



AEROSPACE INFORMATION REPORT

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Superseding AIR6181

Electronic Propulsion Control System/Aircraft
Interface Control Documents

RATIONALE

AIR6181 is based on the previously issued ARP4874 to inform engine and aircraft manufacturers on the structure and content of an Interface Control Document for an Electronic Engine Control System. This revision reflects the input received as part of the Five-Year Review process.

FOREWORD

Electronic propulsion control systems have become established for a number of applications in the commercial field.

Frequently, a given aircraft can have engines from different engine manufacturers, and also a given engine type may be used in different aircraft. Without an accepted standard, this multiplicity can lead to large resource expenditure in documenting the interfaces between the engine and the aircraft.

As electronic propulsion control systems become more complex, with increased data and functional integration, this problem will be aggravated in the future and significant benefit will result from an accepted standard which can apply to all applications.

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Documents

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1. SCOPE

This SAE Aerospace Information Report (AIR) provides guidelines to document the functional and physical interface requirements for the electrical systems (including an Electronic Engine Control System (EECS) and its components) between a given propulsion system and the aircraft on which the system is installed.

The Interface Control Document (ICD) is considered to be a subset of the Engine Installation Manual, with interface considerations between the Airframer and Engine manufacturer. Although it can be developed concurrently with the Airframer and Engine manufacturer, its format and content result from an agreement between the Engine and Aircraft Type Certificate Holders, using the Certification Guidelines.

Within this document, the following definitions are adapted from the AC33.28-1 and CS-Definitions:

- “Engine Control System” means any system or device which is part of the Engine Type design, which controls, limits, or monitors Engine operation and is necessary for continued airworthiness of the Engine.
- “Electronic Engine Control System” (EECS) means an Engine Control System in which the primary functions are provided using electronics. It includes all the components (i.e., electrical, electronic, hydro-mechanical and pneumatic) which are necessary for the control of the Engine and may incorporate other control functions where desired.

The term “EEC” is used to refer to the Electronic Engine Control unit. The term “aircraft” is used with the global meaning of aircraft or rotorcraft.

The scope includes commercial and general aviation aircraft powered by piston, turbofan, turboprop, and turboshaft engines equipped with electronic engine controls. It can also be applicable to an Auxiliary Power Unit (APU) equipped with an electronic control.

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 the other publications shall be the issue in effect on the date of the purchase order. In the event of conflict between the text of this document and 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 Regulatory Publications

2.1.1.1 EASA Publications

Available from European Aviation Safety Agency, Konrad-Adenauer-Ufer 3, D-50668 Cologne, Germany (for visitors and for mail over 1 kg) and Postfach 10 12 53, D-50452 Cologne, Germany (for mail 1 kg or less); Tel: +49 221 8999 000, www.easa.europa.eu.

AMC 20-1	Certification of Aircraft Propulsion Systems Equipped with Electronic Controls
AMC 20-2	Certification of Essential APU Equipped with Electronic Controls
AMC 20-3	Certification of Engines Equipped with Electronic Engine Control Systems
CS-E 20	“Engine Configuration and Interfaces” and AMC E 20
CS-E 30	“Assumptions” and AMC E 30
CS-E 50	“Engine Control System” and AMC E 50

2.1.1.2 FAA Publications

Available from Federal Aviation Administration, 800 Independence Avenue, SW, Washington, DC 20591, Tel: 866-835-5322, www.faa.gov.

AC 33.28-3 Guidance Material for 14 CFR §33.28 Engine Control Systems

TSO C-77B Gas Turbine Auxiliary Power Units

2.2 Acronyms/Abbreviations

DFDR	Digital Flight Data Recorder
EEC	Electronic Engine Controller (i.e., the physical device)
EECS	Electronic Engine Control System
EVMS	Engine Vibration Monitoring SystemICDInterface Control Document
LRU	Line Replaceable Unit
TCMA	Thrust Control Malfunction Accommodation

3. INTERFACE DEFINITION OVERVIEW

3.1 Purpose

The purpose of defining interfaces between the powerplant control system and other aircraft and powerplant systems is to ensure the powerplant and the aircraft as a whole, perform safely, effectively, predictably, and reliably.

The definition of the interfaces between a powerplant control system and the related aircraft systems is the physical and functional relationship of one system to the other (i.e., how they fit and function together). In addition, integration of these interfaces is a necessary part of certifying an aircraft propulsion system equipped with electronic controls.

3.2 Interface Definition Requirements

Considerations to be addressed when determining and documenting interfaces include:

- a. Physical Interface Characteristics: These include electrical, mechanical, optical, and environmental characteristics.
- b. Functional Interface Characteristics: The objectives of the functions performed, and the data exchanged between the aircraft and the electronic propulsion control systems involved, that allow the engine and aircraft to operate as an integrated system.
- c. Digital communication link characteristics (standard being used, including any deviation)

4. INTERFACE CONTROL DOCUMENT (ICD)

4.1 Purpose

The purpose of the ICD is to define the physical and functional interface for the electrical systems, including the EEC, between a given propulsion system and a given aircraft.

The ICD can be initially developed as a source of high-level system requirements; however, it is a living document that captures the actual characteristics of the system, as it is implemented.

The definition of physical and functional interface characteristics should embrace both normal and degraded operating modes together with appropriate fault detection, accommodation, and annunciation requirements.

NOTE: This is not intended to make the ICD a failure modes and effects analysis report, but instead to describe and define the system-functional requirements which are related to failures of aircraft and control system components/interfaces/data, which can be used as aircraft system design requirements.

It is to be mentioned that the information described as the content of the ICD can be split in several documents, depending on the Engine Manufacturer's internal documentation process. The intended audience of the ICD will include the responsible design engineering organizations at both the engine manufacturer and at the aircraft manufacturer. The completed ICD is a useful resource document for certification substantiation, certification test procedure development, for engine and aircraft manufacturer's maintenance training organizations, for airline maintenance engineering organizations, and for manufacturers of flight and maintenance crew training simulators.

Distribution of the ICD is sometimes constrained by proprietary data concerns or by government export license restrictions. These factors and the intended audience should be discussed before preparation of the document to ensure it fulfills its intended purpose.

4.2 ICD Preparation

The ICD is one of several sources of engineering data which define the installation of the engine control system in the aircraft. The complete definition of the installation generally includes, but may not be limited to:

- Engine Installation Drawing
- Engine Installation Manual

Typically, the aircraft manufacturer and engine manufacturer will jointly define and agree on the development and configuration management plan for the ICD, as a part of the engine specification and engine integration plan negotiation process, and complete it during the subsequent design phases for the propulsion system and engine.

The means for controlling the configuration of the document needs to be agreed upon at the beginning of the program, because this may affect the structure of the document (see 4.3).

The plan for development of the ICD should be designed to recognize the existence of all sources of engineering data, including the previous drawings and manual, and avoid duplication of information.

During the developmental and mature program phases, a revision to the ICD should be made in accordance with the following criteria: Software update to the EEC (or the aircraft electronic systems that interface with the EEC), when functional or interface requirements are impacted, or if there are physical changes to the interface. This will ensure accurate documentation of changes to the aircraft/engine interfaces or features which affect the engine control system. A well-maintained/accurate ICD is also an essential tool to avoid interface issues in mature programs undergoing retrofit upgrades, by providing tracking status of interface changes which have occurred to the engine or aircraft.

Where specific chapters of the ICD contain pertinent information/requirements concerning other manufacturers/suppliers to the aircraft (i.e., Avionics, Landing Gear, Throttle Quadrant, etc.), their information could be included within the chapters with which they are involved.

4.3 ICD Format and Content

An example of an outline structure for the ICD is shown in Figure 1. The specific section description, placement order, and numbers shown for each topic are intended to be for reference only.

It is understood that certain applications may not include features which are listed as sections in the example (such as Thrust Reversers). They may also include additional sections which are not listed (as in the case of "rotorcraft").

Specific sections, such as paragraphs discussing system description, functionality, and functional interface requirements, should be expanded as necessary for a given application.

In some applications, it may be of use to configure each section as a stand-alone item. For projects which require large documents, this approach allows the ICD to be divided into smaller, more manageable sections which may be configured and released separately as the design progresses. In this arrangement, each section would contain a detailed change history, table of contents, signature sheets, etc. A master summary document could be created to identify the latest version of each section.

For configuration control purposes, it is suggested that the document defines the application, physical interface configuration, and software version.

The document will provide a description of the overall system, providing information and requirements on all aircraft and propulsion system LRUs to which the electronic propulsion control system components interface.

The detailed definition will cover the functional requirements and both the physical and functional characteristics of all data, signals, and power associated with the aircraft to propulsion system interface, and vice-versa. The use of data tables and high-level flow/logic diagrams may be used to describe the functional requirements. Due to export control constraints of detailed logic diagrams, which are used to create executable software code, it may be suggested not to include these logic diagrams in the ICD.

Coordination between all parties involved (Airframer, Engine manufacturer, other suppliers) is important for any changes that affect the interface information, including the use of aircraft data in engine control functions and engine data in aircraft control functions. The data supplier should be made aware that their transmitted data is being used in a specific function and that no changes to the data format or characteristics should occur without proper and complete impact analysis by the receiver system.

Appendix A presents additional, more specific details for suggested ICD content. Note that the suggested format incorporates all discussion of functional interface requirements in Section 8. Alternatively, individual functional requirements may be included in separate paragraphs, e.g., 8.2, 8.5, etc. Aspects such as fault detection, accommodation, annunciation, and dispatch criteria for each function may be included as subsections within the paragraph that discusses that function.

4.4 Electronic Transfer of Documents

In preparing the plan for development of the ICD, consideration should be given to permit transfer of the document electronically between the engine manufacturer and the aircraft manufacturer.