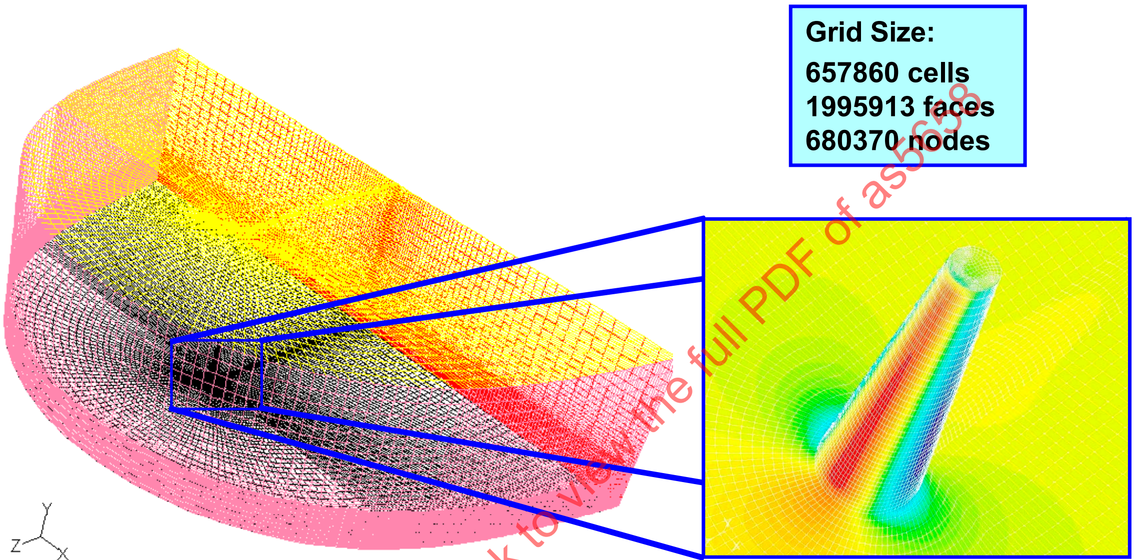


FIGURE 29 – COMPUTATIONAL FLUID DYNAMIC CONTROL VOLUME

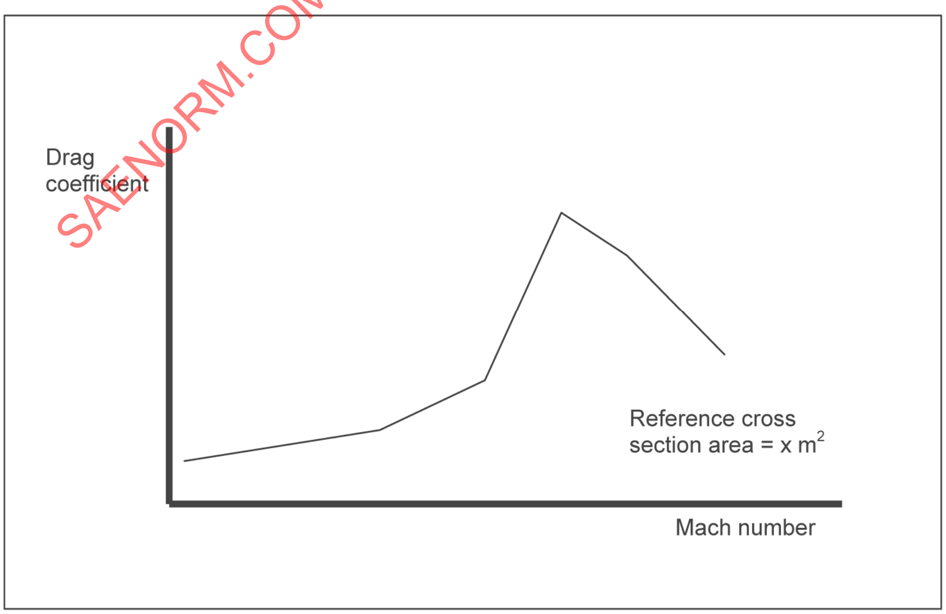


FIGURE 30 – ZERO LIFT DRAG VS. MACH NUMBER

6. SAFETY

Safety is a prime requirement of airborne systems. Therefore, it is essential that all safety requirements are adequately captured within the ICD. This section records the safety features relating to the design of the system: special requirements relating to ordnance, cockpit/crew escape features, multiple redundant datalink for unmanned aerial systems (UASs), safety critical fault management, etc.

Safety should be designed in to any system from the outset. This reduces the requirements for special operating procedures to ensure safety.

6.1 System Safety & Mission Criticality

The interface design features necessary for system safety for ground and flight: platform, flight crew, route de-confliction (airspace management including civil air traffic regulations), ground crew, etc. are identified and listed herein. In addition, each interface should be assessed to determine the system safety impact and criticality to the continued performance of the defined mission.

This should include the definition and listing of dangerous components, installation, radiation, dangerous areas around the subsystem and/or the platform and specific handling procedures such as following a payload failure and fire-fighting measures.

6.1.1 Installation

---------- Begin Example

6.1.1.1 Electrical

Means are to be provided so that power may be cut off while installing, replacing, or interchanging complete equipment, assembly or parts thereof.

The main power off/on switch, located on the electrical equipment:

- Will be designed to provide cut-off of all incoming power to equipment.
- Will be designed such that incoming power line connections are given physical protection against accidental contact.

6.1.1.2 Interlocks

Various equipment designs require different approaches to the use of interlocks. These will fall into one or more of the following categories and will be consistent with equipment or system specifications.

6.1.1.3 High Voltage Protection

Test points are to be provided so that all high voltages can be measured at relatively low potential. In no case will the potential being measured exceed 300 volts peak relative to ground.

Voltage divider resistance between the test point and ground will consist of at least two equal valued resistors in parallel.

6.1.1.4 High Current Protection

All terminals or power busses supplying 25 amps or more of current are protected against accidental short circuits. This protection employs one or more of the following:

- Guards or barriers.
- Sufficient space separation to prevent short circuits.
- Caution – warning signs.

6.1.1.5 Connections for External Power

Application of power to externally powered test equipment or electronic equipment meets the following requirements:

- Power is controlled by a power ON-OFF switch located on the front panel.
- A green indicator lamp is provided to indicate "power on" to the test set except for low power dry battery operated equipment.
- Neither side of the supply voltage is directly connected to the chassis.
- The grounding conductor has a continuous identifying marker of green or green with one or more yellow strips which readily distinguishes it from the other connector(s).

6.1.1.6 Electrical Connectors

Connectors used to provide separation of or connection to multiple electrical circuits cannot be inserted into the wrong receptacle or mating unit.

The operator is not to be exposed to electrical shock or burns when normal disconnect methods are used.

6.1.1.7 Physical Measures

Prevent inadvertent reversing or improper mating of mechanical linkage, instrument leads and electrical connections.

Interlock switches will conform to one or more of the following:

- The interlock switch is automatic and eliminates all power from the equipment when the access door, cover, or plate is removed.
- The interlock switch is automatic, with manually operated electrical bypass device to permit maintenance.

---------- End Example

6.1.2 Radiation

The interface design features necessary should account for dangerous areas (keep-out zones from electromagnetic radiated, laser, x-ray, and microwave emissions).

---------- Begin Example

6.1.2.1 Dangerous Areas

Areas around the aircraft that can be hazardous to ground personnel should be

6.1.2.1.1 Radar Safety Cone

Areas around the aircraft that can be hazardous to ground personnel from emissions from the radar shall be clearly identified to those personnel at risk. For the installation concerned, the hazardous is described as a cone, with its apex centered at the focal point of the antenna and extending to cover the complete sweep of the antenna in two dimensions (see FIGURE).

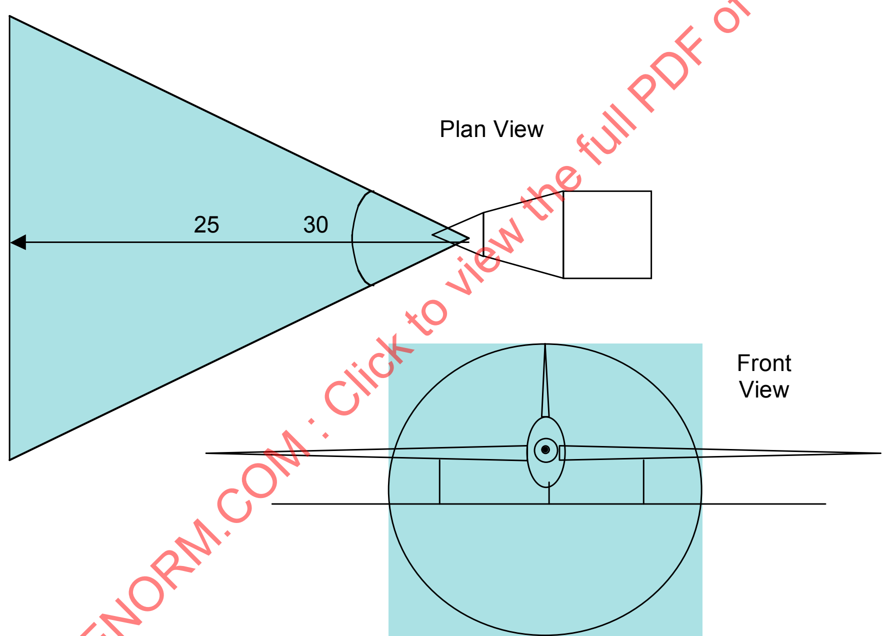


FIGURE 31 – RADAR SAFE DISTANCE

---------- End Example

Some subsystem payloads may be susceptible to ignition by electromagnetic radiation (such as radar or radio transmitters, chaff, flare, and laser designate systems). Features to avoid such hazards are outlined below.

---------- Begin Example

6.1.2.2 Electromagnetic Radiation Susceptibility

Manufacturer's recommendations and guidelines shall be followed to maintain a safe distance from potential flammable materials, liquids, and gases. In addition, there should be required controls such as: protective housings, interlocks, training, mechanical or electrical stops or attenuators, remote interlock connectors, emission delay or activation warning systems, emergency off buttons.

Ordnance with Electrically Initiated Devices (EIDs) will not be inadvertently ignited during, or experience degraded performance characteristics after, exposure to the external radiated electromagnetic environment table (below) or Hazards of Electro-Magnetic Radiation to Ordnance (HERO) for either direct RF induced actuation or coupling to the associated firing circuits. Compliance shall be verified by system, subsystem, and equipment level tests and analysis. For electromagnetic environment in the High Frequency band derived from near field conditions, verification by test shall use transmitting antennas representative of the types present in the installation.

TABLE 4 – ELECTROMAGNETIC FIELD

Frequency (Hz)	Environment (V/m - rms)	
	Peak	Average
10k-150M	200	200
150M-225M	3,120	270
225M-400M	2,830	240
400M-700M	4,000	750
700M-790M	3,500	240
790M-1000M	3,500	610
1G-2G	5,670	1,000
2G-2.7G	21,270	850
2.7G-3.6G	27,460	1,230
3.6G-4G	21,270	850
4G-5.4G	15,000	610
5.4G-5.9G	15,000	1,230
5.9G-6G	15,000	610
6G-7.9G	12,650	670
7.9G-8G	12,650	810
8G-14G	21,270	1,270
14G-18G	21,270	614
18G-40G	5,000	750

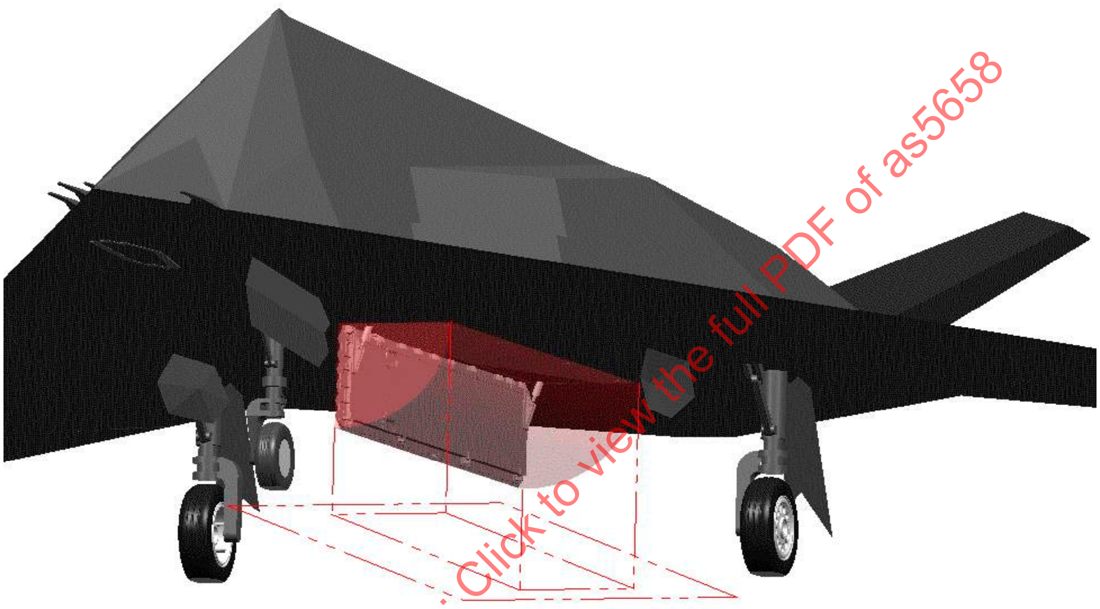
---------- End Example

6.1.3 Dangerous Areas

The interface design features necessary should account for dangerous areas (keep-out zones) from: hot air, fast-moving parts, hydraulic fluid, high-pressure systems, payload dispensing, exotic fuels, propeller and engine in-take/exhaust, etc.

---------- Begin Example

FIGURE 31 shows the platform keep-out zone for bomb-bay door movement and subsystem loading/unloading.



Danger area projected onto ground plane:

Small rectangle ~ 3ft x 16ft, Large rectangle ~ 7ft x 20ft (2ft buffer)

FIGURE 31 – BOMB-BAY DOOR KEEP-OUT ZONE

---------- End Example

6.1.4 Special Handling Procedures

The interface design features necessary should account for special handling of: explosive devices, high-pressure vessels, caustic materials, etc.

---------- Begin Example

6.1.4.1 Compressed Air

Compressed gas cylinders, portable tanks, and cargo tanks shall have pressure relief devices installed and maintained in accordance with Compressed Gas Association Pamphlets S-1.1-1963 and 1965 addenda and S-1.2-1963, which is incorporated by reference as specified in OSHA CFR Title 29, Part 1910.6.

6.1.4.2 Batteries

Penetrating electrolytes contain substances that are damaging health.

The battery electrolyte (lithium) reacts strongly with water and generates flammable gases. Do not bring into contact with water. Lithium is flammable and caustic. If penetrating electrolyte is recognized, a safety mask and solvent-resisting gloves must always be worn when removing the electrolyte.

---------- End Example

6.1.5 Foreign Object Debris/Damage (FOD)

The interface design features should account for the prevention of FOD.

---------- Begin Example

The reduction of potential damage and elimination of FOD hazards begin with the design process. Design features include:

- Identify and eliminate foreign object entrapment areas.
- Identify and seal areas through which foreign objects can migrate.
- Use screens over exposed openings when appropriate: e.g., intakes, exhausts, etc.
- Install special access panels, ports, etc., for inspection and clean-out of foreign objects that could potentially cause damage.
- Use blind fasteners in critical areas, such as fuel cells, that are not prone to leaving debris during installation.
- Use fasteners with self-retaining features to secure high usage access panels.
- Locate service points, ground points, and built-in test equipment in areas which are least FOD sensitive.
- Use compatible metals and seals to prevent accelerated deterioration and subsequent failure of seal materials.
- Use conformal coatings as a positive seal against entry of minute foreign object including dust and water vapor.
- Design aircraft inlets to minimize traps where water can collect and freeze. Wets should be easily plugged and completely sealed against water when plugged.
- Provide screening or other means of foreign object blockage for water drainage holes forward of the engine inlet path.

---------- End Example

6.2 Special Considerations

The interface design features necessary should account for special considerations required for ground and/or flight, such as: ejection seats, remote-destruct of UASs, etc.

---------- Begin Example

6.2.1 Special Considerations - Ejection Plane Criteria

The subsystem shall be designed to not obstruct the ejection plane of the platform during egress.

When forced to eject, the pilot and seat trajectory is controlled by a set of guide rails until the combination is clear of the plane. The ejection velocity vE is constant along a direction θE from the y axis of the plane. Ejection occurs when the pilot/seat has traveled a vertical distance y1. FIGURE 32 shows the ejection geometry.

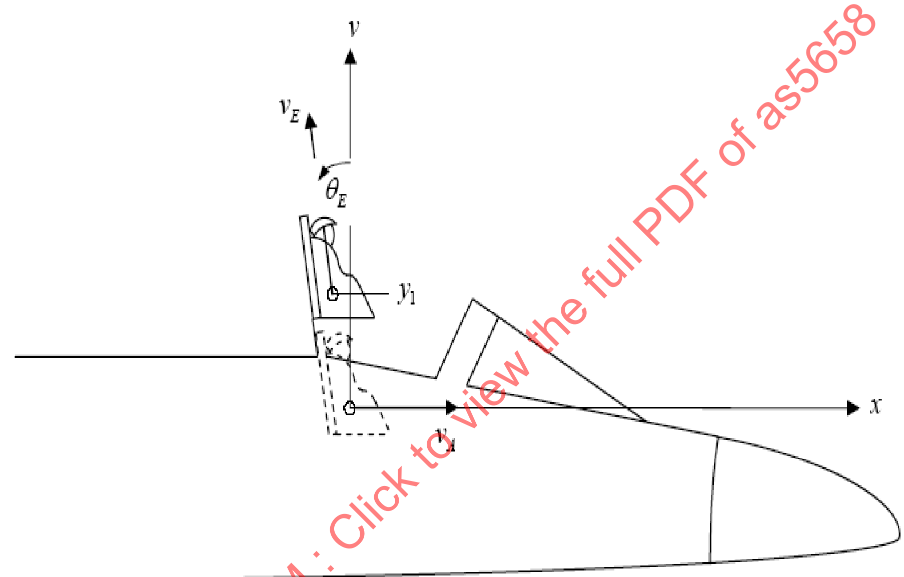


FIGURE 32 – EJECTION SEAT OPERATION AREA

Analysis of safe separation of the pilot/seat from the aircraft should be performed including trajectory and path relative to stabilizers, trajectory and canopy separation, altitude and speed, and initiation/sequence/timing. Provisions should be made that in the event of obstruction during ejection, mechanisms are in place to move, destroy, or separate the subsystem or portion of the subsystem during the ejection process. In some case, the subsystem or portion of the subsystem may be carried with the pilot/crew upon egress (for example, a pen for a mission planning/data processing pen tablet).

6.2.2 LASER Arm Functional Measures

Defensive techniques are employed to ensure that the Laser Arm signal can only be generated when the following interlocks have been made:

- The aircraft is deemed to be in-flight.
- Laser Enable power is applied.

Built-in test facilities continuously monitor the Laser Arm signal to detect if it becomes energized when not intended.

---------- End Example

7. ENVIRONMENTAL CONSIDERATIONS

This section defines the environmental considerations for subsystem integration.

Because the ICD is not a specification or requirements document, the content of the following subsections is often referenced to a specification, a standards document or an applicable standards test procedure (e.g. MIL-STD-810 Environmental Test Methods). There are various distinctions in certain subsections possible e.g. with respect to the severity of the environment and the resulting operational capabilities for the subsystem (see next paragraph).

7.1 Introduction

The content of the following paragraph and an overview is given in this section.

The following terms shall be used defining the severity of environmental influences:

a. Survive

   The subsystem, in addition to staying safe throughout and following exposure to the environment, will subsequently be capable of operating satisfactorily within its performance limits.

b. Operate

   The subsystem will survive exposure to, and function correctly within its performance limits during exposure to the specified environment.

c. Remain safe

   The subsystem will not endanger personnel or the platform or other subsystems when exposed to the specified environment, or subsequently during any handling and disposal; the subsystem is not required to operate in or after exposure to the specific environment.

7.2 Environmental Condition

The following data can be regarded from the subsystem only viewpoint and from the platform viewpoint concerning the platform/subsystem combination. Depending on integration progress, the content may evolve from subsystem only environmental conditions to the overall platform/subsystem environmental condition. Any influence from subsystem to platform and vice versa is covered. From an integration viewpoint, in most cases the platform part defines the limitations of the overall system.

7.2.1 General

General environmental considerations on how the system is used e.g. a coarse description of an overall operational envelope can be included here.

7.2.2 Altitude and Ambient Pressure

The altitude and pressure the subsystem/platform can withstand/perform in with/without performance deviations or damage (i.e. definition to survive, operate or remain safe). Maximum and minimum altitude and pressure values can be defined. Special precautions to prevent damage either to the subsystem or the platform shall be identified. Reference may be given to the mission phase to which the values apply in order to distinguish from phases with the equipment in non-operational or operational state.

---------- Begin Example

7.2.2.1 Altitude

Maximum carriage altitude	20000 m

7.2.2.2 Ambient Pressure and Conditions

The ambient pressure and condition at the equipment installation area will be as in TABLE 55.

TABLE 5 – AMBIENT PRESSURE

Maximum ambient pressure	150 kPa
Minimum ambient pressure	1 kPa

---------- End Example

7.2.3 Dynamic Pressure Change

The dynamic pressure change the subsystem/platform can withstand/perform in with/without performance deviations or damage (i.e. definition to survive, operate or remain safe). Pressure rate change can be defined. The pressure change range shall include the environment related to a nuclear strike. Special precautions to prevent damage either to the subsystem or the platform shall be identified. Reference may be given to the mission phase to which the values apply in order to distinguish from phases with the equipment in non-operational or operational state.

---------- Begin Example

The equipment shall survive dynamic pressure change in accordance with TABLE 6. See FIGURE 34 for the definition of real world dynamic pressure.

The equipment shall remain safe a dynamic pressure change allocated with a nuclear strike not exceeding 500kPa.

TABLE 6 – DYNAMIC PRESSURE CHANGE

Maximum pressure change increase (maximum value to be achieved after 5 sec)	300 kPa
Maximum pressure change decrease (minimum value to be achieved after 5 sec)	100 kPa

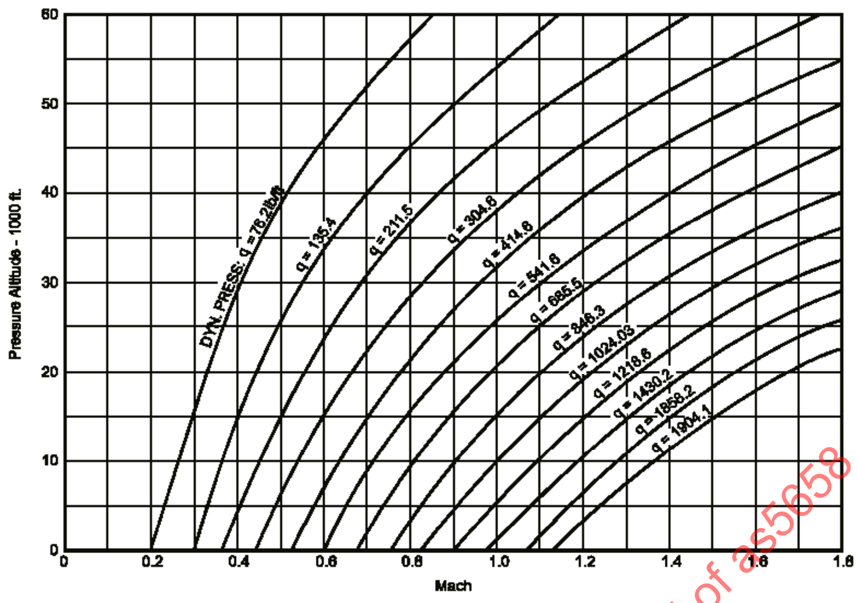


FIGURE 34 – DYNAMIC PRESSURE AS FUNCTION OF MACH NUMBER

---------- End Example

7.2.4 Temperatures

Temperatures the subsystem/platform can withstand/perform in with/without performance deviations or damage (i.e. definition to survive, operate or remain safe). The temperature range shall include the environment related to a nuclear strike and exposure to aerodynamic heating. Maximum and minimum extreme temperature values and temperature shock shall be defined. Special precautions to prevent from damage either to subsystem or platform shall be identified. Temperature is often allocated with altitude like pressure in 7.2.2. The following subsections on level 4 are identified as an example; the ordering in an ICD is to the author's discretion.

---------- Begin Example

7.2.4.1 Temperature

TABLE 7 – TEMPERATURE REQUIREMENTS

High temperature extreme (non-operational)	+80 deg C
Low temperature extreme (non-operational)	-60 deg C
High temperature extreme (operational)	+60 deg C
Low temperature extreme (operational)	-50 deg C

For equipment mounted on the platform structure, exposure to aerodynamic heating shall be addressed following ground soak at 49 °C.

7.2.4.2 Temperature/Altitude

TABLE 8 – TEMPERATURE ALTITUDE

IN FLIGHT OPERATION		GROUND SOAK			
		OPERATING		NON OPERATING	
MAX	MIN	MAX	MIN	MAX	MIN
External Bay: 100 °C per 40 min. at sea level and 110 °C at 40 kft per 30 sec. Up to 15 cm from leading edge: 95 °C per 40 min. at sea level and 122 °C at 50 kft per 40 sec	-41 °C	+85°C	-40 °C	+70 °C	-35 °C

7.2.4.3 Temperature Shock

The equipment can be exposed without performance degradation to sudden (within 5 minutes) atmospheric temperature changes over the range -54 °C to 71 °C or in accordance with a specific temperature shock profile (see FIGURE 35). It shall remain safe when exposed to a temperature shock allocated to a nuclear strike not exceeding 100 °C.

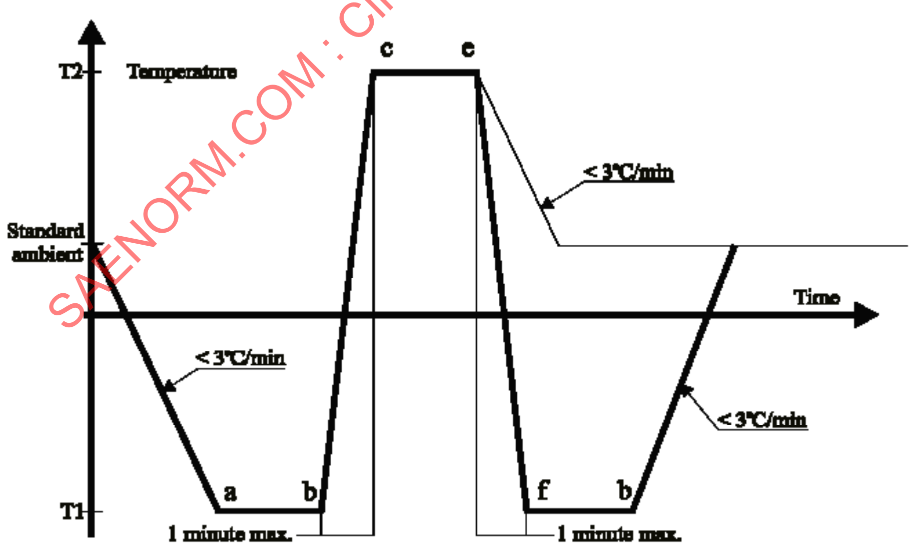


FIGURE 35 – TEMPERATURE SHOCK

---------- End Example

7.2.5 Humidity

Humidity the subsystem/platform can withstand/perform in with/without performance deviations or damage (i.e. definition to survive, operate or remain safe). Maximum and minimum humidity values shall be defined. Special precautions to prevent from damage either to subsystem or the platform shall be identified.

Remark: Humidity is often regarded in conjunction with temperature and pressure and an allocated profile.

---------- Begin Example

The equipment does not suffer any degradation and is able to operate correctly during and after exposure to the humid environment as defined in the following TABLE 9 and FIGURE 36.

TABLE 9 – HUMIDITY

Humidity	Pressure	Temperature
95%	Ambient	40 deg Celsius

The subsystem performs without degradation after exposure to high relative humidity in accordance with the diurnal cycle defined in MIL-STD-210, Table VI, for up to 30 daily cycles during Alert Status. The subsystem performs without degradation during and after exposure to the humidity conditions defined for a 10 percent risk per MIL-STD-210, Tables XXI through XXII, during flight.

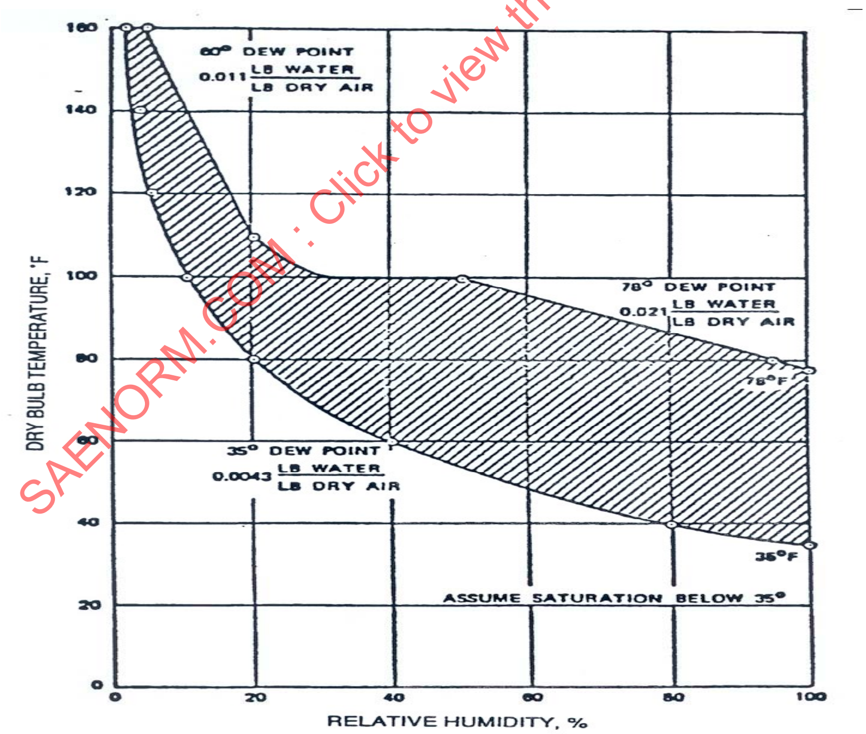


FIGURE 36 – DEW POINT

---------- End Example

7.2.6 Solar Radiation

Solar radiation, the subsystem/platform can withstand/perform in with/without performance deviations or damage (i.e. definition to survive, operate or remain safe). Values of collocated peak temperature etc. will be defined. Special precautions to prevent from damage either to subsystem or the platform shall be identified.

---------- Begin Example

Materials exposed to direct sunlight would not deteriorate or degrade through the effects of ultraviolet light Exposure to solar radiation must not affect maintainability performance or significantly affect reliability.

Illumination in 10 cycles of 8 hours duration each with exposure to 1120 W/m2

See also FIGURE 37

VALUES ARE FROM STANAG 2895 - Temperatures of categories A1, A2 and A3 in ^{0}C; solar radiation in W/m^2

A1	35	34	34	33	33	32	33	35	38	41	43	44	47	48	48	49	48	48	46	42	41	39	38	37
A2	33	32	32	31	30	30	31	34	37	39	41	42	43	44	44	44	43	42	40	38	36	35	34	33
A3	30	29	29	28	28	28	29	30	31	34	36	37	38	38	39	39	38	37	35	34	34	32	32	31
W	0	0	0	0	0	55	270	505	730	915	1040	1120	1120	1040	915	730	505	270	55	0	0	0	0	0

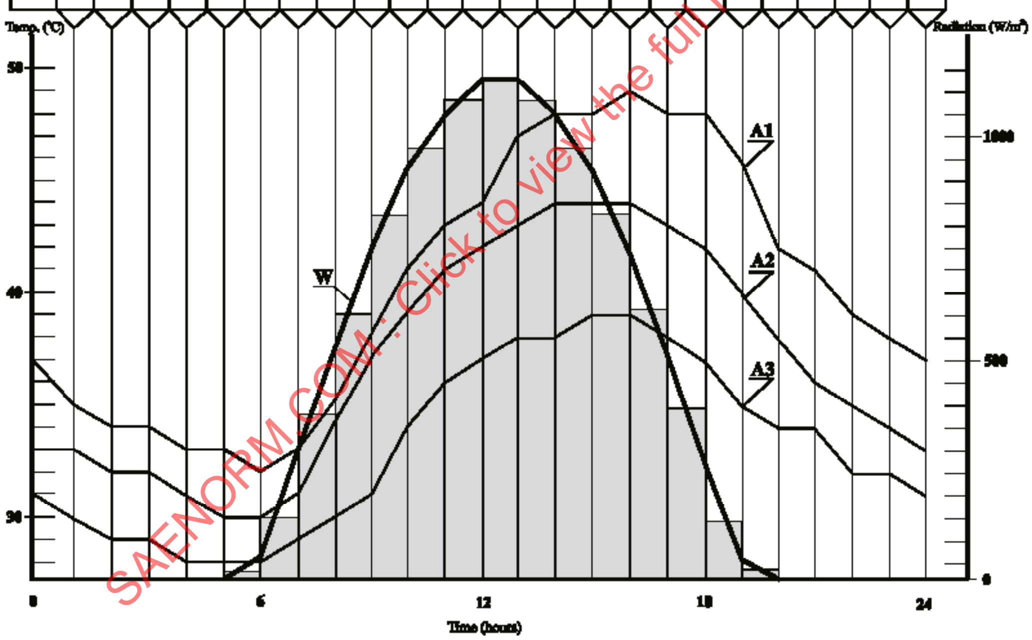


FIGURE 37 – SOLAR RADIATION CYCLE

---------- End Example

7.2.7 Fungus Resistance

Fungus resistance, the subsystem/platform can withstand/perform in with/without performance deviations or damage (i.e. definition to survive, operate or remain safe). Maximum and minimum fungus resistance and exposure values and definition of the fungus type shall be given. Special precautions to prevent from damage either to subsystem or the platform shall be identified.

---------- Begin Example

Materials, which are not nutrient for fungi is used. Where this is not feasible, suitable fungicidal agents or other means are used to protect materials.

The subsystem design will incorporate materials, which are non-nutritive, resist fungus growth, or are not affected by fungus growth.

---------- End Example

7.2.8 Salt Fog

Salt fog, the subsystem/platform can withstand/perform in with/without performance deviations or damage (i.e. definition to survive, operate or remain safe). Maximum and minimum Salt fog values and test definition like equipment exposure times, drying period etc shall be defined. Special precautions to prevent from damage either to subsystem or the platform shall be identified.

---------- Begin Example

The equipment does not suffer any degradation (no clogging of mechanical parts, no electrical malfunctions, only minimum corrosion) and is able to operate correctly during and after exposure to a salt fog solution of 5% + 1% for 48 hours.

---------- End Example

7.2.9 Rain - Rain Erosion

Rain - rain erosion the subsystem/platform can withstand/perform in with/without performance deviations or damage (i.e. definition to survive, operate or remain safe). Maximum and minimum Rain - rain erosion values, rain impact, rain rate, wind velocity, droplet size, duration and temperature shall be defined. Special precautions to prevent from damage either to subsystem or the platform shall be identified.

---------- Begin Example

Rainfall:

The amount of rainfall that the platform will be exposed to covers a 24 hour period as in TABLE 10:

TABLE 10 – RAIN RATES

Amount	Mm	305	51	279*	178
Duration	H	11.92	0.08	11.00	1.0
Rate	mm/h	25.4	610	25.4	178
Drop Size	Mm	2.25	4.0	2.25	3.2

*Wind speed of 35 knots.

---------- End Example

7.2.10 Hail (for external carriage or subsystems mounted on the external surface)

Hail intensity, the subsystem/platform can withstand/perform in with/without performance deviations or damage (i.e. definition to survive, operate or remain safe). Maximum and minimum hail size, hail impact and speed shall be defined. Special precautions to prevent from damage either to subsystem or the platform shall be identified.

---------- Begin Example

The equipment is qualified for the following hail conditions:

TABLE 11 – HAIL DEFINITIONS

HAIL DIM (mm)	SPEED (m/s)	IMPACT-NORMAL (Joule)	IMPACT-TOTAL (Joule)
25	131	10.9	63

---------- End Example

7.2.11 Drip

Fluids dripping from overhead platform structures onto the subsystem or from the subsystem to the platform with/without performance deviations or damage (i.e. definition to survive, operate or remain safe) to the subsystem shall be defined. Maximum drip/drip rates shall be defined. Special precautions to prevent damage either to the subsystem or the platform shall be identified.

---------- Begin Example

The subsystem shall withstand exposure to water dripping from overhead structure or equipment, in accordance with the 45 degree drip proof requirements of MIL-STD-108 Paragraph 4.3 without any performance degradation.

---------- End Example

7.2.12 Sand and Dust

Sand and dust the subsystem/platform can withstand/perform in with/without performance deviations or damage (i.e. definition to survive, operate or remain safe). Maximum and minimum Sand and dust values e.g. minimum and maximum air velocity and particle size shall be defined. Special precautions to prevent from damage either to subsystem or the platform (e.g. dust cover removal instant) shall be identified.

---------- Begin Example

The equipment does not suffer any degradation and is able to operate correctly during and after exposure to a sandy and dusty environment.

In detail, the equipment is not adversely affected when exposed to sand and dust levels 0.001-0.125 inch diameter particle size (0.00254-0.3175 mm), 100 knots relative velocity.

The subsystem performs without degradation after exposure to blowing sand in concentrations up to 1.03 grams per cubic meter, with particle sizes between 74 and 350 micrometers in diameter, and wind speeds up to 35 knots for a period of up to 90 minutes.

The subsystem performs without degradation after exposure to blowing dust in concentrations up to 1.03 grams per cubic meter, with particle sizes of less than 150 micrometers in diameter with 75 plus or minus 2 percent of the particles by weight less than 44 micrometers, and wind speeds, during tests, between 3 knots and 17 knots for 12 hours.

The subsystem performs without degradation after exposure to blowing sand in concentrations up to 1.03 grams per cubic meter, with particle sizes between 74 and 350 micrometers in diameter, and wind speeds up to 220 knots at angles of attack from 0 to 14 degrees for up to 120 seconds.

---------- End Example

7.2.13 Icing/Freezing Rain

Icing, the subsystem/platform can withstand/perform in with/without performance deviations or damage (i.e. definition to survive, operate or remain safe). Minimum/maximum measures for icing and freezing rain shall be defined. Special precautions to prevent from damage either to subsystem or the platform such as pre-mission de-icing shall be identified.

---------- Begin Example

Conditions:

25 mm/h for 10 min. (E 4.2 mm thickness built up over 10 minutes).

25 mm/h for 1 hr on airfield and handling

Pre-mission de-icing is required.

Note: During Air Carriage from Ma 0.5 to Ma 0.9 or more, the subsystem surface is heated and thus any ice build up, which has not previously been removed on the ground, will be thawed.

No structural or system failure will result from ice built up. Ice built up has to be removed prior to take off and further built up is prevented by aerodynamic heating. Removal of ice built up shall not damage the subsystem. Thus the requirements are considered compatible.

---------- End Example

7.2.14 Climatic Zones

The climatic zones the subsystem can survive, operate in or remain safe shall be defined.

---------- Begin Example

The platform and subsystem are capable of operation in climatic zones A1, A2, A2. C0, C2 as defined in STANAG 2895, Annex A.

---------- End Example

7.2.15 Vibration

Vibration levels the subsystem/platform can withstand/perform in with/without performance deviations or damage (i.e. definition to survive, operate or remain safe). Maximum and minimum vibration peak values in accordance with defined vibration profiles shall be given. Special precautions to prevent from damage either to subsystem or the platform shall be identified.

---------- Begin Example

The equipment withstands the following conditions

Power Spectrum:

ωomax(Functional)=0.04 g2/Hz)

ωomax(Endurance; 1hr)=0.18 g2/Hz

Duration: 1.0 hour per axis (3 axis)

and with the vibration test spectrum as defined in the following FIGURE 38:

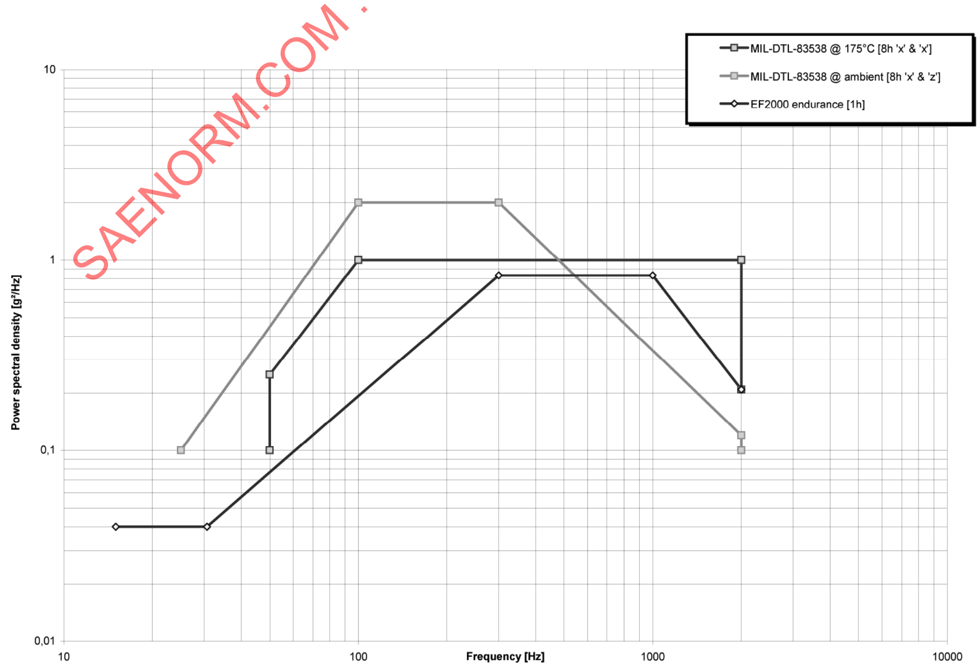


FIGURE 38 – VIBRATION LEVELS

---------- End Example

7.2.16 Gunfire Vibration

Gunfire vibration levels the subsystem/platform can withstand/perform in with/without performance deviations or damage (i.e. definition to survive, operate or remain safe). Maximum and minimum gunfire vibration values caused by the on-board gun of the platform shall be defined. Special precautions to prevent from damage either to subsystem or the platform shall be identified.

---------- Begin Example

The Gunfire Vibration Test is performed to assure that equipment mounted in an platform or extend the platform structure with onboard guns (i.e. conformal equipment) can withstand the vibration levels caused by the overpressure pulses emitting from the gun nozzle. FIGURE 39 shows the vibration spectrum.

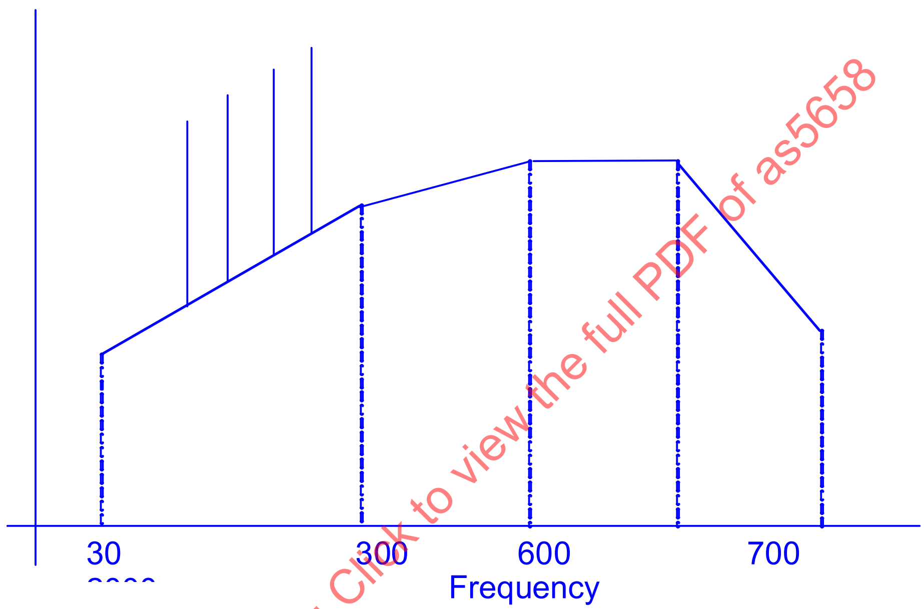


FIGURE 39 – GUNFIRE VIBRATION

---------- End Example

7.2.17 Mechanical Shock

Mechanical shock the subsystem/platform can withstand/perform in with/without performance deviations or damage (i.e. definition to survive, operate or remain safe). Shock values to sustain continued operation and performance e.g. during a defined number of arrested landings or catapult launches or hard landings shall be defined. Special precautions to prevent from damage either to subsystem or the platform shall be identified.

---------- Begin Example

The Equipment withstands the relatively infrequent non-repetitive shock or transient vibrations encountered in handling, transportation and service environments.

Shock response spectrum requirement:

Two half sine shock pulse with a peak value of 300 m/s² (30 g) and a duration of

2.5 ms and with a peak value of 75 m/s² (7-5 g) and a duration of 40 ms are considered to cover the requirements.

Three shock pulses per test direction and shock type are required to qualify the equipment for in-service use.

---------- End Example

7.2.18 Acoustic Noise

Acoustic noise, the subsystem/platform can withstand/perform in with/without performance deviations or damage (i.e. definition to survive, operate or remain safe). Maximum and minimum acoustic noise values and defined noise spectrum shall be specified. Special precautions to prevent from damage either to subsystem or the platform shall be identified.

---------- Begin Example

The equipment shall suffer no degradation and meet the requirements when subjected to the acoustic noise environment with the following Functional and Endurance spectra (see also FIGURE 40):

a. Functional Spectrum

Flat spectrum, with a constant 1/3 octave band level of 148 dB, in the frequency range 125-2500 Hz

1/3 octave band level reduction, with a 3 dB/octave slope, up to 8000 Hz and down to 100 Hz

For testing purpose the functional spectrum shall applied ½ hour before and after the execution of the Endurance Spectrum

b. Endurance Spectrum

Flat spectrum with a constant 1/3 octave band level of 153 dB, in the frequency range 125-2500 Hz

1/3 octave band level

The application time of endurance spectrum, for testing or fatigue analysis purpose is 3 hours. Levels may be reduced increasing the application time according to the following equation:

LI = L0+2.5 Log (T0=/TI)

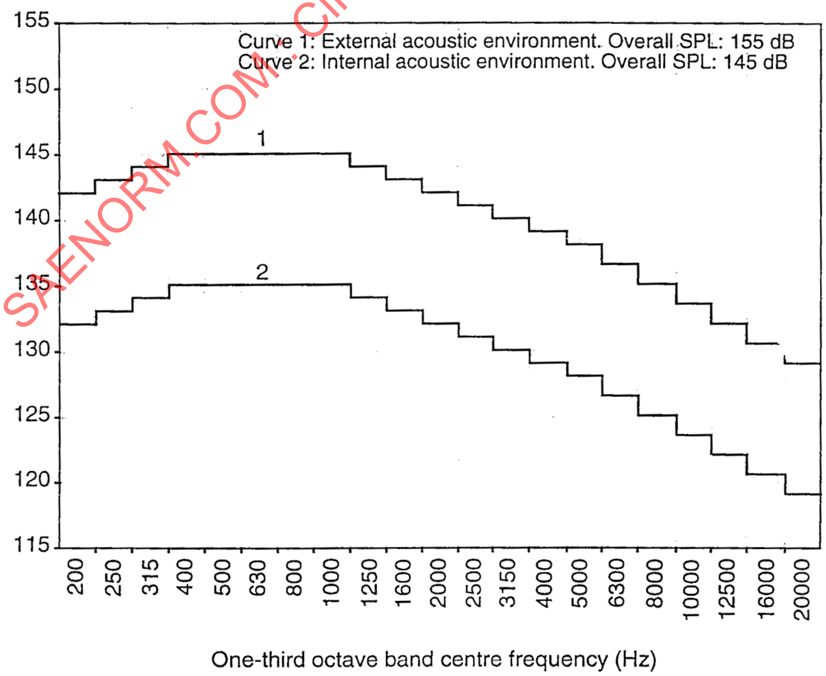


FIGURE 40 – ACOUSTIC NOISE SPECTRUM

---------- End Example

7.2.19 Linear Acceleration

Linear Acceleration the subsystem/platform can withstand/perform in with/without performance deviations or damage (i.e. definition to survive, operate or remain safe). Maximum and minimum linear acceleration values shall be defined. Special precautions to prevent from damage either to subsystem or the platform shall be identified.

---------- Begin Example

The Equipment/Subsystem shall suffer no degradation when exposed to the following accelerations.

Design Factors of Safety (FS) for all operational phases of the subsystem are established as follows:

During flight prior to the point at which structural failure of the subsystem would no longer endanger the platform

Ultimate FS = xyz

Yield FS = xyz

The platform requirement is that the equipment must (I) survive and be fully functional afterwards and (II) operate with full performance under these conditions with the following g levels:

TABLE 12 – LINEAR ACCELERATION LEVELS FOR SURVIVE AND OPERATE REQUIREMENTS

	Fore	Aft	Lat	Up	Down
I	4.7	4.7	14.1	19.8	14.6
II	3.6	3.6	10.8	15.2	11.3

Compatibility Statement: The subsystem test values are not fully compatible with the platform requirements. Analysis for flight conditions shall take place against actual platform loads.

---------- End Example

7.2.20 Angular Motion, Acceleration and Angular Rates

Angular motion, angular acceleration and angular rates the subsystem/platform can withstand/perform in with/without performance deviations or damage (i.e. definition to survive, operate or remain safe). Maximum and minimum angular motion, acceleration and angular rates shall be defined. Special precautions to prevent from damage either to subsystem or the platform shall be identified.

---------- Begin Example

In conjunction with the definition of the air carriage loads for carriage envelope, the platform and subsystem are capable of operation up to the maximum values for angular motion as defined in TABLE 13:

TABLE 13 – ANGULAR RATES AND ACCELERATIONS

Angular Rates		Angular Accelerations	
Pitch	± x r/s	Pitch	± x r/s^2
Roll	± x r/s	Roll	± x r/s^2
Yaw	± x r/s	Yaw	± x r/s^2

---------- End Example

7.2.21 Radiation (nuclear)

Nuclear Radiation, the subsystem/platform can withstand/perform in with/without performance deviations or damage (i.e. definition to survive, operate or remain safe). Maximum, minimum nuclear radiation values shall be defined. Special precautions to prevent from damage either to subsystem or platform shall be defined. If the platform or subsystem is designed to survive in a nuclear environment this is the paragraph to describe the environment.

---------- Begin Example

Nuclear Electromagnetic Pulse Requirements

The Equipment has to fulfill the requirement of the peculiar platform requirement.

Requirements to be applied for are in accordance with

- NEMP 1 Nuclear Electromagnetic Pulse, Current Injection Test requirements

Nuclear Hardening Requirements as well as test requirements – defined for platform – are specified in a dedicated Specification.

---------- End Example

7.2.22 X-Ray Emissions

X-ray emissions a subsystem/platform can withstand/perform in with/without performance deviations or damage (i.e. definition to survive, operate or remain safe). Maximum values shall be defined. Special precautions to prevent damage either to the subsystem or the platform shall be identified.

---------- Begin Example

Whenever the equipment is being operated on the platform, it shall not radiate X-ray energy greater than 0.5 milli-roentgens when measured at 5 cm from the surface of the equipment.

---------- End Example

7.2.23 Explosive Atmosphere

Explosive atmosphere, the subsystem/platform can withstand/perform in with/without performance deviations or damage (i.e. definition to survive, operate or remain safe). Maximum and minimum explosive atmosphere values including the definition of the explosives and the explosive fuel used shall be defined. Special precautions to prevent from damage either to subsystem or the platform shall be identified.

---------- Begin Example

The subsystem is constructed such that it does not produce internal or external arcs and/or sparks, during normal operation, unless these are contained within a hermetically sealed case.

If this is not possible the supplier shall prove the ability of his equipment to operate in an explosive atmosphere as defined by FIGURE 41 without causing an explosion.

$$\text{Volume of 95 percent n-hexane (ml)} =$$

$$\left(4.27 \text{ x } 10^{-4}\right)\left[\frac{(\text{net chamber vol}(\text{liters})) \text{ x } (\text{chamber pressure}(\text{pascals}))}{(\text{chamber temp}(\text{K})) \text{ x } (\text{specific gravity of n} - \text{hexane})}\right]$$

FIGURE 41 – COMPOSITION OF EXPLOSIVE ATMOSPHERE

Qualification is in accordance to a peculiar platform environmental requirement.

---------- End Example

7.2.24 Contamination

Contamination, in which the subsystem/platform can withstand/perform in with/without performance deviations or damage (i.e. definition to survive, operate or remain safe). Maximum and minimum contamination values shall be defined. These could be contamination caused by corrosive fluids like hydraulic fluid, de-icing fluid etc. These corrosive fluids may be defined in a table together with the concentration limits specifying margins for equipment deterioration and corrosion. Special precautions to prevent from damage either to subsystem or the platform shall be identified.

---------- Begin Example

The subsystem shall operate after exposure to the contamination sources listed in TABLE 14.

TABLE 14 – CONTAMINATION SOURCES

Equivalent National Specification	No	Fluid	NATO Code
AA-M-C 142(n) AA-M-C 141(d)	1 2	FUEL	F.40 F.34
AA-M-O 216 g	3	HYDRAULIC FLUID	H.515
MIL-S-8802 B	4	CABIN and FUEL TANK SEALING COMPOUND	------
	5	FIRE EXTINGUISHANT	------
	6	ENGINE & GEARBOX OIL	0160
TT-I-735(a) Am 2 (Grade B) O-M-232(e) Am.1 (Grade A)	7 8 9 10	DE-ICING FLUID	S 737 S 747
MIL-STD-810E Method 509.3	11	Sea Water	

---------- End Example

7.2.25 Bio and Chemical Hardening

Required bio and chemical hardening with which the subsystem/platform is able to withstand/perform in a bio or chemical environment with/without performance deviations or damage (i.e. definition to survive, operate or remain safe) shall be defined. Maximum and minimum hardening values shall be defined. Special precautions to prevent damage either to the subsystem or the platform shall be identified.

---------- Begin Example

The life and operation of the platform and subsystem are not adversely affected by exposure to the following contaminants, subject to completion of the routine maintenance procedures defined in Document xxx:

---------- End Example

7.2.26 TEMPEST

Tempest is a U.S. government code word that identifies a classified set of standards for limiting electric or electromagnetic radiation emanations from electronic equipment. If required, the ICD shall define specific measures to prevent inadvertent emissions.

---------- Begin Example

The interface shall be designed in a way to comply with the national tempest requirements. Bonding and shielding have to comply with MIL-STD-xyz. The equipment shall be designed and tested to the requirements of AMSG-720B or AMSG-788 as appropriate. As these requirements are usually classified, a specific example is NOT included here.

---------- End Example

7.2.27 Nuclear Biological Chemical (NBC) De-contamination

NBC decontamination impact on the subsystem design and the interface shall be defined in this paragraph.

---------- Begin Example

As applicable, equipment design shall be compatible with NBC protection and shall permit performance of mission-essential operations, communications, maintenance, resupply and decontamination tasks by suitably clothed, trained, and acclimatized personnel for the survival periods and NBC environments required by the system. Equipment design shall also facilitate NBC hardness surveillance and shall minimize susceptibility to reduction of inherent NBC hardness as a result of operator- or maintainer-induced errors/damage, i.e.:

a. NBC hardness shall be easily verifiable by maintenance personnel before and after maintenance actions (hardness surveillance).

b. NBC hardness shall not be degraded when routine (scheduled) and corrective (unscheduled) maintenance are performed.

c. Maintenance of the equipment's inherent NBC hardness shall not be dependent on maintenance personnel expertise and critical alignments/maintenance actions.

---------- End Example

7.3 Electromagnetic Environmental Effects (E3):

Describes the electromagnetic radiation the subsystem/platform can withstand/perform in with/without performance deviations or damage. Maximum and minimum electromagnetic radiation values, frequency ranges, field strength and electrical characteristics shall be defined. Special precautions to prevent from damage either to subsystem or the platform shall be identified. If the platform or subsystem is required to survive high electromagnetic radiation then this paragraph will define this environment. Specific data to define electromagnetic environmental effects or to prevent from electromagnetic influence shall be addressed. Where applicable reference shall be made to available standards.

---------- Begin Example

Electromagnetic Compatibility Specification for Equipment

MIL-STD-461	Electromagnetic Interference Characteristics, Requirements for Equipment
MIL-STD-462	Electromagnetic Interference Characteristics, Measurements of
MIL-STD-463	Definition of Systems and Units, Electromagnetic Interference Technology
Defense Standard 59-41	(1986) Parts I-III Electromagnetic Compatibility of Equipment
MIL-STD-831	Test Reports, Preparation of
MIL-STD-1757A	Lightning Qualification Test Techniques for Aerospace Vehicles
MIL-B-5087	Bonding Electrical Lightning Protection

---------- End Example

7.3.1 Conducted Emissions, Power Lines

The limits of conducted emissions and limits for power leads shall be defined in this section. If appropriate, a compatibility statement can be given.

---------- Begin Example

The conducted emissions on all power leads to and from the subsystem shall not exceed the limits specified in FIGURE 42 within the bandwidth 20 Hz to 100 MHz. The limits are comparable with MIL-STD 461C, CE01 and CE03.

Compatibility Statement:

Not required.

---------- End Example

7.3.2 Conducted Emissions, Control and Signal Lines

The limits of conducted emissions and limits for control and signal lines shall be defined in this section. If appropriate, a compatibility statement can be given.

---------- Begin Example

The conducted emissions on all control and signal lines to and from the subsystem shall not exceed the limits specified in FIGURE 42 within the bandwidth 20 Hz to 100 MHz. The limits are comparable with MIL-STD 461C, CE01 and CE03.

Compatibility Statement:

Not required.

---------- End Example

7.3.3 Exported Spikes and Transients

Limits for spikes and transients are addressed in this section. If appropriate, a compatibility statement can be given.

---------- Begin Example

The amplitude and duration of transients appearing on DC power leads shall not exceed the limits specified FIGURE 43.

Compatibility Statement:

Not required.

---------- End Example

7.3.4 Radiated Emissions, Electric Field

Limits for radiated emissions and the electric field around the interface shall be specified over a defined frequency range. If appropriate, a compatibility statement can be given.

---------- Begin Example

The electric field emissions from the subsystem including interconnecting cables shall not exceed the limits specified in FIGURE 44 when using a bandwidth between 50 kHz to 18 GHz. The limits are comparable with MIL-STD 461C, RE02, Curve #2.

Compatibility Statement:

Not required.

---------- End Example

7.3.5 Conducted Susceptibilities, Power Leads

Limits for conducted susceptibility shall be defined. If appropriate, a compatibility statement can be given.

---------- Begin Example

The subsystem shall operate when subjected to continuous wave signals using the frequencies from 20 Hz to 50 kHz and amplitudes shown in FIGURE 45. The signals are comparable to MIL-STD 461C, CS01. The subsystem shall remain safe when the voltage limit is increased by 6dB.

Specification requires the subsystem to retain its full performance during and after encountering the EMC environment. With the enhanced voltage limits (+6 dB) the subsystem is allowed to go into a fail-safe state and shall revert to full performance after removal of the enhanced voltage limits.

Compatibility Statement:

Not required.

---------- End Example

7.3.6 Bulk Current Injection Test

If a bulk current injection test is required, the limits for the injected current into e.g. a cable shall be defined. If appropriate, a compatibility statement can be given.

---------- Begin Example

The subsystem shall operate when subjected to signals specified FIGURE 46 and FIGURE 47 for “Non-safety Critical Equipment“ (Bulk Current Injection Method). The bandwidth used shall be between 50 kHz and 400 MHz.

The subsystem shall remain safe when subjected to signals specified in FIGURE 46 and FIGURE 47 for “Safety Critical Equipment“ (Bulk Current Injection Method). The bandwidth used shall be between 50 kHz and 400 MHz.

The specification requires the subsystem to retain its full performance during and after encountering the EMC environment. With the enhanced voltage limits (+6 dB) the subsystem is allowed to go into a fail safe state and shall revert to full performance after removal of the enhanced voltage limits.

Compatibility Statement:

Not required.

---------- End Example

7.3.7 Imported Spikes and Transients

This section shall define imported spikes like waveform or values if applied to the power leads. If appropriate, a compatibility statement can be given.

---------- Begin Example

The subsystem shall operate when the transients defined in TABLE 15 and TABLE 16 of the spike waveform specified in FIGURE 48 are applied to the power leads. The signals are comparable to MIL-STD 461C, CS06.

Compatibility Statement:

Not required.

---------- End Example

7.3.8 Radiated Susceptibility, Magnetic Induction Field

This section shall define equipment behavior in case of radiated susceptibility in the presence of a magnetic field. The waveform and/or signal limits shall be defined. If appropriate, a compatibility statement can be given.

---------- Begin Example

The subsystem shall operate when subjected to the signal limits as specified below:

- Power Frequency Test (20 A/DC; 20 A/400 Hz)
- Spike Test (Spikes as defined in TABLE and FIGURE 48)

The requirements are comparable to MIL-STD 461C, RS02.

Compatibility Statement:

Not required.

---------- End Example

7.3.9 Radiated Susceptibility, Electric Field

This section shall define the behavior in case of radiated susceptibility in the presence of an electric field. The waveform and/or signal limits shall be defined. If appropriate, a compatibility statement can be given.

---------- Begin Example

The subsystem shall operate when subjected to the continuous and modulated signals specified in TABLE 17. The signal levels for the electric field continuous wave are specified in Table 7-14 . The bandwidth shall be 50 kHz to 40 GHz.

The subsystem, either operational or non-operational shall survive when subjected to the continuous and modulated signals specified in TABLE . The signal levels for the electric field continuous wave are specified in Table 18 column “Survive“. The bandwidth shall be 50 kHz to 18 GHz.

Note: Subsystem integration to specific platforms may require the increase of the bandwidth for this testing up to 40 GHz as well, in order to obtain full clearance levels.

Compatibility Statement:

Not required.

The subsystem, either operational or non-operational shall remain safe when subjected to the electric field as defined in STANAG 4234.

Compatibility Statement:

Not required.

---------- End Example

7.3.10 DC Magnetic Field Environment

This section defines the requirements for the equipment function in the presence of a close to DC magnetic field. If appropriate, a compatibility statement can be given.

---------- Begin Example

The subsystem shall remain safe and should survive magnetic fields of up to 800 A/m with a reversing polarity at a rate of field changes of 1600 A/m/sec. The frequency is less than 1 Hz. During exposure to the magnetic fields the non-operational subsystem is stored in the closed container.

Compatibility Statement:

Not required.

---------- End Example

7.3.11 Compass Safe Distance

Compass safe distance is used to describe possible mutual influence of inertial equipment caused by electromagnetic radiation. If appropriate, a compatibility statement can be given.

---------- Begin Example

The magnetic field emitted by the operational or non-operational subsystem shall not cause a compass deviation of more than x° when measured 1m away from the outer surface.

The compass safe distance of the subsystem does not exceed 1 m when measured in accordance with document RTCA/DO-160C, section 15 Environmental Conditions and Test Procedures for Airborne Equipment.

Compatibility Statement:

Not required.

---------- End Example

7.3.12 EMP

This section shall specify the robustness of the subsystem or equipment against EMP. It shall also include values for EMP caused by nuclear explosion. If appropriate, a compatibility statement can be given.

---------- Begin Example

The subsystem shall operate in the free field EMP environment according to FIGURE 51 without degradation.

The subsystem shall survive electromagnetic fields 50% above the maximum level in FIGURE 51. It shall remain safe for electromagnetic fields exceeding the operational levels FIGURE 51 by 500%.

Compatibility Statement:

Not required.

---------- End Example

7.3.13 Conducted Emissions, Antenna Terminal

This section shall specify tolerable emissions at the receiver inputs (antenna terminals) in the different modes (receive or transmit). If appropriate, a compatibility statement can be given.

---------- Begin Example

The conducted emissions appearing at the antenna terminals of receivers and transmitters (F0 < 1.2 GHz) shall be measured. Within the bandwidth 14 kHz to 40 GHz the measured emissions shall not exceed the following limits:

- Receiver/transmitter in standby mode:xydBµV
- Transmitter in transmit mode FIGURE 49

This requirement is identical to MIL-STD-461C, CE06 and MIL-STD-461D, CE106.

Compatibility Statement:

Not required.

---------- End Example

7.3.14 Spurious and Harmonic Emissions

A transmitter shall not exceed the transmission values specified in this section. If appropriate, a compatibility statement can be given.

---------- Begin Example

The radiated emissions transmitted via the antenna of transmitters (F0 > 1.2 GHz) within the bandwidth 14 kHz to 40 GHz shall not exceed the limits specified FIGURE 49. This requirement is identical to MIL-STD-461C, RE03 and MIL-STD-461D, RE103.

Compatibility Statement:

Not required.

---------- End Example

7.3.15 Inter-Modulation

This section shall specify maximum values for any inter-modulation products between different signals generated during the operation of equipment or subsystems. If appropriate, a compatibility statement can be given.

---------- Begin Example

The presence of inter-modulation products from two signals shall be determined at receivers and tuned amplifiers operating in the frequency range of 1 MHz to 40 GHz.

Inter-modulation products from two signals shall not be present in the frequency range of 30 Hz to 40 GHz at specified frequencies and out put levels of 2 signal generators when

- Signal generator 1 is set to 66 dB above the level obtained to produce the standard reference output.
- Signal generator 2 is set to 66 dB above the level obtained to produce the standard reference output

This requirement is identical to MIL-STD-461C, CS03 and MIL-STD-461D, CS103.

Compatibility Statement:

Not required.

---------- End Example

7.3.16 Rejection of Unwanted Signals

The subsystem or equipment shall be able to suppress unwanted signals in accordance with the values specified in this section. If appropriate, a compatibility statement can be given.

---------- Begin Example

The presence of input terminal spurious responses using two signals shall be determined at receivers and tuned amplifiers operating in the frequency range of 1 MHz to 40 GHz. The subsystem shall not exhibit any undesired responses when subjected to the test signal specified in FIGURE 50. This requirement is identical to MIL-STD-461C, CS04 and MIL-STD-461D, CS104.

Compatibility Statement:

Not required.

---------- End Example

7.3.17 Cross-Modulation

This section shall specify maximum values for any cross-modulation products between different signals generated during the operation of equipment or subsystems. If appropriate, a compatibility statement can be given.

---------- Begin Example

The presence of cross modulating products using two signals shall be determined at receivers and tuned amplifiers operating in the frequency range of 30 Hz to 40 GHz. The subsystem shall not exhibit due to cross-modulation any malfunction, degradation or deviation from specified value with 2 signal generators running at frequencies adjusted to f1 = fo and f2 = fo + IF and output levels adjusted to Out1 = 10 dB; Out2 = 66 dB above the level obtained to produce the standard reference output. This requirement is identical to MIL-STD-461C, CS05 and MIL-STD-461D, CS105.

Compatibility Statement:

Not required.

---------- End Example

7.3.18 Electrostatic Discharge

Means to allow for/prevent from electrostatic discharge/charge shall be defined in this section. If appropriate, a compatibility statement can be given.

---------- Begin Example

Bare subsystem

The subsystem shall not be damaged nor become unsafe when exposed to a discharge of 25 kV from a 100 pF capacitor through a 1500 ohm resistor (human body model) to the equipment case or structure.

Connector Contacts

Connector contacts exposed during flight line maintenance or ground handling shall withstand a discharge of 4 kV from a 100 pF capacitor through a 1500 ohm resistor without damage to the subsystem.

See also TABLE 19

Compatibility Statement:

Not required.

---------- End Example

7.3.19 Lightning Protection

Description of special measures for the subsystem and/or the platform to protect against lightning strikes shall be included here. Data may contain maximum voltage or current levels, electrical field strength, etc, which can be withstood by the subsystem or the platform in conjunction with applicable protection measures.

If appropriate, a compatibility statement can be given.

---------- Begin Example

Dedicated to platform requirements, for example

Platform EMC Specification to be applied with test requirements

- LEMP 1 Lightning, Slow Pulse Test
- LEMP 2 Lightning, Fast Pulse Test

The subsystem shall comply with direct lightning effects in FIGURE 52, with indirect lightning effects in FIGURE 53 and Table 20 and for near lightning effects in TABLE 21.

Compatibility Statement:

Not required.

---------- End Example

Figures for E3 Subsection

The tables can be included in a separate section if required. The arrangement of the figures and tables in the ICD is to the authors discretion.

---------- Begin Example

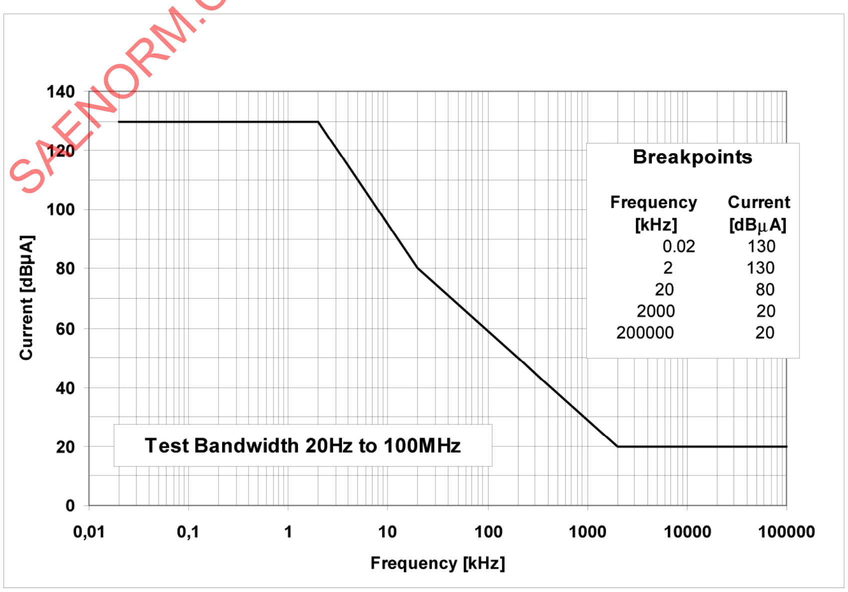


FIGURE 42 – CONDUCTED EMISSIONS, LIMITS FOR POWER LEADS/CONTROL AND SIGNAL LINES

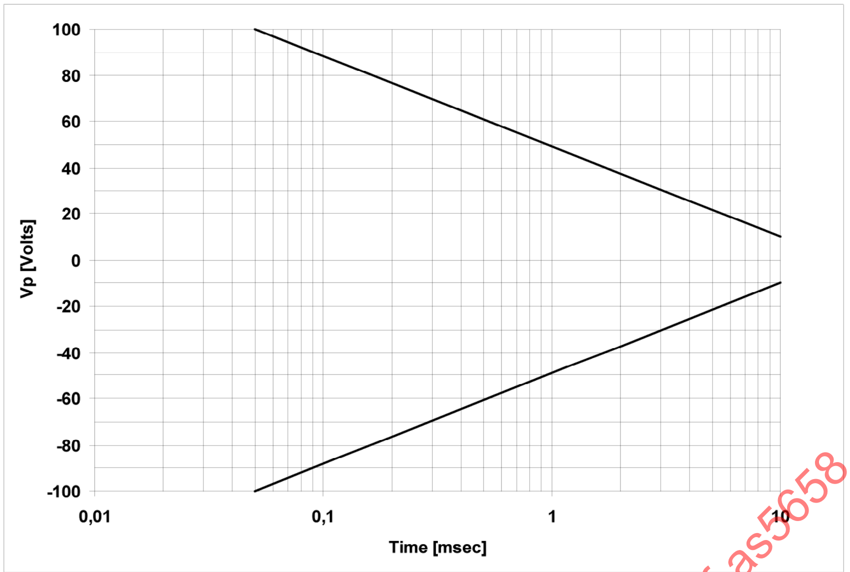


FIGURE 43 – CONDUCTED EMISSIONS, LIMITS FOR 28 VOLT DC SUPPLY LEADS

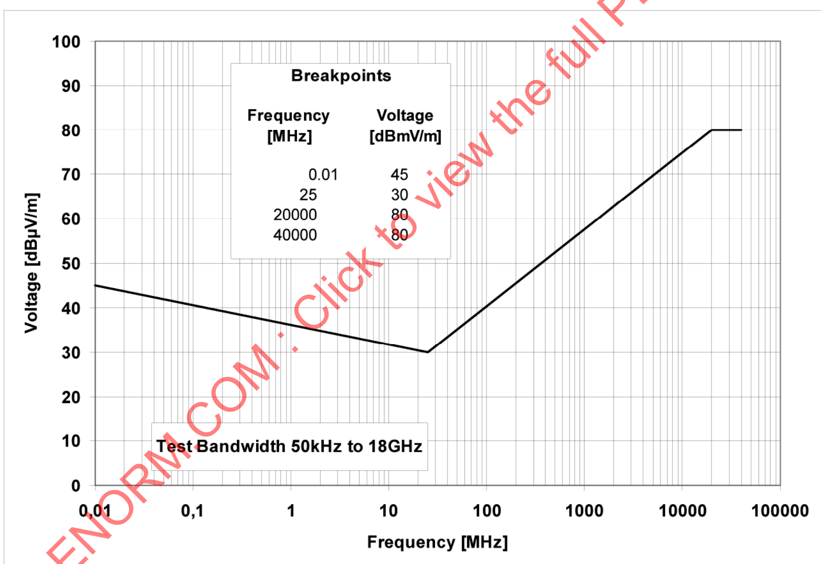


FIGURE 44 – LIMITS FOR RADIATED EMISSION, ELECTRIC FIELDS

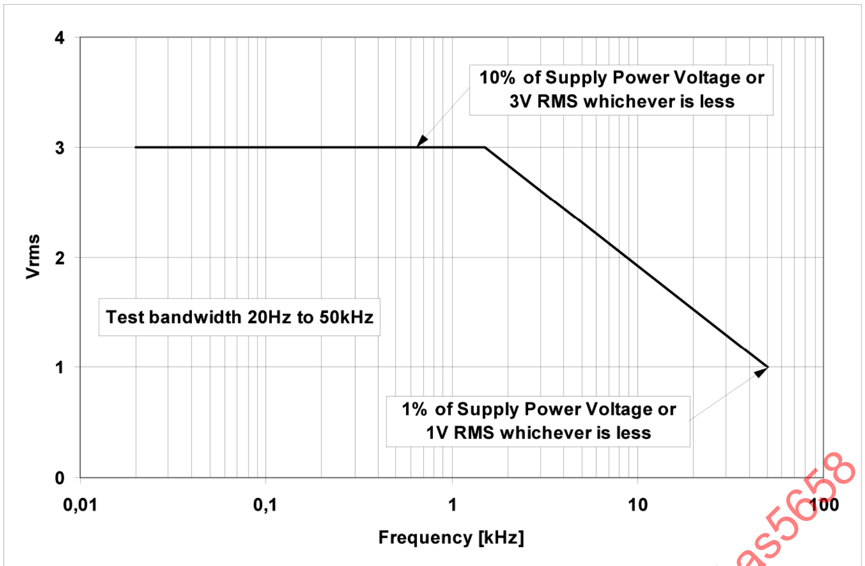


FIGURE 45 – LIMITS FOR CONDUCTED SUSCEPTIBILITY, POWER LEADS

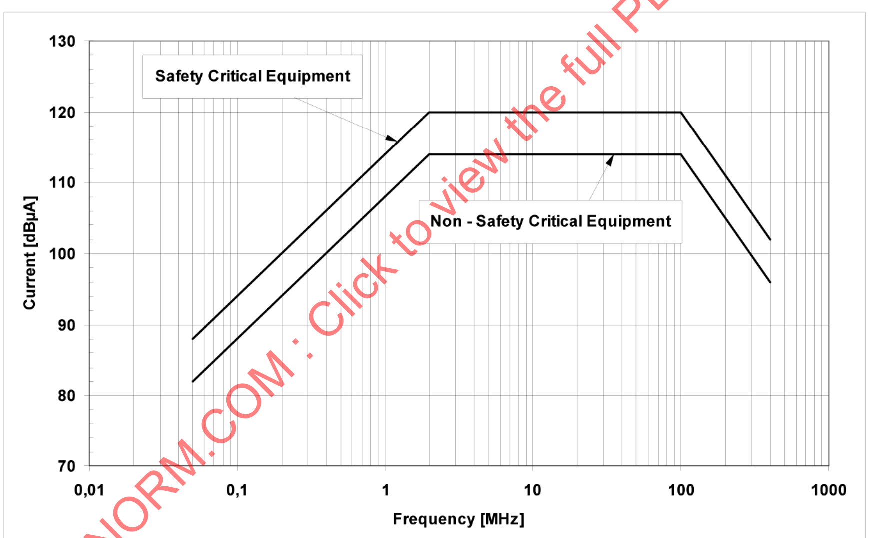


FIGURE 46 – LIMITS OF CURRENT INJECTED INTO CALIBRATION JIG DURING CALIBRATION

FIGURE 47 – LIMITS OF CURRENT INJECTED INTO A CABLE DURING TEST

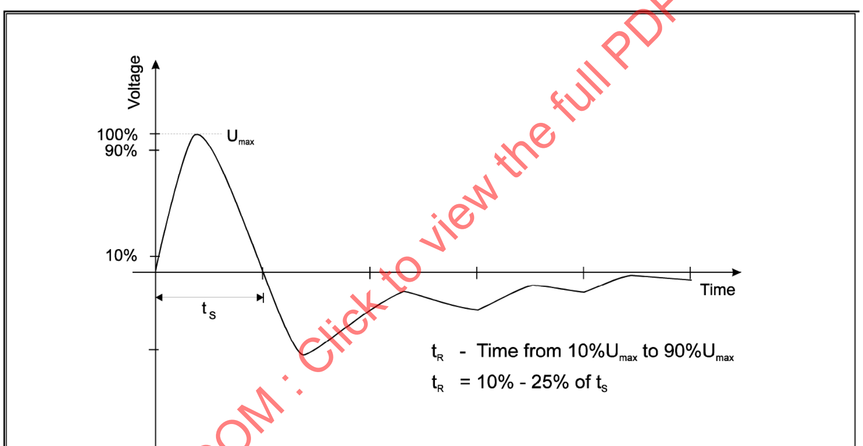


FIGURE 48 – TYPICAL SPIKE WAVE FORM, CONDUCTED SUSCEPTIBILITY

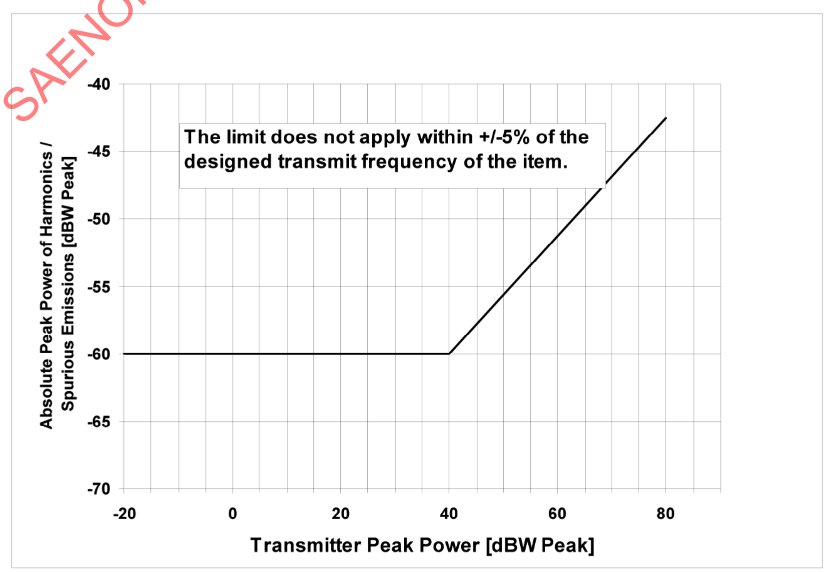
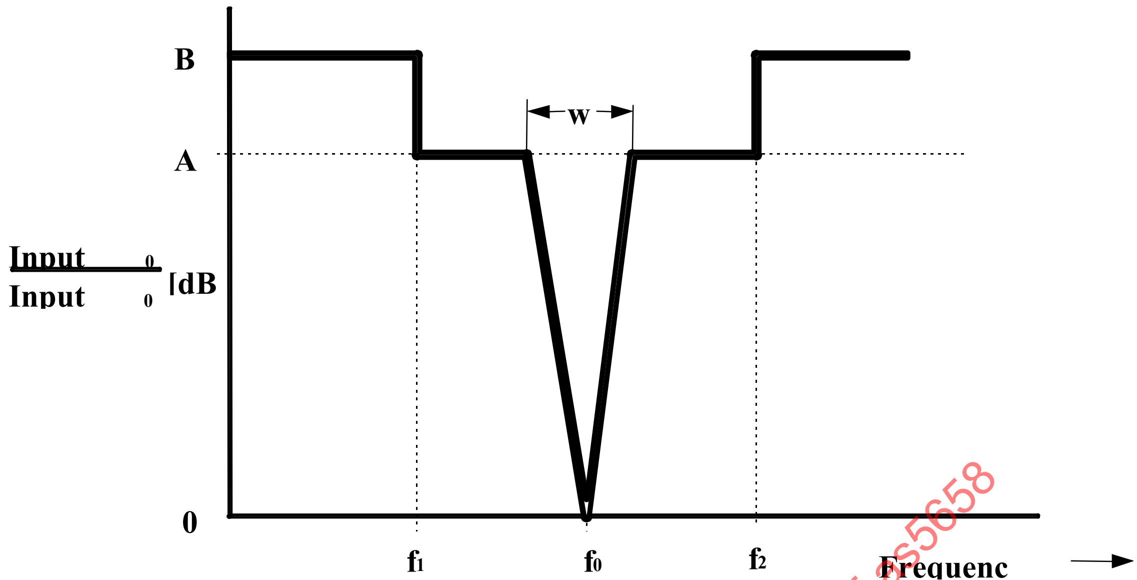


FIGURE 49 – LIMITS OF TRANSMITTER/RECEIVER EMISSIONS



f0 Selected frequency (defined in the subsystem's test plan); if no worst case frequency anticipated select band center.

f1 Lowest tunable frequency of receiver band in use or lowest frequency of transmitter passband

f2 Highest tunable frequency of receiver band in use or highest frequency of transmitter passband

w Band of frequency excluded from the test defined by the bandwidth between the 80 dB points of the receiver selectivity curve; if not specified use f0+/-5%.

Limits:

1. The limit at A is 66 dB above the input level required to produce the standard reference output. This limit shall not be used for transmitters.

2. The limit B shall be 0d Bm applied directly to the input terminals.

FIGURE 50 – SIGNALS FOR TRANSMITTER/RECEIVER TEST CONDUCTED SUSCEPTIBILITY

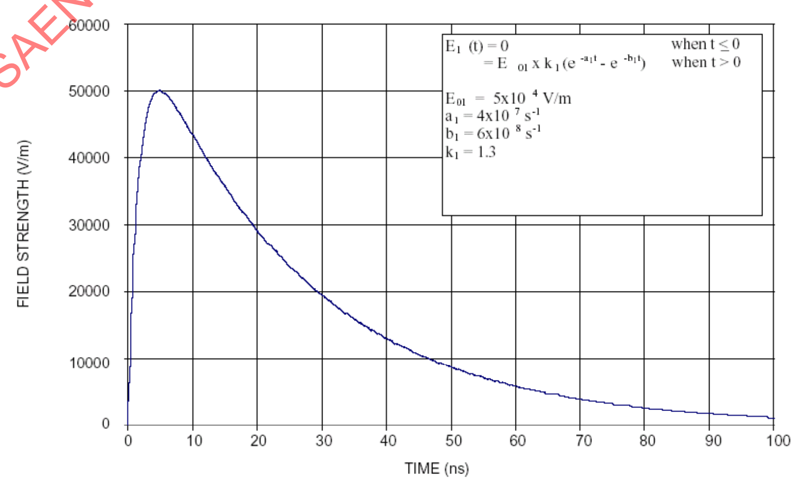


FIGURE 51 – FREE-FIELD EMP ENVIRONMENT

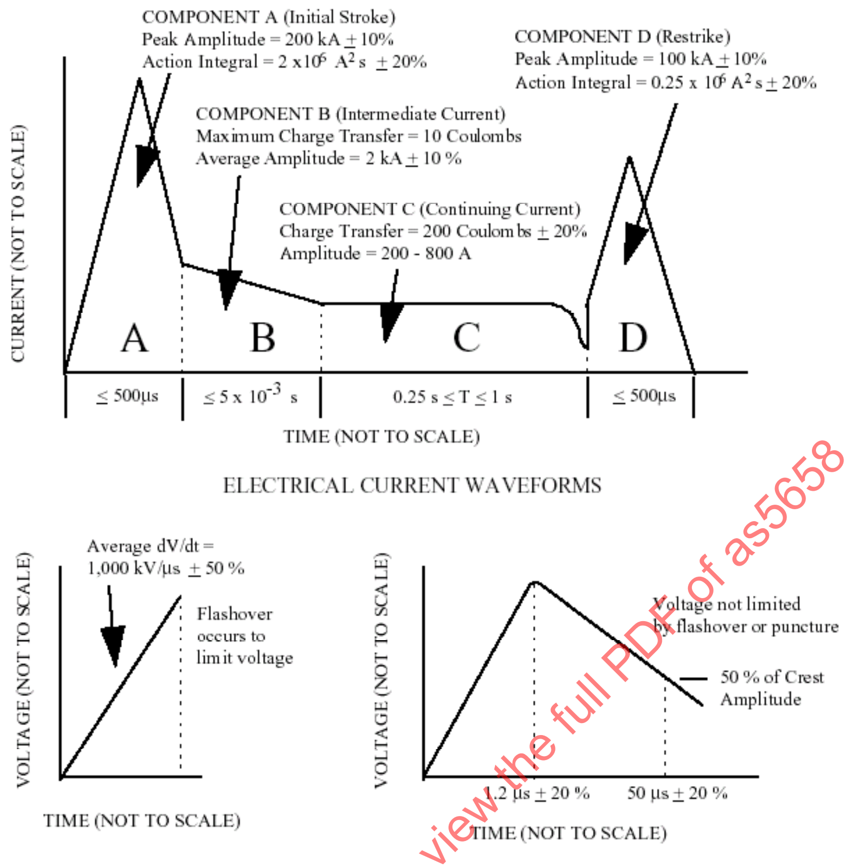


FIGURE 52 – LIGHTNING DIRECT EFFECTS ENVIRONMENT

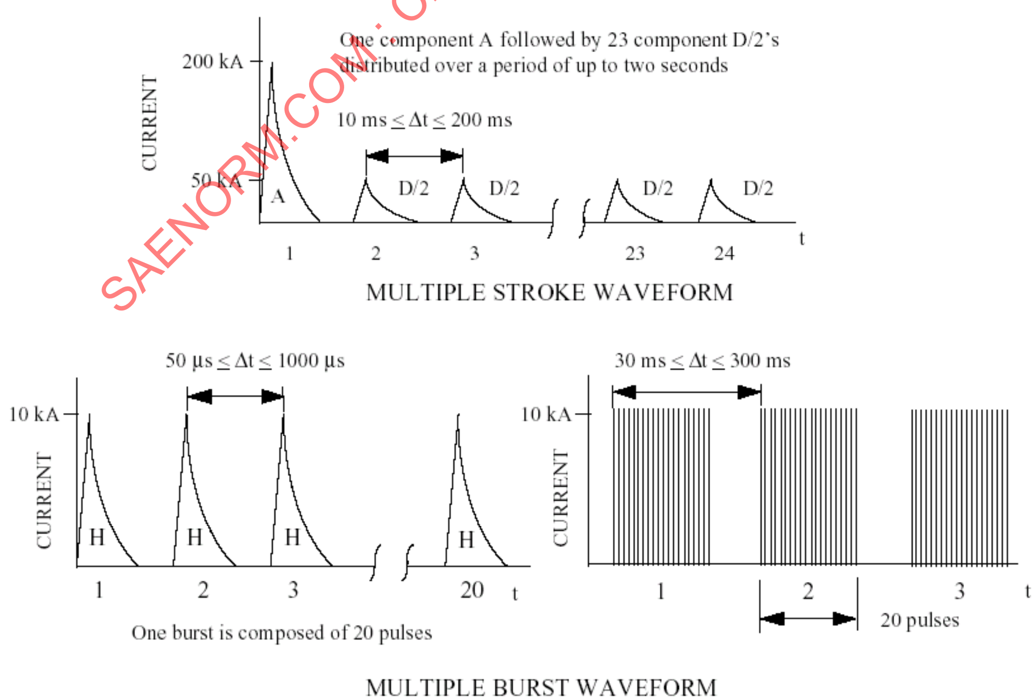


FIGURE 53 – LIGHTNING INDIRECT EFFECTS ENVIRONMENT

---------- End Example

7.3.20 Tables for E3 Subsection:

---------- Begin Example

TABLE 15 – SPIKES, CONDUCTED SUSCEPTIBILITY

	U_{max}	t_S
	28 V DC Lines	
Slow Spike	+/-220 V	10 µsec
Fast Spike	+/-470 V	150 nsec

TABLE 16 – SPIKES, RADIATED SUSCEPTIBILITY

	U_{max}	t_S
	28 V DC Lines	
Slow Spike	+/-100 V	10 µsec
Fast Spike	+/-250 V	150 nsec

TABLE 17 – ELECTRIC FIELD CONTINUOUS WAVE CHARACTERISTICS

	Electric Field [V/m]	
Frequency Range	**Operate**	**Survive**
20 kHz - 1 GHz	200	200
1 GHz - 18 GHz	200	600
18 GHz - 40 GHz	200	600
NOTE:If higher peak values at certain frequencies are required for individual sections or units of the subsystem the applicable electric fields are defined in the relevant specifications.		

Note: If higher peak values at certain frequencies are required for individual sections or units of the subsystem the applicable electric fields are defined in the relevant specifications.

TABLE 18 – MODULATION CHARACTERISTICS

Frequency Range [kHz]	Signal Characteristic/Modulation Type
50 kHz - 2 MHz	1. Continuous Wave 2. Amplitude Modulation, 100% square wave at 1 kHz pulse repetition frequency
2 MHz - 30 MHz	1. Continuous Wave 2. Amplitude Modulation, 100% square wave at 1 kHz pulse repetition frequency 3. Amplitude Modulation, 100% square wave at 1-3 Hz pulse repetition frequency
30 MHz - 1 GHz	1. Continuous Wave 2. Amplitude Modulation, 100% square wave at 1 kHz pulse repetition frequency
150 MHz - 225 MHz 580 MHz - 610 MHz 790 MHz - 1 GHz 1 GHz - 40 GHz	1. Continuous Wave 2. 100% Pulse Modulation, 1 kHz pulse repetition frequency, 1 µs pulse width, 3. Double Modulation consisting of 100% pulse modulation with pulse repetition frequency of 1 kHz (+/0.1 kHz) with a pulse duration of 1 µs (+/- 0.1 µs) together with a square wave modulation at 100% with a frequency of 0.5 (+/- 0.1) Hz

TABLE 19 – ELECTROSTATIC DISCHARGE PARAMETERS ACCORDING TO STANAG4235

ESD Parameters				
Applicability	**Voltage**	**Capacitance**	**Resistance**	**Discharge Inductance**
on outside contour of container with non-operational subsystem stored inside	300 kV	1000 pF	≤1.0 Ohm	<20 µH
on operational and non-operational subsystem and components	25 kV	500 pF	500 Ohm	<5 µH

TABLE 20 – LIGHTNING INDIRECT EFFECTS WAVEFORM PATTERNS

Current Component	Description	$i(t) = I_o (\varepsilon^{-\alpha t} - \varepsilon^{-\beta t})$ t is time in seconds (s)		
		I_o (Amperes)	α (s^{-1})	β (s^{-1})
A	Severe stroke	218,810	11,354	647,265
B	Intermediate current	11,300	700	2,000
C	Continuing current	400 for 0.5 s	Not applicable	Not applicable
D	Restrike	109,405	22,708	1,294,530
D/2	Multiple stroke	54,703	22,708	1,294,530
H	Multiple burst	10,572	187,191	19,105,100

TABLE 21 – ELECTROMAGNETIC FIELDS FROM NEAR STRIKE LIGHTNING

Magnetic field rate of change @ 10 meters	2.2×10^9 A/m/s
Electric field rate of change @ 10 meters	6.8×10^{11} V/m/s

---------- End Example

7.4 Subsystem Life Constraints:

The subsystem life in the various conditions e.g. during storage or carriage flights shall be listed in this section. Any restrictions or investigative analysis shall be defined.

---------- Begin Example

Using the sortie profiles defined in document xxx, the air carriage life of the subsystem is xxx hours. The subsystem is carried conformal with parts of it exposed to the airflow and to other external environmental influences.

---------- End Example

8. PILOT VEHICLE INTERFACE

Pilot Vehicle Interface (PVI) considers the design and relationship regarding the function and physical aspects of the subsystem in relation to the operator of the platform, whether manned or unmanned. Examples used were taken from MIL-STD-1472.

---------- Begin Example

8.1 Control-Display Integration.

8.1.1 General Criteria

Relationship: The relationships of a control to its associated display and the display to the control shall be immediately apparent and unambiguous to the operator.

Design: Control-display relationships shall be apparent through proximity, similarity of groupings, coding, framing, labeling, and similar techniques.

Complexity and precision: The complexity and precision required for manipulating controls and monitoring displays shall be consistent with the precision required of the system. Control-display complexity and precision shall not exceed the operator's capability to discriminate display detail or manipulate controls (in terms of manual dexterity, coordination or reaction time) under the dynamic conditions and environment in which human performance is expected to occur.

Feedback: There should be no discernible time lag between a change in a system condition being controlled or monitored and its indication on a display. If there is a time lag between control actuation and ultimate system state, the system should provide immediate feedback to the user of the process and direction of parameter change. Feedback shall be intrinsic or extrinsic to indicate (without ambiguity, uncertainty, or error) to the operator that the control is properly actuated, that the desired response is achieved, and when the desired response is complete.

Simultaneous access: If more than one crew member must have simultaneous access to a group of controls or displays to ensure proper functioning of a system or subsystem, each operator assigned to control and monitor a function or group of related functions shall have physical and visual access to all controls, displays, and communication capability necessary to adequately perform the assigned tasks.

8.1.2 Position Relationships

Functional grouping: Functionally related controls and displays shall be located close to each other and arranged in functional groups, e.g., power, status, and test.

Sequence: Functional groups of controls and displays shall be located to provide for left-to-right (preferred) or top-to-bottom order of use, or both.

Consistency: The location of recurring functional groups and individual items shall be similar from panel to panel. Mirror image arrangements shall not be used.

Display commonality: When multiple displays and multiple display formats are used, nomenclature and symbols should be common on all displays, as appropriate. Text or readout fields, common to all displays, (e.g., system advisories) should be in a standard location on all display panels and formats.

Emergency use: Emergency displays and controls shall be located where they can be seen and reached without delay (e.g., warning lights within a 30° cone about the operator's normal line of sight (see FIGURE 54 below); an emergency control close to its related warning display, or use of the nearest available hand in its nominal operating position).

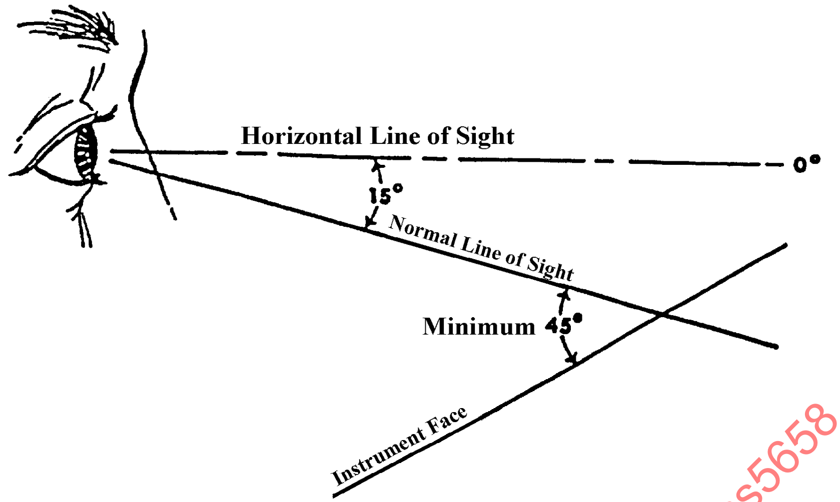


FIGURE 54 – EMERGENCY DISPLAYS LINE OF SIGHT

8.1.3 Signal Precedence

Each of the following signals shall take precedence over those below them:

a. Emergency action

b. Critical warning

c. Warning

d. Caution

e. Informational signal

8.2 Visual Displays

8.2.1 Warning/Caution

A warning/caution display shall provide the operator with a greater probability of detecting the triggering condition than normal observation would provide in the absence of the display.

Warning signals: Visual warning signals should be presented using flashing red with flash frequency between 3 and 5 Hz with a 50% duty cycle. The flash rate for all such warning signals shall be synchronized. If used in conjunction with caution signals, warning signals should be coded to be easily distinguished from caution signals.

Caution signals. Visual caution signals should be yellow. A minimum of two discriminatory characteristics should be employed to ensure rapid identification and interpretation of caution signals. If used in conjunction with warning signals, caution signals should be not more than half the intensity of the warning signal. If cautions take the form of flashing text, the text should flash at a rate not greater than 2 Hz with ON/OFF interval of about 70% on.

Text height: Text for visual warning and caution signals should be presented using characters between 8.7 - 17.4 milli-radians (30 and 60 minutes of subtended arc) as measured from the longest anticipated viewing distance, with the larger size used where conditions may be adverse.

8.2.2 Display Illumination and Light Distribution

Normal: When maximum dark adaptation is not required, low brightness white light (preferably integral and adjustable as appropriate) shall be used; however, when maximum dark adaptation is required, low luminance [0.07 - 0.35 cd/m2 (0.02 - 0.10 ft-L)] red light (greater than 620 nm) shall be provided.

Night vision device compatibility: Where night vision device compatibility is required, the spectral output of all light emitting from or illuminating a display should be not greater than 600 nm in wavelength. The lighting shall be continuously variable to the full OFF position. In the OFF position, no current shall flow through the lamps.

Light distribution: External illumination on a group of displays shall vary not more than 3:1 between the brightest and the darkest area. Self-luminous displays shall have either individually adjustable luminance or be visibly uniform over the range of luminance settings normally used.

8.2.3 Location and Arrangement

Orientation: Display faces shall be perpendicular to the operator's normal line of sight whenever feasible and shall be not less than 45° from the normal line of sight (see Figures above). Parallax shall be minimized.

Maximum viewing distance: The viewing distance from the eye reference point of the seated operator to displays located close to their associated controls shall not exceed 64 cm (25 in). Otherwise, there is no maximum limit other than that imposed by legibility limitations, which shall be compensated for by proper design. NOTE: A viewing distance of up to 76 cm (30 in) may be used with ejection seats.

Minimum viewing distance: The effective viewing distance to displays, with the exception of cathode ray tube displays and collimated displays, shall not be less than 330 mm (13 in) and preferably not less than 510 mm (20 in).

8.2.4 Coding

Flash rate: No more than two flash rates should be used and they shall differ by not less than 2 Hz. The higher flash rate shall reflect the more critical information and should be not greater than 5 Hz. The slower flash rate shall be not less than 0.8 Hz. If possible, flashing should be synchronized. Text characters that must be read should not flash.

8.2.5 Electronic Displays

Luminance range: The display luminance adjustability (highest to lowest) range should be not less than 50:1.

Character height: As measured from the greatest anticipated viewing distance, the visual angle subtended by height of black-and-white characters should be not less than 4.6 mrad (16 min) with 5.8 mrad (20 min) preferred; the visual angle subtended by height of colored characters should be not less than 6.1 mrad (21 min) with 8.7 mrad (30 min) preferred.

Font characteristics: Font style shall allow discrimination of similar characters, e.g., letter I/number 1, letter Z/number 2. A common, standard font should be used. Where users must read quickly under adverse conditions (e.g., poor lighting), a sans serif style should be used. Text should contain a conventional mix of uppercase and lowercase letters. The use of all capital letters should be limited to abbreviations and acronyms.

Signal size and image quality: When a target of complex shape is to be distinguished from a non target shape that is also complex, the target signal should subtend not less than 6 mrad (20 min) of visual angle and should subtend not less than 10 lines of resolution elements.

8.2.6 Cathode Ray Tube (CRT) Displays

Luminance: Ambient luminance shall not contribute more than 25% of screen brightness through diffuse reflection and phosphor excitation. A control shall be provided to vary the CRT luminance from 10% of minimum ambient luminance to full CRT luminance. The brighter of characters or their background shall have a luminance not less than 35 cd/m2 (10 ft-L) and, where military applications or survivability require, shall be adjustable to zero.

Contrast: Contrast between light characters and a dark screen background shall be not less than 6:1 (10:1 preferred); contrast between dark characters on a light screen background shall be not less than 1:6 (1:10 preferred). In bright ambient illumination, to attract attention, or to sharpen edges, contrast ratio should be not less than 7:1; in dark ambient illumination for continuous reading, contrast ratio should be not less than 5:1; to camouflage images or smooth edges, contrast ratio should be not greater than 3:1.

8.3 Audio Indicators

8.3.1 General.

Use: Audio indicators should be provided under the following conditions:

a. The information to be processed is short, simple, and transitory, requiring an immediate or time-based response.

b. The common mode of visual display is restricted by over-burdening; ambient light variability or limitation; operator mobility; degradation of vision by vibration, high g-forces, hypoxia, or other environmental considerations; or anticipated operator inattention.

c. The criticality of the event makes supplementary or redundant notification desirable.

d. It is desirable to warn, alert, or cue the operator to subsequent additional response.

e. Custom or usage has created anticipation of an audio indicator.

f. Voice communication is necessary or desirable.

Signal type. When an audio presentation is required, the optimum type of signal should be presented in accordance with table below. Audio signals should not interfere with other sound sources, including verbal communication. Auditory presentation is preferred over visual presentation: (1) for signals of acoustic origin; (2) for warning signals to call attention to imminent or potential danger; (3) for situations when many displays are visually presented, e.g., piloting an airplane; (4) for presenting information independently of head orientation; (5) for situations when darkness limits vision or makes seeing impossible; (6) for conditions of anoxia or high positive g forces; and (7) when signals must be distinguished from noise, especially periodic signals in noise. Table 22 shows the relevant signal detection levels.

TABLE 22 – AUDIO SIGNAL IDENTIFICATION CAPABILITIES

Function	Tones (Periodic)	Complex Sounds (Non-Periodic)	Speech
Quantitative Indication	Poor Maximum of 5 to 6 tones absolutely recognizable	Poor Interpolation between signals inaccurate	Good Minimum time and error in obtaining exact value in terms compatible with response
Qualitative Indication	Poor-to-Fair Difficult to judge approximate value and direction of deviation from null setting unless presented in close temporal sequence	Poor Difficult to judge approximate deviation from desired value	Poor Information concerning displacement, direction, and rate presented in form compatible with required response
Status Indication	Good Start and stop timing – continuous information where rate of change of input is low	Good Especially suitable for irregularly occurring signals (e.g. alarm signals)	Poor Inefficient; more easily masked; problem of repeatability
Tracking	Fair Null position easily monitored; problem of signal-response compatibility	Poor Required qualitative indications difficult to provide	Good Meaning intrinsic in signal
General	Good for automatic communication of limited information – meaning must be learned; easily generated	Some sounds available with common meaning (e.g. fire bell) – easily generated	Most effective for rapid (but not automatic) communication of complex, multi-dimensional information. Meaning intrinsic in signal and context when standardized. Minimum of new learning required.

GeneralGood for automatic communication of limited information – meaning must be learned; easily generated.- Some sounds available with common meaning (e.g. fire bell) – easily generated. Most effective for rapid (but not automatic) communication of complex, multi-dimensional information. Meaning intrinsic in signal and context when standardized. Minimum of new learning required.

Manual overrides: Non-critical audio signals should be capable of being turned off at the discretion of the user. Where this capability is provided, a visual indication that the signal has been turned off shall be provided to the user.

8.3.2 Audio Warnings.

Two element signals: When reaction time is critical and a two element signal is necessary, an alerting signal of 0.5 second duration shall be provided. All essential information shall be transmitted in the first 2.0 seconds of the identifying or action signal.

8.3.3 Characteristics of Audio Warning Signals.

Frequency range: The frequency range shall be between 200 and 5000 Hz and, if possible, between 500 and 3000 Hz. When signals must travel over 300 m (985 ft), sounds with frequencies below 1000 Hz should be used. Frequencies below 500 Hz should be used when signals must bend around obstacles or pass through partitions.

Discomfort: Audio warning signals should not be of such intensity as to cause discomfort or "ringing" in the ears. Levels should not exceed 115 dB at the ear of the listener.

8.3.4 Signal Characteristics in Relation to Operational Conditions and Objectives.

Audibility: A signal-to-noise ratio of at least 10 dB shall be provided in at least one octave band between 200 and 5000 Hz at the operating position of the intended receiver is usually sufficient. Signal to noise ratios can be greater as long as the levels do not exceed 115 dB at the ear of the listener.

Attention and avoidance of startle reaction: Signals with high alerting capacity should be provided when the system or equipment requires the operator to concentrate attention.

Such signals shall not, however, be so startling as to preclude appropriate responses or interfere with other functions by holding attention away from other critical signals. To minimize startle reactions, the increase in sound level during any 0.5 sec period should be not greater than 30 dB. In addition, the first 0.2 sec of a signal should not be presented at maximum intensity, use square topped waveforms, or present abruptly rising waveforms.

8.3.5 Verbal Warning Signals.

Intensity: Verbal alarms for critical functions shall be not less than 20 dB above the speech interference level at the operating position of the intended receiver.

8.3.6 Controls for Audio Warning Devices.

Automatic or manual shut-off: When an audio signal is designed to persist as long as it contributes useful information, a shut-off switch, controllable by the operator, the sensing mechanism, or both, shall be provided, depending on the operational situation and safety factors. When a manual shut-off is used, a visual indication that the warning has been turned off shall be provided.

Automatic reset: Whether an audio warning signal is designed to be terminated automatically, manually, or both, an automatic reset function shall be provided. The automatic reset function shall be controlled by the sensing mechanism which shall recycle the signal system to a specified condition as a function of time or the state of the signaling system so that the warning device can sound again if the condition repeats.

8.3.7 Speech Transmission Equipment.

Frequency: Microphones and associated system-input devices shall respond optimally to that part of the speech spectrum most essential to intelligibility (i.e., 200 to 6100 Hz). Where system engineering necessitates speech-transmission bandwidths narrower than 200 to 6100 Hz, the minimum acceptable frequency range shall be 250 to 4000 Hz.

Dynamic range: The dynamic range of a microphone used with a selected amplifier shall be wide enough to admit variations in signal input of at least 50 dB.

High-pass filtering: In an environment with predominantly low-frequency noise, 300 Hz cut-off, high-pass filtering should be used. In very loud, low frequency noise environments (100 dB overall), noise canceling microphones shall be used and shall be capable of achieving an improvement of not less than 10 dB peak-speech to root-mean-square-noise ratio as compared with non-noise-canceling microphones of equivalent transmission characteristics.

8.3.8 Speech Reception Equipment.

Frequency range: Headphones and loudspeakers shall be subject to the same frequency response restrictions as microphones and transmission equipment except that loudspeakers for use in multi-speaker installations and multiple channels fed into headphones (e.g., where several speech channels are to be monitored simultaneously) shall respond uniformly (±5 dB) from 100 to 4800 Hz.

8.3.9 Operating Controls for Voice Communication Equipment.

Volume controls: Accessible volume or gain controls shall be provided for each communication receiving channel (e.g., loudspeakers or headphones) with sufficient electrical power to drive sound pressure level to at least 100 dB overall when using two earphones, and shall have pressure operated gain control switches to compensate for altitude in un-pressurized compartments. The minimum setting of the volume control shall be limited to an audible level, i.e., it shall not be possible to inadvertently disable the system with the volume control. Power (on-off) and volume adjustment should not be combined into the same control; however, if conditions justify their combination, a noticeable detent position shall be provided between the OFF position and the lower end of the continuous range of volume adjustment. When combined power and volume controls are used, the OFF position shall be labeled.

Squelch control: Where communication channels are to be continuously monitored, each channel shall be provided with a signal-activated switching device (squelch control) to suppress channel noise during no-signal periods. A manually operated on-off switch, to deactivate the squelch when receiving weak signals, shall be provided.

8.4 Night Vision Imaging System (NVIS) Compatibility

MIL-STD-3009 should be used to define NVIS compatibility. Considerations are with respect to:

- Compartment lighting
- Emergency exit lighting
- Caution and advisory signals
- Map and utility lights
- Daylight legibility and readability
- Night operations
- Luminance
- Chromacity
- Radiance
- Light leaks
- Luminance uniformity
- Reflections
- NVG - Verify that the appropriate exterior aerial refueling lights are compatible with night vision goggles (NVG) and that displays have been provided to the appropriate crewmembers to indicate the necessary information to conduct the aerial refueling operation safely. Display lights are variable intensity and NVG compatible.

---------- End Example

9. WIRELESS COMMUNICATION

9.1 Overview

Communication subsystem is defined as a set of equipment/devices used to relay voice, data, and information from one subsystem to another. The subsystem consists of: one or a set of Remote Terminals (RTs), mount, control, indicator, antenna, antenna electronics, ancillary devices, and software/firmware.

---------- Begin Example

FIGURE 55 shows the communication layout of the wireless system.

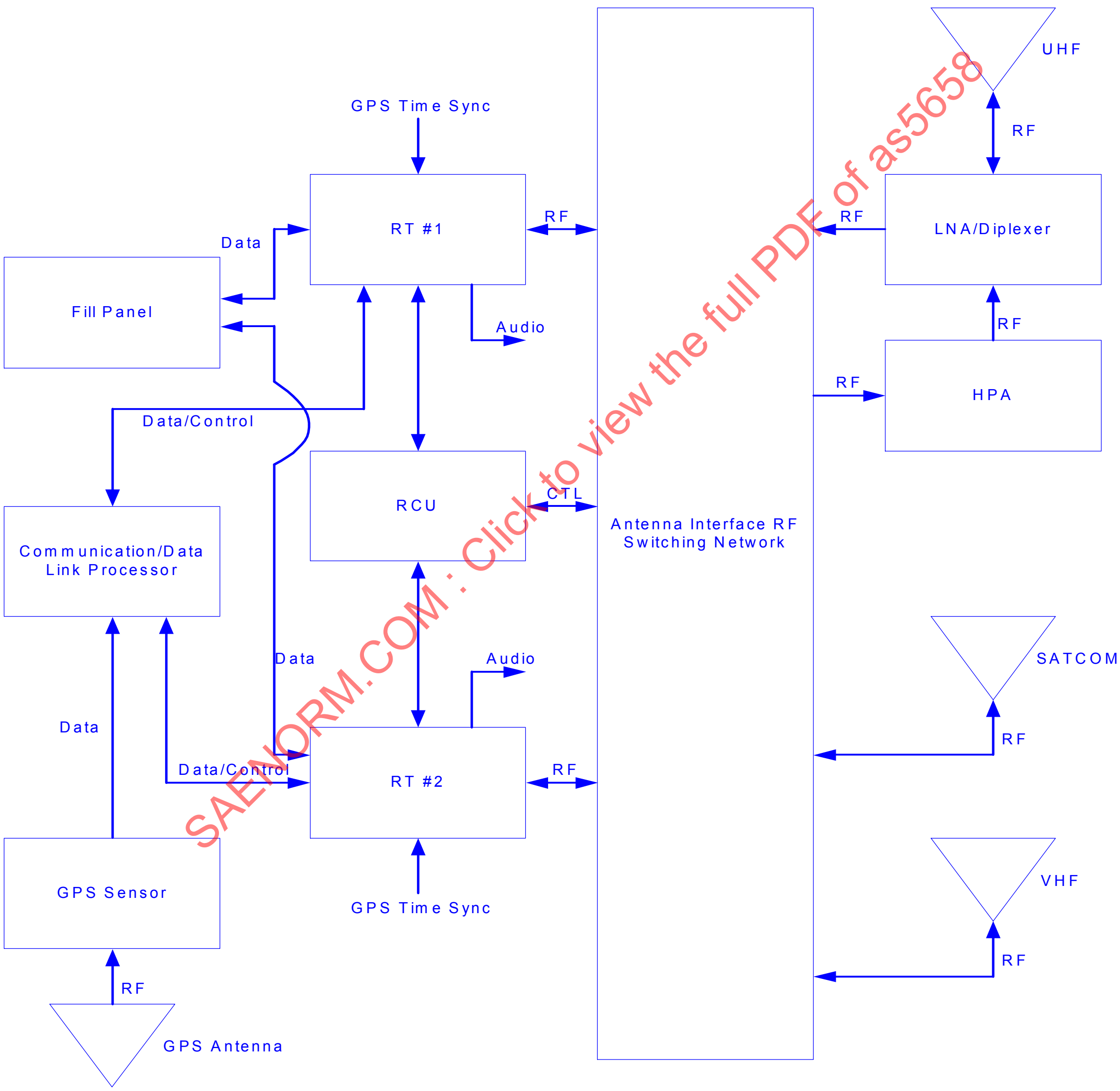


FIGURE 55 – COMMUNICATION SYSTEM ARCHITECTURE LAYOUT

---------- End Example

The communication subsystem may communicate with other subsystems on the platform, other subsystems on another airborne platform, ground based subsystems, and satellite systems/networks.

A distinction is made between information interface which tend to be data-centric and in which the design take much of their structure from the form of the information they contain. Communication interface tend to be domain-general and process-focused where they take their form from the interaction processes than the content of the domain.

9.2 Reception/Transmission

From a platform standpoint, the interface considerations between the communication subsystem and the platform and/or other platforms is the frequency of operation, and the considerations during communication transmit and receive such as power, sensitivity, exposure, security, and channel isolation.

---------- Begin Example

Antenna

The choice of antennas is based on a combination of communication subsystem selected and the platform operational requirements. Size and location on the platform may determine the type of antenna that can be used which will determine the selection of communication subsystem based on frequency of operation. Also, the ability to communicate via voice or data with other vehicles (airborne, ground, and satellite systems) in the mission theatre is also a factor in choice of antenna. Link 16 compatible data link subsystems generally operate in the L-Band (1 GHz) while SATCOM data links may consider military UHF band (220 to 400 MHz). Another major consideration is the radar cross section characteristics (RCS) and minimizing the increase in the platform RCS due to integration of the antenna. Another consideration is on the aerodynamics effects of adding an antenna and thus a consideration of whether to have an in-contour or out-of-contour antenna.

A platform may have several antennas based on all the communication needs. For example, standard antennas recommended for ARC-210 are VHF/UHF and L-Band tune able blade units. Broadband antennas are sometimes used to cover a wide frequency range but pay a penalty with reduced antenna gain. Antenna connections to the RT is made directly to connectors and in the case of ARC-210, there are up to three antennas that may be connected.

Reception

Some communication subsystem may have a Low Noise Amplifier/diplexer to isolate transmit and receive signals while using the same antenna. The diplexer section consists of transmit high pass filter and receive band pass filter, with both connected to a common antenna port. The communication subsystem may not be defaulted to a common port and usually requires a jumper to a ground on the RT connection to provide this capability. Provision need to be made in the platform to accommodate the LNA/diplexer if the unit is separate from the communication subsystem RT. Average operating power requirements vary but ARC-210 family RT-1794 is less than 50 watts for receive based on 28VDC power.

Transmission

The communication subsystem may have a high power amplifier (HPA) to amplify the transmit signal to a nominal level (for example, 100 watts AM average power or 125 watts FM average power). Provision need to be made in the platform to accommodate the HPA if the unit is separate from the communication subsystem RT. Average operating power requirements vary but ARC-210 family RT-1794 is less than 200 watts for transmit based on 28VDC power.

Security

Many communication subsystems are integrated with KY-58 to provide COMSEC secure voice and data capability. Many communication subsystems also have frequency hopping capability: spread spectrum method to transmit signals by rapidly switching a carrier among many frequency channels, using a pseudo-random sequence known to both receiver and transmitter. Main purpose of frequency hopping is to reduce the ability to intercept but also used to reduce noise and interference. The combination of COMSEC cipher text (CT) operation simultaneously with HAVE QUICK (HQ) frequency hopping operation requires additional control over Push-To-Talk (PTT) keying sequences to ensure proper timing for necessary KY-58 crypto operations to occur. The platform integrator(s) along with communication subsystem designers need to determine the keying requirements for the platform.

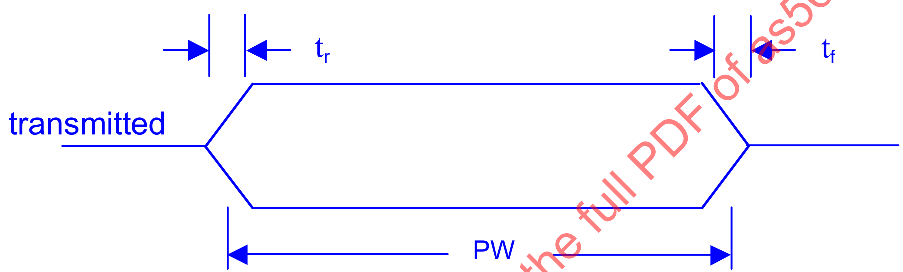
Timing Requirements and Synchronization

Any time synchronization used by the subsystem to reduce lock-on time or improve estimates in space relative to the platform will be described in this section. Only the signal for time synchronization shall be described in this section, the functional aspects of time synchronization shall be described in the functional interface in Volume 2 section 3.

The intent to employ time synchronization is to reduce the subsystems time to search for the link and consequentially the first message.

Transfer Signal Characteristics/ Waveform

If the subsystem must be controlled over free space either in a simple or complex way, this paragraph describes e.g. the RF power, frequency, stability, bit rates etc., i.e. the electromagnetic signature of the wireless signal. This could be split into two subsections where appropriate, one for the aircraft and one for the subsystem or, if not feasible, the point where the measures are to be taken shall be defined.



t_r,t_f are measured between 10% and 90% voltage
PW is measured at 50% voltage

FIGURE 56 – DATA LINK PULSE CHARACTERISTIC

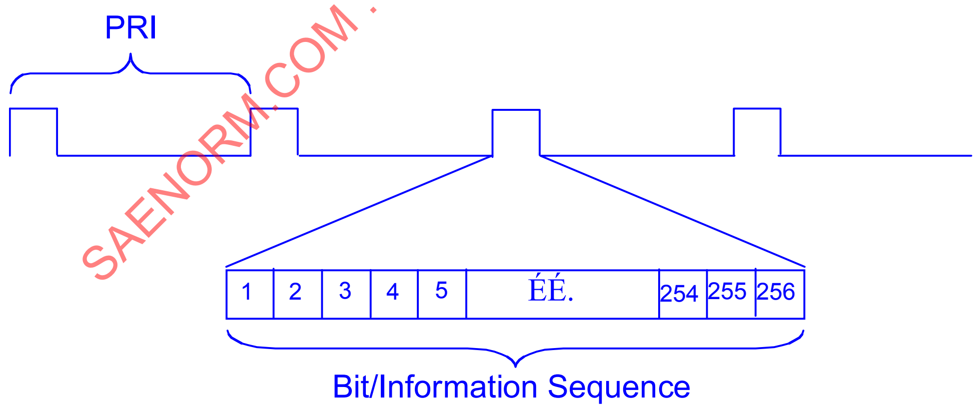


FIGURE 57 – PRI AND INFORMATION SEQUENCE

Uplink from subsystem to platform: video

- to be defined -

---------- End Example

9.3 Other Interface Considerations

This section should address any subsystem communication interfaces not already addressed.

---------- Begin Example

GPS

The communication subsystem may interface with the GPS subsystem on the platform to allow receipt of coordinated universal time (UTC) from a GPS receiver for time tagging purposes. In addition, the communication subsystem may require the use of accurate GPS information to correlate target position and platform reference information.

Gain/Loss Considerations

The GPS Antenna System (GAS) Antenna Electronics (AE) is advertised to be a form fit function replacement to the existing AE-1 and AE-1A. However, the GAS-1 Mid-Course Receiver (MCR) selectable output gain is defaulted to +45 db instead of the AE-1/AE-1A gain requirement of +17 db. The requirements are shown in TABLE 23

TABLE 23 – MCR GAIN REQUIREMENTS

Pin a	Pin g	Pin h	MCR Gain
Open Circuit	Open Circuit	Open Circuit	45
Open Circuit	Open Circuit	Ground	41
Open Circuit	Ground	Open Circuit	37
Open Circuit	Ground	Ground	33
Ground	Open Circuit	Open Circuit	29
Ground	Open Circuit	Ground	25
Ground	Ground	Open Circuit	21
Ground	Ground	Ground	17

Wiring modification and/or combination of amplifier and attenuators may be necessary to achieve acceptable gain/loss budget. This is critical to support other platform subsystems that require GPS and whether the gain value at the input of the subsystem is outside the specified receiver sensitivity range.

Calculated signal levels (nominal and not actual representation):

L1-C/A Satellite Signal-130 dB +/- 6 dB

Antenna-4 dB +/- 4 dB

GAS AE-117 dB +/- 0.5 dB

1760 Amplifier40 dB +/- 1 dB

Line Loss-5 dB

Stores Management Processor (SMP) loss-5 dB

Line Loss-10 dB

Calculated signal to 1760 weapon-97 +/- 7.3 dB (RSS)

Based on the 1760 weapon signal input requirements, modifications may need to be made on the platform or gain levels may need to be adjusted.

---------- End Example

10. SUPPORT/ MAINTENANCE INTERFACE

The support interface describes all supporting measures for the installation, handling, loading, labeling and marking relevant during and after the integration of the subsystem. Whenever possible reference to an existing standard shall be made. Only in cases where different requirements apply, it shall be included in the interface description.

10.1 Installation and Handling

The platform installation and subsystem handling procedures are described in this section.

10.1.1 Platform Installation Provisions (e.g. fixtures for installation)

This section shall identify the fixtures on the platform used as parts of the installation routines. Equivalent details for the subsystem may be identified in the ICD Mechanical Section. However, they will be included with the details of the procedure for installation contained in separate documentation that must be referenced by this section of the ICD. Additional information (if any) provided in the ICD should be of a general nature only.

---------- Begin Example

The subsystem shall be installed using the fixture shown in FIGURE 58.

FIGURE 58 – SUBSYSTEM INSTALLATION FIXTURE

Example Required

---------- End Example

10.1.2 Handling of the Subsystem

This section shall cover any handling associated with routine operations of the subsystem, including for instance, replenishment of consumables and replacement of video/film cassettes in reconnaissance equipment while mounted/ installed on the platform. This section of the ICD should be used only to introduce the actions necessary, but reference out to other documentation for the detailed procedures.

---------- Begin Example

While the subsystem is in its container, it shall be contained in an anti-static bag. While the subsystem is removed from its container, it shall be placed on an anti-static mat and connected to earth ground.

---------- End Example

10.2 Maintenance Interface

The maintenance interface shall describe the replacement of equipment or parts of the equipment, the required tools, any design rules and design criteria (e.g. error proof design measures), controls, accessibility, fasteners, connectors, cables and cable routing and test equipment required for and after the installation. The detailed interface specifics for the various devices can be found in the respective mechanical, electrical or other physical interface sections. This section and the following markings section cover the human ergonomics interface.

This section may comprise the following subsections

---------- Begin Example

- General
    - General maintenance procedures and considerations for the equipment and the maintainer like required tools, tool construction, emergency procedures and overall design considerations.
- Mounting of items within units
    - Mounting sequence of parts of the equipment/ subsystem
- Adjustment controls
    - Controls required for maintenance purposes including the requirements for knobs, screwdriver adjustments, the marking of the controls (ie. scales, calibration, criticality, location of the adjustment controls).
- Accessibility
    - Access of the equipment and its parts for maintenance, test and installation. Including descriptions of required rotations of the equipment for installation, obstruction prevention, and the preference for mission critical parts of the equipment wrt. the difficulty to access.
- Consumables
    - like lubrication, batteries, filters
- Cases
    - used for subsystem/ equipment transport and storage
- Covers
    - for protection and transport
- Access openings
    - for maintenance purposes
- Fasteners
    - Torque requirements and tools

- Unit design for efficient handling
    - E.g. interface requirements for rests and stands or required extensions to maintain and/ or install the equipment. Defines the human interface for maximum weight lift with and without tool support, load size, carrying limits, pull forces and handle design and preferred location
- Mounting
    - Describes the mounting and installation requirements for the subsystem/ equipment including alignment, labeling, stops, interlocks, hinges and covers to be removed prior to installation
- Conductors
    - Cable coding, cable clamps, the ergonomic length and cable routing including the access identification
- Connectors
    - Ergonomic design of connectors for equipment/ subsystem installation including ease of connect/ disconnect keying, alignment, orientation identification, testing, trouble shooting and labeling
- Test equipment
    - Storage space and proper instructions for portable test equipment
- Failure indications and fuse requirements
    - Easy identification of failures, general failure requirements and use of fuses
- Printed circuit boards
    - The design of printed circuit boards, its accessibility and required tools for installation and removal of the PCBs

---------- End Example

10.3 Design of Equipment for Remote Handling

The remote handling of subsystems, which cannot be directly accessed is described in this section

---------- Begin Example

Self-alignment devices shall be provided for the rearward components of the subsystem.

Quick-disconnect devices shall be provided to allow the remote disconnect of the equipment

Fasteners shall be captive and readily replaceable by the remote-handling technique.

Each lock or latching mechanism shall be operable from a single point, have a positive catch, and provide a clear visual indication of the latch position.

---------- End Example

10.4 Marking/ Labeling

The following paragraphs provide the requirements for the application of marking materials (inks, paints, and labels) onto parts and assemblies to form legible and durable characters for part numbers, serial numbers, reference designators, orientation stripes, arrows, etc. This includes alternate marking methods which do not require the use of ink or paint to form characters and the identification of items of military property.

This section may comprise the following subsections

---------- Begin Example

- Marking
  - Classification
    - Type e.g. Type I - Application to nonporous surfaces or Type II - Application to nonporous surfaces etc.
  - Marking requirements (Marking equipment and materials like paint, thinners etc.)
  - Required procedures and operations
- Labels
- Cleaning and surface preparation
- Application of marking material
  - mixing and application of marking material
- Alternate marking methods and materials
  - Any alternate marking methods and materials required by special surfaces
- Application of characters
- Other recommended procedures and operations
  - Special handling for labeling paint not covered by the sections above including incompatible materials.

---------- End Example

10.5 Item Identification

The identification of parts like part numbers and the installation of these, bar codes and UID is specified in this section.

It may comprise the following subsections

---------- Begin Example

- Parts Identification
- Linear Bar Code and 2D Data Matrix Labels
- Unique Identification (UID)

---------- End Example

10.6 Memory Load/Verify (MLV)

The purpose of the MLV function is to provide the capability to upload the operational software and mission data and download mission data and fault log information over a bus interface. The MLV interface is the subject of this section. The two subsections describe the bus interface to load the data physically into the equipment. This is supplemented by any interlocks required for enabling the software upload.

10.7 ID Tagging

If Radio Frequency Tags are used, they shall be specified in this section.

The following structure is a proposal for possible subsections

---------- Begin Example

- Identification of Classes
  - e.g. Class IX - Weapon Systems Repair Parts & Components
- Case and Pallet Tagging
- Item Level (IUID) Tagging
- RFID Hardware and Software
- Tag Classes and Sizes
- Number Formats and Representations
- DoD Tag Data Construct
- Advance Ship Notice (ASN) Transactions
- Tag Placement

---------- End Example

APPENDIX B - VOLUME 2 – PLATFORM/SUBSYSTEM INTERFACE CONTROL DOCUMENT

1. INTRODUCTION

The introduction of the CICD shall give an overview of the document. Scope, updating rules, used terms and a general description are included. The whole ICD comprises 2 Volumes, Volume 1 contains the more stable parts of the integration process while this volume covers the logical and functional interface, which changes more often in the course of an integration. The introduction can be regarded as unique for both volumes, or, like in this example, for each volume separately. The introduction of the CICD volume 2 shall clearly define the subject interface, with a description of how related interfaces are being managed. The interface definition may be achieved by reference to volume 1.

Besides an overview of the ICD, this section shall give an insight in the position of the ICD with respect to the project documentation.

---------- Begin Example

The following document tree in FIGURE 1 is provided for information only and to assist the readers understanding. It shows the posítion of the ICD in the context of the project document set.

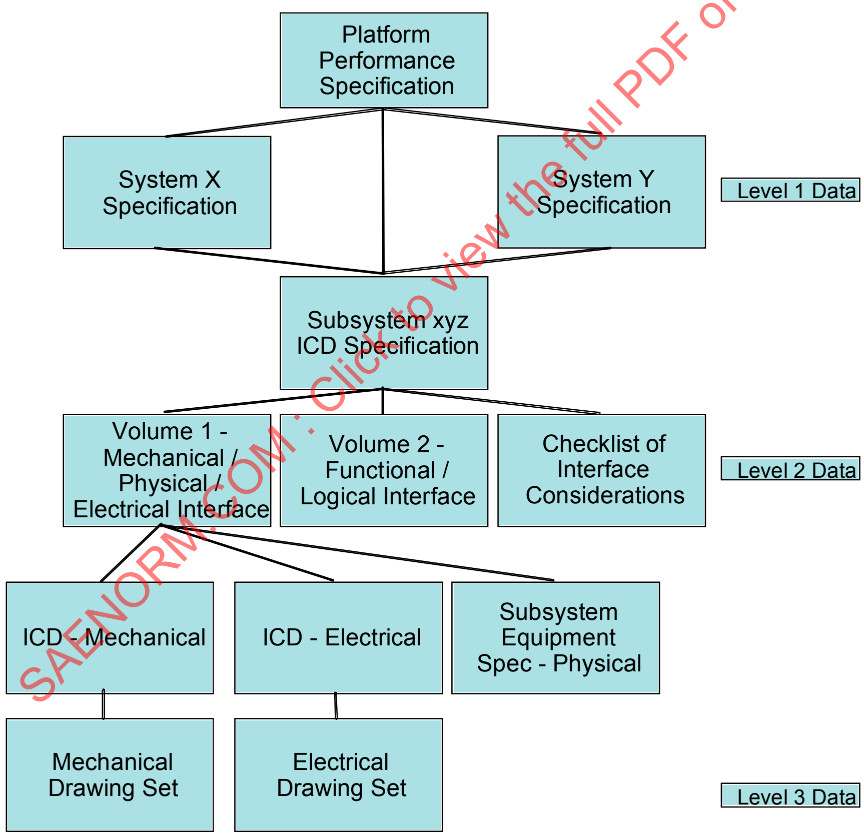


FIGURE 1 – DOCUMENT TREE

---------- End Example

1.1 Scope

This SAE Aerospace Standard (AS) defines the editorial format and policies necessary for the publication of Interface Control documents. The Platform Subsystem Interface Control Document Format defines a common format for platform subsystem interface documents to foster increased interoperability and consistent interface definition. It is designed with the versatility to serve differing "ICD" philosophies and organizations.

This aerospace standard defines the common technical data sections for the Platform Subsystem Interface Control Document Format down to the third header level for the majority of sub-sections. The Platform Subsystem Interface Control Document Format Aerospace Standard provides a structured document format in appendixes supported by example paragraphs, drawings, etc.

---------- Begin Example

Section 3 addresses the functional interface between the subsystem xyz and the host platform abc.

Section 4 addresses the communication interface between the subsystem xyz and the host platform abc.

Section 5 contains requirements for the active/ passive interface like an UHF communication etc.

Section 6 provides the information sheets.

Section 7 contains the information sheets for the wireless communication.

---------- End Example

1.2 Updating

This section is used to document the update procedures of this volume e.g. applied change procedures, or the section shall be used to establish the change process.

---------- Begin Example

The ICD shall be updated on the design responsible authority's discretion. The information about and the reception of any updates are under the responsibility of the user. The update procedure shall be control by the established Interface Control Process as defined in document xyz.

---------- End Example

1.3 Information Accuracy

This section records information concerning handling of values during the generation process of the ICD e.g. marking of currently unconfirmed values, uncertain statements or uncertain definitions.

---------- Begin Example

Throughout this document and unless otherwise stated, when a value is quoted which is still unconfirmed, a ´TBC´ rating follows the quoted value.

A star rating as follows grades this TBC rating system:

TBC* detailed calculations but not yet finalized

TBC** simple calculations and/or previous experience

TBC*** best estimate

---------- End Example

1.4 Definition of Terms

This section records the rules to specify use of wording in the document like “may”, “shall” etc.

---------- Begin Example

1.4.1 Utilization of Common Terms

The word "shall" in the text expresses a mandatory requirement of the specification. Departure from such a requirement is not permissible without formal agreement between customer and the aircraft company.

The word "should" in the text expresses a recommendation or advice on implementing a requirement of the specification. The customer expects such recommendation or advice to be followed unless good reasons are stated for not doing so.

The word "must" in the text is used for a legislative or regulatory requirement (e.g. health and safety) with which both the customer and the aircraft company shall comply. It is not used to express a requirement of the specification

The word "will" in the text is used for the future tense. It does not express a requirement of the specification.

The word "may" in the text expresses a permissible practice or action. It does not express a requirement of the specification.

Plain text (i.e. text not containing the above key words) is used to state facts and to describe existing capabilities or features. Such text does not express a requirement of the specification.

1.4.2 Non-Common Terms

Terms not specified in 1.4.1 are of informal nature and are not authoritative.

---------- End Example

1.5 General Description

The system controlled by this interface shall be described. Subject to deletion if already covered by 1.1.

The subsystem controlled and affected by this interface shall be described.

---------- Begin Example

The subsystem ´xyz´ is an active RF sensor subsystem:

- Capable of providing SAR imagery with a resolution of xxx.
- Integrated laser for tracking and designation of specific target(s).
- Integrated with the platform main computer and the subsystem and associated subsystem processor to perform its designated function.
- The platform ´abc´ is a low observable, agile all-weather super-sonic strike fighter aircraft:
- Wireless capability including high bandwidth video transmission and reception.

---------- End Example

1.6 Commonality Considerations

Subsystem commonality means for use of subsystems on different platforms.

---------- Begin Example

The subsystem is to be used on all platforms equipped with a fibre channel interface and all related standards therein.

---------- End Example

2. APPLICABLE DOCUMENTS

2.1 SAE Publications

This section shall give an overview of the content of the applicable documents. It may be a repetition of volume 1 content, but shall also list explicit volume 2 references.

---------- Begin Example

The following documents, of the exact issue shown, form a part of this document to the extent specified herein. In the event of conflict between the document referenced herein and the contents of this document, see 2.6, Precedence.

AS5643-IEEE-1394b Interface Requirements for Military and Aerospace Vehicle Applications

---------- End Example

2.2 ANSI Publications

Platform or subsystem related ANSI specifications relevant to the interface shall be listed in this section.

---------- Begin Example

Equipment Specification subsystem box xxx-yyy-zzz

System Specification for integration of subsystem xyz SS-123

System Software Requirement Specification SSRS-123

---------- End Example

2.3 U.S. Government Publications

Platform or subsystem related US government publications relevant to the interface shall be listed in this section.

---------- Begin Example

STANAG 4586 (NATO Standardization Agreement) Leading the Way to NATO UAV Systems Interoperability

---------- End Example

2.4 Applicable References

Supplier Documents, Plans, Configuration Procedures, Drawings

---------- Begin Example

Drawing x

Drawing y

---------- End Example

2.5 Project Specific Documents

Project handbooks, project specific and interface relevant technical notes shall be listed here.

---------- Begin Example

MIL-HDBK-xyz

---------- End Example

2.6 Precedence

Defines the sequencing of documents including this ICD and which documents control the others, etc.

---------- Begin Example

In the event of conflict between requirements specified in this and referenced documents, the following order of precedence applies:

Document 1

Document 2

Document 3

---------- End Example

2.7 Definitions

2.7.1 Terminology

The terminology section provides a definition of any terminology used in this ICD.

2.7.2 Abbreviations and Acronyms

The abbreviations and acronyms section provides a definition for all abbreviations and acronyms used in this ICD.

3. FUNCTIONAL INTERFACE

This section contains the functional description of the platform/sensor equipment interface, with each topic being described from the perspective of the platform and of the subsystem. The information defined in this section shall include the function and use of every analogue and digital information present on the interface. For those interfaces that include data bus communications, the descriptions must extend to every message; word and bit exchanged on the interface and listed in the information format sheets contained in Sections 6 and 7 of this volume of the ICD.

The description of all aspects of the active/passive communication interface in addition to the allocation within this section has been distributed between several sections in the CICD. These are namely Volume 1 Section 9 Active/Passive Communications where the general set-up and the signal characteristic is described while Section 5 of Volume 2 encompasses the Active/ Passive Communication Interface describing the general signal structure and signal control issues.

Due to the widely adopted UML/SysML standard, it is suggested to use UML/ SysML notation and diagrams for the representation of the functional interface whenever possible. This facilitates a follow on systems integration process and allows an easy use and incorporation in DoDAF views.

The examples have been chosen in order to cover a wide field of possible interfaces including legacy MIL-STD-1553 and an up-to-date fibre channel interface.

3.1 General

This general description gives an overview of the content for the following paragraphs i.e. the partitioning of the functional requirements and a reference to the subparagraphs together with a short description of the content.

Baseline for the used data and definitions are provided in 3.2.
The relevant states and modes of the system for the interface are defined in 3.3.
The timeline of the overall system in a coarse view is provided in 3.4, while 3.5 describes the events in the required detail. It is assumed that the descriptive approach between 3.4 and 3.5. should be incremental, i.e. while 3.4 gives the overview, it has to be detailed in 3.5. A more detailed timeline in 3.5 compared to 3.4 is also suggested.

3.2 Basic Mission Data and Definitions

The section provides general information about the required data to be exchanged over the interface and the use of the agreed co-ordinate systems and definitions. The standard method by which all message bit, bytes and words will be referenced shall be defined. All requirements shall be numbered for further referencing.

---------- Begin Example

The interface discussions in this section refer to these messages in order to provide an understanding of the communication between the host platform and the Subsystem. The convention for referring to interface messages, words and bits is as follows: messages will be identified by brackets and will be formatted as follows [message number with an R or T/word number(s)/bit number(s)]. The message is indicated as a subsystem-received message with an R suffix, and is a subsystem-transmitted message with a T suffix. All host platform “shall“ are numbered as {as_xxx}, all subsystem “shall“ are numbered as {ss_xxx}, host platform “may“ are numbered as {am_xxx}, all subsystem “may“ are numbered as {sm_xxx}, where “xxx“ is incremented for each occurrence.

3.2.1 Mission Data Overview

In this section, an overview of the mission data described and used in the following sections is provided.

The sensor equipment shall {ws_xxx} support the messages in Table 1.

TABLE 1 – MESSAGE TRAFFIC SUMMARY

1553 Subaddress	MESSAGE NAME
1T	Store Description
2R	PTAM
3R	Time
6R	Navigation Uncertainty
9R	Moment Arm
12R	GPS Crypto Key
17R/T	Modify/Add Target Data
22T	Weapon Monitor
24R	Specific Weapon Control
24T	Specific Weapon Status
28R	Ground Test Control
28T	Ground Test Report
29R	Reprogramming Control
29T	Reprogramming Status

MDT MESSAGES	
Subaddress	Message Name
13R/T-001	Targeting Data
13R/T-005	Almanac
13R/T-007	AS Status/SV Config.
13R/T-010	Ephemeris #1
13R/T-011	Ephemeris #2
13R/T-026	GPS CNM

3.2.2 Axis Systems and Parameter Definitions

Describes the co-ordinate systems to be used by subsystem and/or platform and the basis for the systems e.g. WGS 84 and a reference to established standards. All systems used in this volume shall be described in this section while the instant of use will be addressed in the event description part. Examples are the ECEF system (see below), the North-East-Down coordinate frame, Local Level Wander Azimuth Coordinate Frame and the Body Coordinate Frame covering moment and lever arms for transfer alignment purposes. Earth models and altitude reference parameters are also covered in this section.

In addition to the geographic or platform relevant co-ordinate systems, this section shall cover aerodynamic axes.

---------- End Example

3.3 States and/or Modes of Operation

The approach of the Avionics CICD format for functional requirements is to break down the requirements for the subsystem/platform system incrementally from very top level systems operation down to the detailed requirements. The format of this document requires a top level description of subsystem/platform modes and states in 3.3, followed by a breakdown of each mode/state into the sequence of events to achieve each entry and exit defined in 3.4, then the detailed requirements for each event is defined in 3.5. The decomposition in 3.3, 3.4, and 3.5 provide an example of a coherent breakdown from top level modes/states to detailed requirements.

Section 3.3.1 comprises the description of the system states and/or modes for the subsystem, the platform (if feasible and necessary) and/or the interaction of both. This includes the allowed transitions from one state and/or mode to the other, entry and exit conditions (alternate and normal). For some subsystems, the system operation may only contain modes or only states. For other subsystems, there may be states within modes or modes within states. The ICD format does not restrict the description of the system operation to modes or states, but allows the author the option of choosing which is best for describing their particular system.

The examples were chosen to show the variety of possible representations of the functional interface. The author may pick the view suitable for their system interface.

The description of the system functions shall be kept to an understandable level and if possible be further decomposed. E.g. the state transition diagram in FIGURE 3 could be split in multiple STDs or decomposition levels dependent on the complexity of the subsystem and its description.

---------- Begin Example

The sensor equipment will be integrated in the following avionics architecture FIGURE 2:

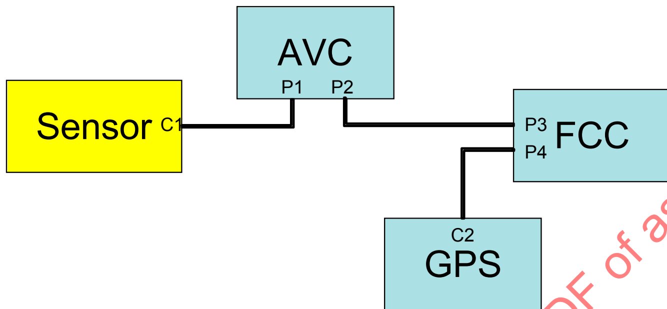


FIGURE 2 – AVIONICS ARCHITECTURE

The communication is performed via a Fibre Channel connection.

The sensor equipment has 2 major states as shown below:

1) Power Off

2) Operate

The operate state contains two further states of operation as shown below.

a Normal

i Initialization

ii Mission Plan Loading

iii IBIT

iv Maintenance

v Standby

vi Operation

b Fail

c The normal state contains 6 further states. The Initialization, Standby and Operation states are part of the normal procedure, the remaining states or modes are either single events like mission data loading during mission preparation phase or the states/ modes describe exceptions, i.e. procedures like in-flight IBIT mode or Maintenance mode in case of a failure on ground.

3.3.1 Subsystem State/Mode Description

The sensor equipment transitions through a sequence of "states and sub-states or modes" starting with the OFF state (no electrical power applied), and proceeding through Normal mode, Initialization state, Standby State with a transition to the Operation State. The sensor equipment states and sub-states/modes serve as a convenient medium for defining the required subsystem and platform functions to accomplish the system operation. FIGURE 3 depicts the allowable states associated with the sensor equipment operation. TABLE 2 shows the allowable state transitions.

FIGURE 3 – LEVEL 1 SYSTEM STATES

TABLE 2 – STATE TRANSITION

TO FROM	OFF	Operate	Normal	Fail
OFF	-	X	*N* (ss)	X
Operate	N	-	N	A
Normal	N	X	-	A
Fail	A	X	N	-

N, A, X = Normal, Alternate, Forbidden Transition

The following tables describe the functions of each state and sub-state/ mode, and list the valid transitions into each state/ sub-state/ mode as well as the exits from each state/ sub-state/ mode.

TABLE 3 – INITIALIZATION STATE ACTIVITIES

INITIALIZATION	State Activities
Transition into State	From: OFF State Pre-requisites: None Initialization Action: Apply 3 phase power
State Modes and Functions	<u>(P)BIT Mode</u> Entry Criteria: A/C applies 3-phase power Functions during mode: • Sensor equipment completes power up initialization of the system • Sensor equipment performs power-up BIT checks to verify system operation A/C initiates communication Exit Criteria (P)Bit routine completed <u>Bus Configuration Mode</u> Entry Criteria: • A/C applies 3-phase power Functions during mode: • Debounce Delay • Bus reset • Device Configuration Exit Criteria Bus configured, nodes identified, tree position identified <u>Alignment Mode</u> Entry Criteria: Bus configuration successful Functions during mode: • A/C may command BIT • A/C alignment data transfer Exit Criteria Successful alignment of sensor equipment IMU
Alternate Exit	OFF Remove power
Normal Exit	Standby

NOTE:Additional tables would be added to describe all states/ sub-states/ modes, but for brevity of this document, only one sub-state/ mode table is provided as an example. The author does not have to follow this specific table and figure format, but they do provide an example of an internationally accepted format.

---------- End Example

3.4 Sequence of Events

As described in 3.3, the sequence of events is the second level of the breakdown of the systems interface functional requirements. This section describes the sequencing and timelines of the nominal system operation of the interface and the possible deviations and failure cases on a top-level basis. The sequence of events described in this section produces the sequencing of the paragraphs in 3.5 containing the detailed event requirements. The author of the interface control document can adjust the detail of the description in this section, however to support readability it is suggested to provide at least two different grades of detail. One overall description where the main events or states are described and the detailed communication structure between the platform and the subsystem (maybe in the event description as shown in the example below).

In general, the description of events should address the pre-conditions for the entry of this state/mode event, triggers that enable entry into an event or exit from an event, activities that normally occur during the event time, optional activities that can occur during the event, and any inherent system delays associated with the event. These areas should also be reflected in the event timeline chart.

The use of the word “sequence” includes any parallel operation, and is not only applicable to sequential operations of the subsystem. The parallelism can be shown in the sequence diagram and/ or in the state transition diagram of section 3.3.

The following example is a continuation of the example from 3.3 breaking down the sequence of events for a single mode of the initialization state for brevity of this document. It is suggested to use a UML/ SysML activity and/ or sequence diagram to visualize the sequence of events including triggers, guards etc. Due to the variety of subsystems providing a minimum of a functional interface to extensive functional integration, the following is considered as an example from level 3 structures down.

---------- Begin Example

3.4.1 Initialization State Events and Timeline Sequence:

The initialization state contains three modes of operation as shown below.

A (P)BIT mode

B Bus configuration mode

C Alignment mode

The events leading up to entry, processes during and exit from these modes is described below.

3.4.1.1 (P)BIT Mode

…

3.4.1.2 Bus Configuration Mode

After power application the bus configuration mode is entered. The (P)Bit is started in parallel to the bus configuration.

The bus configuration encompasses the initiation of the debounce delay, the bus reset command and the device configuration. All events can be further detailed and are described in section 3.5.

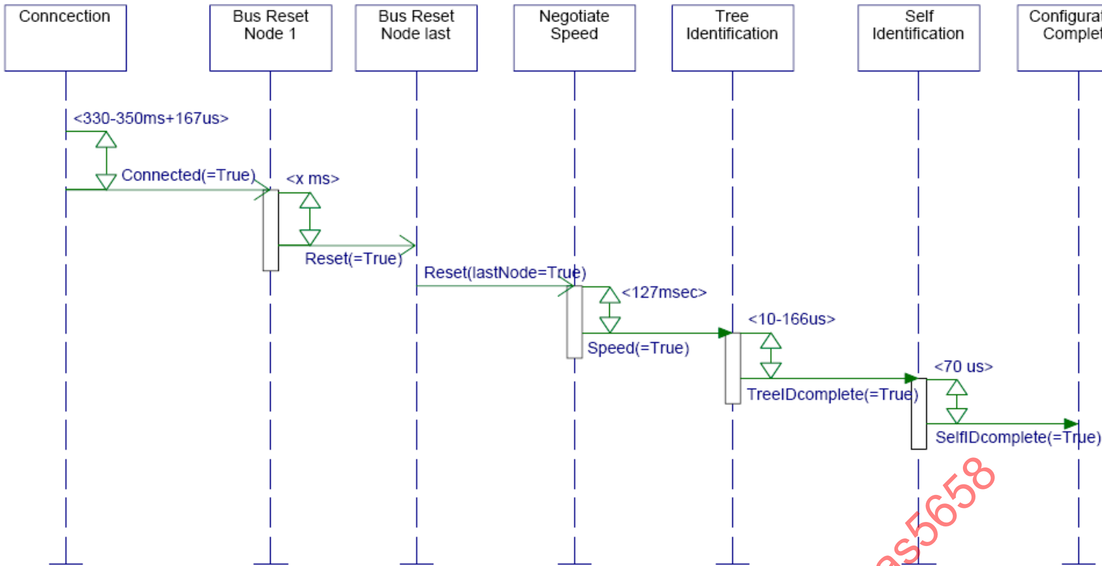


FIGURE 4 – SEQUENCE OF EVENTS: BUS CONFIGURATION

FIGURE 4 shows the sequence of events in a sequence diagram.

The bus will be reset after the sensor equipment joins the bus communication and the bus architecture will be determined. The complete bus intitialization sequence is split in the following events:

- Reset
- Tree identification
- Self Identification

FIGURE 5 illustrates the normal sequence of events that occur during the bus initialization mode. Note: The following chart is provided as an example. The author does not have to follow this figure format.

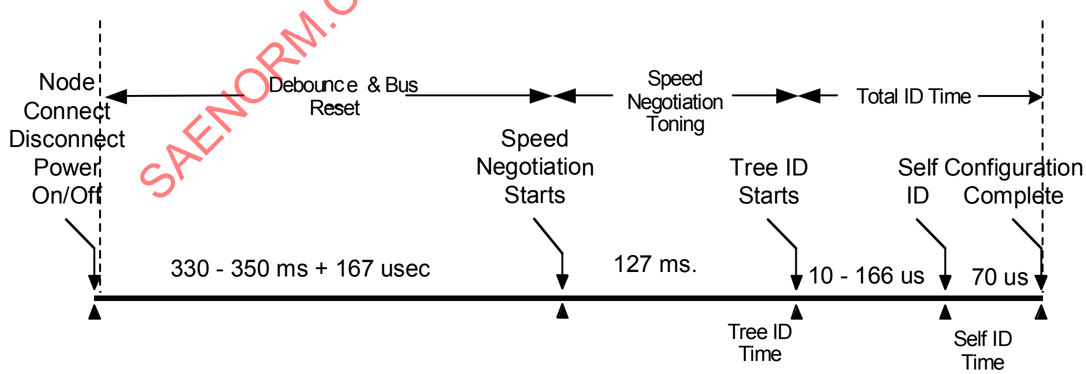


FIGURE 5 – BUS CONFIGURATION TIMELINE

3.4.1.3 Alignment Mode

…

3.4.2 Standby State Events and Timeline Sequence

N/A

3.4.3 Operational State Events and Timeline Sequence

3.4.3.1 Recording Mode

…

---------- End Example

3.5 Event Description

This section describes detail requirements of the events as outlined in the sequence of events paragraph. The following example is a continuation of the example from 3.4 breaking down the detailed requirements for only a single event of the initialization state, bus configuration mode for brevity of this document. The author may chose any representation to explain the detailed functions within the single event e.g. additional timelines, signal definitions, etc.

---------- Begin Example

3.5.1 Initialization State – (P)BIT Mode

…

3.5.2 Initialization State – Bus Configuration Mode

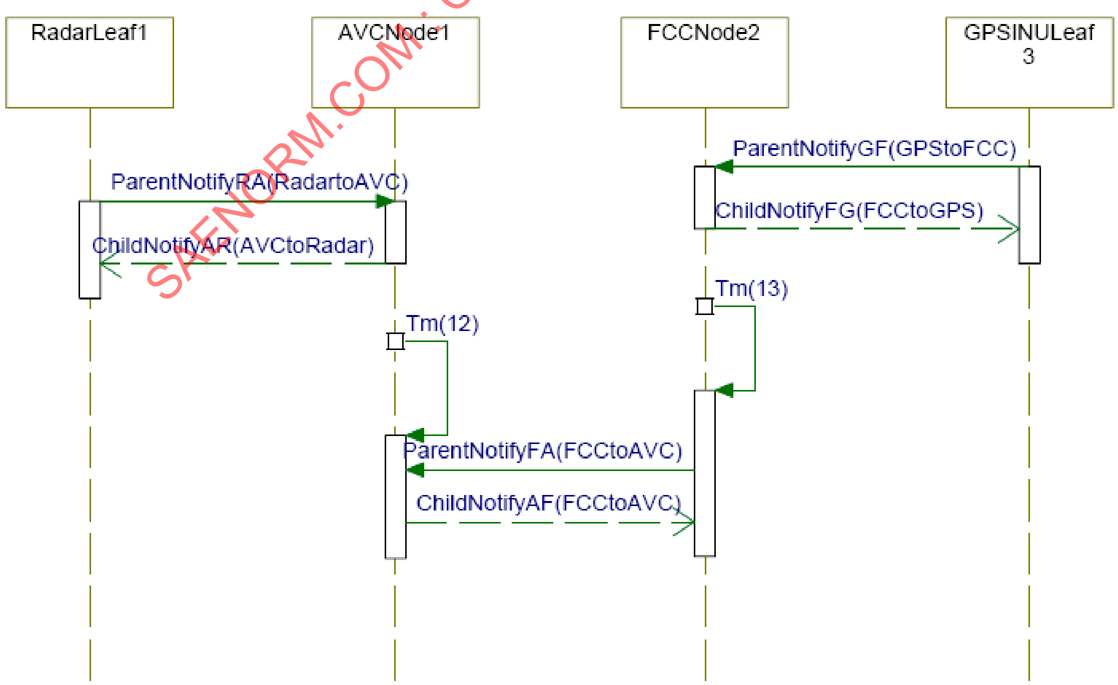


FIGURE 6 – DECOMPOSED EVENT DESCRIPTION:
BUS CONFIGURATION MODE – TREE IDENTIFICATION

The sensor equipment enters the Bus Configuration Mode, and remains in this mode until the new bus architecture is determined following self identification. It leaves the bus configuration mode after communication is established and traverses to the alignment mode, to the fail state when a failure is detected or to the off state in the case that the system is switched off. FIGURE 6 shows the sequence diagram of the tree identification in the bus configuration mode.

3.5.2.1 Required Signals, Lines, Logical Information and Timelines for System Initialization

The power, discrete signal, and digital interfaces listed in the following sections are used during the bus configuration process.

3.5.2.1.1 Power Lines

3-phase, 400 Hz, 115 VAC power with ground connection is provided.

When 400 Hz, 115 VAC power is interrupted for more than 200 microseconds, the sensor equipment may suffer a microprocessor reset and the erasure of its volatile memory, however the program instructions will remain intact. When power is restored, the sensor equipment will re-enter the Initialization State.

3.5.2.1.2 Logical Information

The following logical information is required for bus initialization:

Parent Notify and Child Notify in order to determine the bus configuration.

3.5.2.2 Power Application

The sensor equipment utilizes 3 phase power for sensor equipment initialization and opertation power.

3.5.2.2.1 Platform Requirements

The platform shall {as_001} apply 115 VAC Power.

3.5.2.2.2 Sensor equipment Requirements

When 115 VAC Initialization Power is received from the platform, the sensor equipment shall {ss_001} enter the Initialization State and begin the (P)BIT sequence. This includes checks of the sensor equipment as required in the Sensor equipment Specification.

3.5.2.3 Bus Tree Identification

TABLE 4 provides a nominal sequence for the initialization of fibre channel communication between the platform and sensor equipment.

TABLE 4 – BUS COMMUNICATION INITIALIZATION SEQUENCE TO SENSOR EQUIPMENT

PLATFORM	SENSOR EQUIPMENT
Apply 3 phase power to sensor equipment *Determine branch node status.*	
	Power applied. Start (P)BIT. Determine Leaf Node Status
	Present Parent Notify signaling state on Strobe and Data Lines
Receive Parent Notify signaling state Mark port as child	
Output Child Notify signaling state	
	Mark port as parent port Remove signaling

3.5.2.3.1 Platform Requirements

The platform may {am_003} initiate communication on the fibre channel after 115 VAC power application. The platform shall determine its branch node status. After reception of the Parent_Notify signal on the sensor equipment port, the platform shall {as_002} mark this port as a child port.

The A/C may {am_004} determine the sensor equipment through Sensor equipment ID and its software configuration through the Sensor equipment Configuration Identifier through the respective ID information word (msg #3, w #5, b# 1-10) on the fibre channel.

3.5.2.3.2 Sensor equipment Requirements

After 115 VAC power application, the sensor equipment shall {ss_004} start (P)BIT sequence and shall {ss_005} determine its node status.

Within 10 microseconds after 115 VAC power application the sensor equipment shall (ss_006}

1.enter the Initialization State (P)BIT Mode

2.enter the bus configuration mode.

Within 500 milliseconds after 115 VAC power application the sensor equipment shall (ss_007} provide equipment ID and software configuration information.

3.5.3 Initialization State – Alignment Mode

…

3.5.4 Operational State – X Mode

…

---------- End Example