U.S. Department
of Transportation
**Federal Aviation
Administration**

Advisory Circular

Subject: Integrated Modular Avionics (IMA)

Date: D R A F T

Initiated By: AIR-626D

AC No: 20-170A

This advisory circular (AC) sets forth an acceptable means of compliance for aircraft, aircraft engines, and propellers utilizing integrated modular avionics (IMA) systems. This AC calls out and supplements the guidance of RTCA/DO-297, *Integrated Modular Avionics (IMA) Development Guidance and Certification Considerations,* dated November 8, 2005. This AC revises the previous version to address current IMA certification practices and recent changes to the applicable Technical Standard Orders (TSOs), specifically TSO-C153a, *Integrated Modular Avionics (IMA) Platform and Modules,* and the new TSO-C214, *Functional TSO Equipment using a TSO-C153a-Authorized IMA Platform(s) and/or Module(s).*

If you have suggestions for improving this AC, you may use the form at the end of this AC.

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CHAPTER 1. GENERAL INFORMATION

1.1 Purpose.

1.1.1 This advisory circular (AC) provides a means to demonstrate the airworthiness of integrated modular avionics (IMA) systems when integrated in a product, part, or appliance.

1.1.2 This is a guidance document. Its content is not legally binding in its own right and will not be relied upon by the Department as a separate basis for affirmative enforcement action or other administrative penalty. Conformity with the guidance document is voluntary only. Nonconformity will not affect rights and obligations under existing statutes and regulations.

1.2 Scope and Applicability.

1.2.1 This AC may be used by applicants and design approval holders seeking approval from the FAA for IMA systems installed in type certificated aircraft, aircraft engines, and propellers, or to be used in articles manufactured under a technical standard order authorization (TSOA).

1.2.2 The FAA will consider other means of demonstrating compliance that an applicant may elect to present. Terms such as “should,” “may,” and “must” are used only in the sense of ensuring the applicability of this particular method of compliance when the acceptable method of compliance in this document is used. If the FAA becomes aware of circumstances in which following this AC would not result in compliance with the applicable regulations, the FAA may require additional substantiation or design changes as a basis for finding compliance.

1.2.3 The material contained in this AC does not change or create any additional regulatory requirement, nor does it authorize changes in, or permit deviations from, existing regulatory requirements.

1.2.4 IMA is a shared set of flexible, reusable, and interoperable hardware and software resources that, when integrated, form a system that provides computing resources and services to hosted applications performing aircraft functions [DO-297].

1.2.5 An IMA architecture may integrate several aircraft functions on the same platform. Those functions are provided by several hosted applications that have historically been contained in functionally and physically separated “boxes” or line replaceable units (LRUs).

1.2.6 This AC addresses certification considerations for IMA systems and should apply when:

- Hosted applications[1] on the same platform are designed, verified, and integrated independently (at the application level[2]) from each other; and
- The platforms/modules provide shared resources (typically designed, verified, and integrated independently from the hosted applications);

OR

- A process for obtaining incremental certification[3] credit is anticipated or applied.

1.2.7 An applicant may choose to use this AC for a system that would not fulfill the conditions above. In that case, early discussions should take place between the applicant and the FAA to confirm whether this AC should be followed.

1.3 Cancellation.

1.3.1 This AC cancels AC 20-170, *Integrated Modular Avionics Development, Verification, Integration, and Approval Using RTCA/DO-297 and Technical Standard Order-C153,* dated November 21, 2013.

1.4 Document Overview.

1.4.1 This document provides the following:

- An overview and background information on IMA systems and associated certification concerns (Chapter 2).
- Recognition of the use of RTCA document DO-297, *Integrated Modular Avionics (IMA) Development Guidance and Certification Considerations*, as an acceptable means of compliance for the development and certification of IMA systems. It also clarifies and amends the intent, scope, and use of that document (Chapter 3).
- Introduction of the incremental certification approach and the link to TSO authorizations (TSOAs) (Chapter 4).

[1] A single application hosted on an independently developed platform is considered to be a traditional federated architecture, therefore it is not addressed by this AC. However, if an additional independently developed application is hosted on the same platform at a later stage (e.g., through a major change), this AC should be applied.
[2] Software integration/verification activities are not performed on the whole set of integrated software as in a federated architecture.
[3] Credit for incremental certification in an IMA context, as detailed in Chapter 4 of this AC.

- Additional considerations on dedicated topics, such as environmental qualification, open problem reports (OPRs), and configuration files (Chapter 5) to complement DO-297.

1.5 **Documents to be used with this AC.**

1.5.1 This AC should be used together with the documents listed in Table 1-1 of this AC. The applicable version of the documents for a given project will be established at the time of application.

Table 1-1. Supporting Documents for This AC.

Reference	Title
RTCA/DO-297	Integrated Modular Avionics (IMA) Development Guidance and Certification Considerations
SAE ARP4754*	Certification Considerations for Highly-Integrated or Complex Aircraft Systems
SAE ARP4754A/B	Guidelines for Development of Civil Aircraft and Systems
RTCA/DO-178( )**	Software Considerations in Airborne Systems and Equipment Certification
RTCA/DO-254( )***	Design Assurance Guidance for Airborne Electronic Hardware
RTCA/DO-160( )	Environmental Conditions and Test Procedures for Airborne Equipment
RTCA/DO-200( )	Standards for Processing Aeronautical Data
RTCA/DO-330	Software Tool Qualification Considerations
SAE ARP4761( )	Guidelines and Methods for Conducting the Safety Assessment Process on Civil Airborne Systems and Equipment
TSO-C153a	Integrated Modular Avionics (IMA) Platform and Modules
TSO-C214	Functional TSO Equipment using a TSO-C153a-Authorized IMA Platform(s) and/or Module(s)

* ARP4754A/B should be used unless ARP4754 initial release is the applicable document for a given project.

** DO-178( ) and referenced supplements should be applied as described in AC 20-115D, *Airborne Software Development Assurance Using EUROCAE ED-12( )* and *RTCA DO-178( )* (or later version).

*** DO-254 should be applied as described in AC 20-152A, *Development Assurance for Electronic Hardware* (or later version).

CHAPTER 2. BACKGROUND

2.1 IMA Overview.

2.1.1 IMA use has rapidly expanded in the last two decades and is expected to increase further. With the latest revision to TSO-C153a and the addition of TSO-C214, additional guidance is needed to address specific aspects at the application, component, platform, system, and aircraft levels.

2.1.2 An example of a simple IMA architecture is shown in Figure 2-1 of this AC.

2.1.3 Applications implementing several aircraft functions are hosted on the same platform. Several applications (e.g., Applications 1.1 and 1.2) may contribute to the same aircraft function.

2.1.4 The platform consists of:

- A hardware layer providing resources shared by the applications; and
- A software layer (also known as "middleware") that includes the operating system, health monitoring, various kinds of services, and hardware drivers (core software [DO-297] and support software [TSO-C153a]).

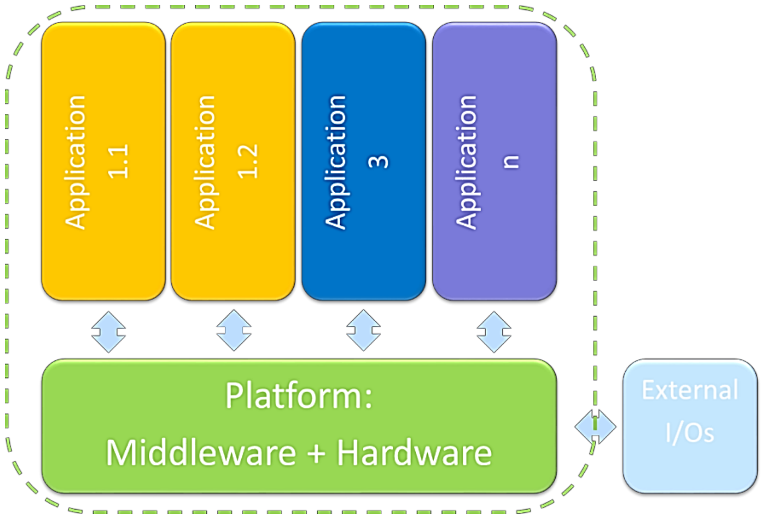
2.1.5 The platform middleware:

- Provides services to the software applications;
- Manages the interfaces between software applications;
- Manages the internal/external resources shared among software applications; and
- Ensures isolation between applications.

2.1.6 External inputs/outputs (I/O) may encompass a wide scope of interfaces such as discrete data, various data buses, or analog signals.

2.1.7 The software applications and the platform may be independently provided by different stakeholders (i.e., different system suppliers or entities pertaining to the same company/group).

Figure 2-1. Illustration of an IMA Architecture.



Note: Examples of different classes of electronic hardware parts that constitute a platform/module can be found in TSO-C153a.

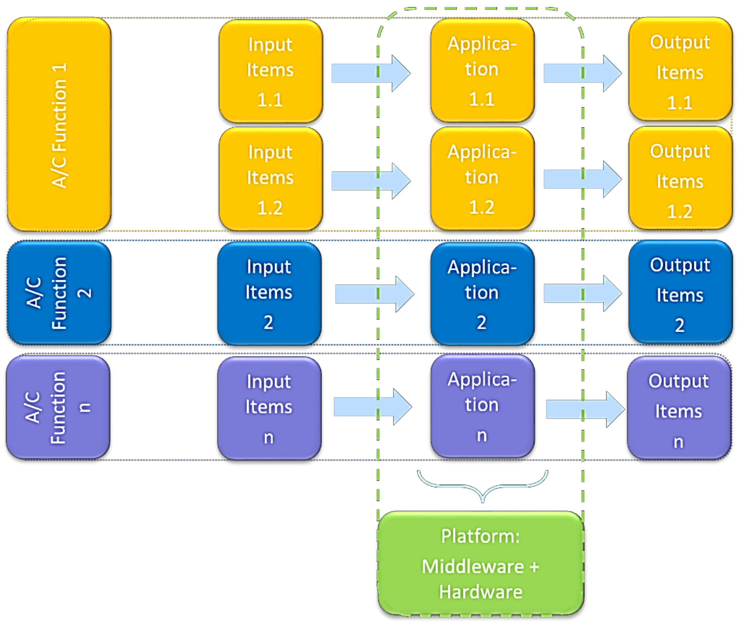
2.1.8 Figure 2-2 of this AC shows a functional projection of an IMA architecture at the aircraft level.

2.1.9 Each aircraft function may have its own set of LRUs connected to the platform that provides data to the application, receives data from the application, or both.

2.1.10 The set of I/O may cover a large range of items, such as:

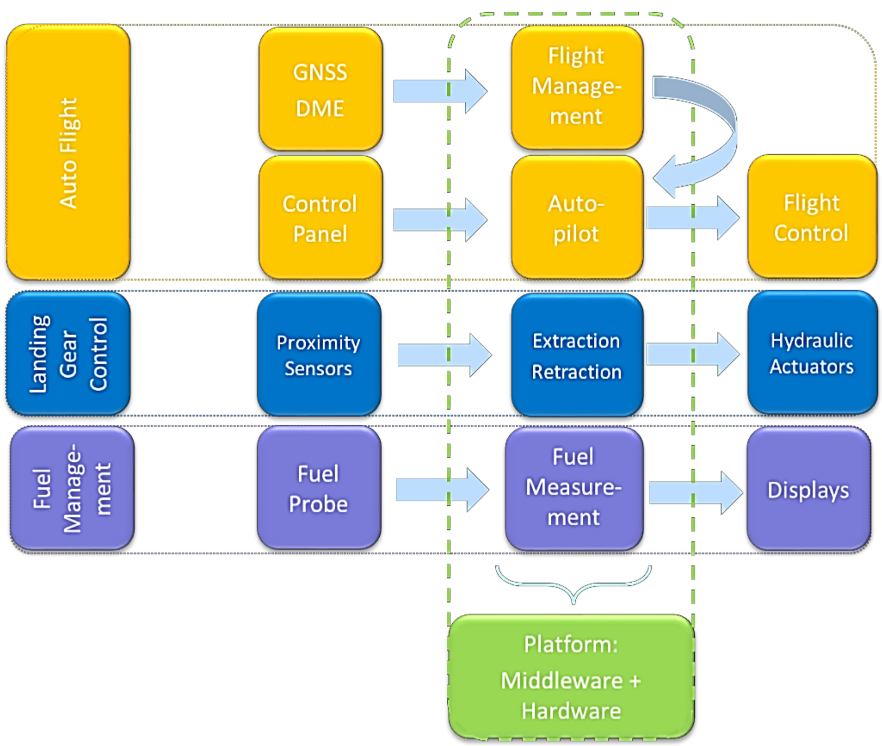
- <u>Input items:</u> Data from sensors, control panels, and data received from other applications/systems.
- <u>Output items:</u> Data to actuators, displays, and data transmitted to other applications/systems.

Figure 2-2. Functional Projection of an IMA Architecture at the Aircraft Level.



2.1.11 An example of IMA architecture is shown in Figure 2-3 of this AC.

Figure 2-3. Illustration of an IMA Architecture.



2.2 **IMA System Breakdown into Aircraft Systems (ATA Chapters).**

2.2.1 The organization of an IMA system into aircraft systems (e.g., ATA chapters) provides structure to a certification project and to the methods used to demonstrate compliance. This breakdown may depend on one or more of the following factors, individually or in combination:

- Aircraft and systems architecture
- Industrial organization and work sharing
- Applicant's development methods
- Aircraft maintenance principles and procedures, which are closely linked to ATA chaptering.

2.2.2 Applicants may elect to address the IMA items and activities, not the hosted functions, within an ATA chapter dedicated to IMA systems such as ATA-42.

2.3 **IMA Certification Concerns.**

2.3.1 The use of an IMA architecture raises several certification concerns, including:

- Failures or faults of the IMA platforms (including hosted applications) or LRUs connected to the communication network and the associated interfaces may cause the malfunction, loss, or partial loss of more than one function;
- The potential for failures to propagate and create multiple failure conditions;
- A lack of design independence among common hardware resources;
- Susceptibility to common mode failures, faults, or design errors within several identical modules or within the communication network;
- A lack of assurance that the system will behave as intended once all the hosted applications are integrated onto the platform/modules, when software and electronic hardware items have been independently developed and verified;
- Inappropriate resource management leading to potential access conflicts and a lack of determinism or unexpected system behavior; and
- Improper isolation mechanisms or configurations that do not ensure correct partitioning between functions.

2.4 Functional Isolation and Independence.

2.4.1 From a safety perspective, the primary purpose of the IMA design and certification activities is to demonstrate that the level of functional isolation and independence between the aircraft functions hosted in the IMA system is equivalent to that which would be achieved in a federated architecture. Functional isolation mostly relies on three pillars:

- Proper allocation of shared resources to prevent adverse interference between hosted applications;
- Robust partitioning that assures the isolation and detection/mitigation of partitioning violations; and
- Fault containment to prevent the propagation of faults between hosted applications.

CHAPTER 3. POLICY FOR IMA SYSTEM CERTIFICATION

Considering the IMA architecture, the industrial organization and work sharing, and the applicant's experience with IMA system development, several approaches are considered, including the use of the DO-297 standard; use of an alternative means to demonstrate compliance; and use of previously recognized IMA certification processes.

3.1 **Use of DO-297.**

3.1.1 Recognition of DO-297.

RTCA document DO-297, *Integrated Modular Avionics (IMA) Development Guidance and Certification Considerations*, published November 8, 2005 (equivalent to EUROCAE document ED-124), provides guidance for the development and certification of IMA systems.

The FAA accepts the use of DO-297 to support the certification of IMA systems when it is combined with the additional considerations described in this AC.

3.1.2 Scope of this AC with Respect to DO-297.

DO-297 addresses aspects of IMA certification that are outside the scope of this AC.

It is not the intent of this AC to cover the development processes for aircraft functions, even if they are implemented by applications hosted in an IMA system.

In relationship with DO-297, this AC is not intended to cover:

- Operational aspects of master minimum equipment lists (MMELs) (DO-297, Chapter 3.9).
- Considerations for continued airworthiness (DO-297, Chapter 6).
- The safety assessment process (DO-297, Chapter 5.1).

The cybersecurity aspects (DO-297, Chapter 5.1.5.8) are not adequate and should be superseded by the applicable cybersecurity standards as defined in the project certification basis.

3.1.3 Clarification and Use of DO-297.

DO-297 defines a complete "end-to-end" framework and a set of objectives to support the certification of IMA systems (i.e., from the development of software/airborne electronic hardware (SW/AEH) items to aircraft integration).

As it covers the complete development and certification of IMA systems, DO-297 may contain some objectives, activities, and life cycle data similar to those that apply to a federated architecture, and which may not be IMA-specific. Additionally, some considerations in DO-297 may overlap or may be addressed by other applicable guidance documents (e.g., ARP4754).

The way DO-297 allocates objectives, activities, and life cycle data to the various "tasks" should not be interpreted as:

- Imposing a unique scheme in terms of the project organization, sequencing of activities, and expected life cycle data required to meet the objectives; or
- Requesting the duplication of activities or life cycle data.

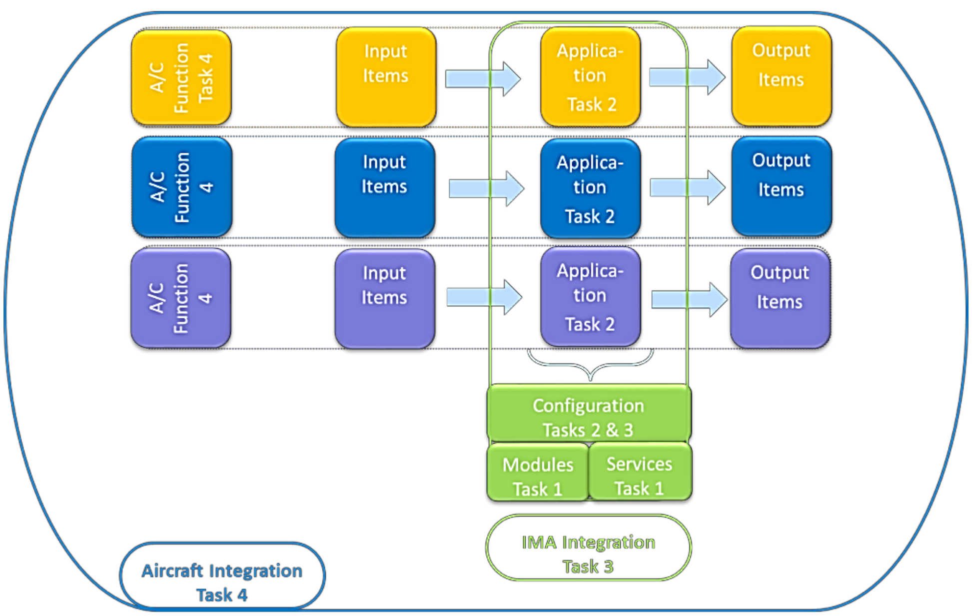
The following sections further explain the flexibility that is inherent in the DO-297 approach.

3.1.3.1 **DO-297 Task Framework.**

DO-297 structures the IMA development activities by tasks and objectives to be achieved at the AEH/SW/module item level. This framework also suggests a definition of roles and responsibilities of the different stakeholders involved in the IMA system development (e.g., application supplier, IMA system integrator).

Figure 3-1 of this AC illustrates a mapping between an IMA system breakdown and the certification tasks of DO-297.

Figure 3-1. Mapping Between an IMA System and the DO-297 Certification Tasks.



Among the considerations detailed in the DO-297 tasks, the key IMA specificities are outlined below:

- Task 1: The need to develop resources/services to be shared by applications and the adequate associated mechanisms (e.g., partitioning, health monitoring, etc.), and the need to document these resources, services, and mechanisms for the IMA platform users.
- Task 2: The need to characterize the applications in terms of their resource usage and execution constraints, and the need to verify that the applications satisfy the platform's usage domain.
- Task 3: The need to verify that the whole set of applications complies with the platform usage domain, and the proper implementation of the resource allocation and platform configuration requests from the applications.
- Task 4: Little specificity in comparison with non-IMA systems.

3.1.3.2 **Relationship with Other Guidelines.**

In order to maximize the credit taken from other standards and existing processes, two certification approaches based on the DO-297 tasks and objectives are considered eligible to support an IMA system certification:

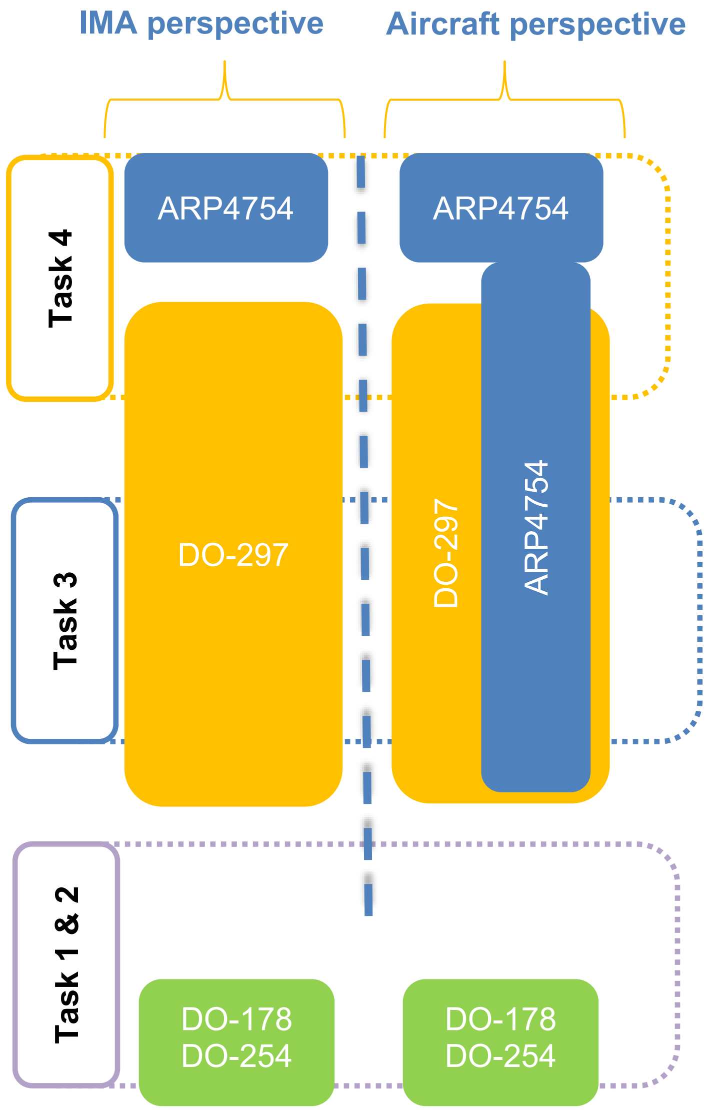
- IMA system perspective: Consider the application of DO-297 as a complete and consistent set of objectives.
- Aircraft perspective: IMA system certification, and its specificities, are addressed within the global framework of the aircraft certification and its related processes. This means DO-297 considerations and objectives may be covered by other aircraft system processes and activities.

As ARP4754( ) provides guidance and an acceptable means of compliance for the development of systems, its processes may be used to cover DO-297 objectives and activities. However, the use of ARP4754( ) will not ensure exhaustive coverage of the DO-297 objectives. Consequently, the IMA-specific objectives and activities of DO-297 will remain to be addressed separately from the ARP4754( ) objectives.

These two approaches are suitable because they ensure the completeness of the activities supporting an IMA system certification.

Figure 3-2 of this AC shows the links between DO-297 tasks and other guidelines.

Figure 3-2. Links Between DO-297 Tasks and Other Guidelines.



3.1.3.3 **Tailoring of DO-297 Tasks.**

A task framework is proposed by DO-297, but it is not the purpose of this AC to enforce this division of tasks. The allocation of objectives to the DO-297 tasks can be tailored by the applicant.

For instance, an IMA specificity is the need to coordinate verification activities such that the performance of the integrated IMA system can be guaranteed without requiring the reverification of each hosted application on the entire integrated system:

- DO-297, Chapter 3.1.3 d.2, may be interpreted as requesting that IMA integration should be performed with the full set of applications. However, the applicant may integrate and verify applications independently on the IMA platform, considering the platform properties (e.g., robust partitioning and resource management).

- Some Task 3 objectives may be anticipated and accomplished with Task 2, or they may be deferred until performance of Task 4.

If the applicant intends to develop an IMA system and the supported aircraft functions by tailoring the DO-297 tasks or by following another framework, the applicant should detail the division of tasks, the objectives of each work package, and the associated activities.

The applicant should describe how the work package objectives map to the DO-297 objectives to ensure they are met within the alternative framework. The DO-297 life cycle data can also be adapted to the division of tasks and work packages defined by the applicant.

Moreover, DO-297 Task 4 may have few IMA specificities compared to a federated architecture. The achievement of Task 4 to support compliance demonstration might be considered outside the scope of this AC, provided that:

- The aircraft integration activity is covered through other guidance and its related applicant processes (to be clarified in the certification plan).

- Task 3 is complete, meaning that no objectives, activities, or life cycle data are deferred to or covered by Task 4.

Another area where tailoring can be performed is requirement validation. DO-297 Chapter 5.3.a. considers that each level of requirements within the hierarchy should be validated prior to validating the next lower level. A strict interpretation of this statement would not allow the development of a platform based on the assumptions for the intended use without consideration of the final aircraft functions (as suggested in Chapter 4.2.1.b). Also, it would imply a top-down approach from the aircraft functions to the level of hardware and the core/support software, which may not be relevant. A bottom-up approach is also feasible, which involves ensuring that the platform usage rules and constraints identified in the platform user guide/manual (Chapter 4.2.12.e.) are fulfilled, and that they satisfy the IMA system requirements.

3.1.4 Use of Alternative Means to Demonstrate Compliance.

If an applicant elects to comply with an alternative means of compliance with 14 CFR, then consistency with the DO-297 acceptance objectives in Annex A tables [A1-A6] (IMA module/platform development process objectives) should be demonstrated.

Early coordination with the FAA is recommended.

3.2 Use of Previously Recognized Means of Compliance.

3.2.1 Applicants may use previously recognized means of compliance as part of a new application if all the following conditions are met:

- Equivalency to DO-297 objectives has been shown;
- The means of compliance were evaluated and found to be acceptable by the FAA on a previous certification project; and
- The new IMA system is similar to the version of the IMA system that was used in the previously accepted certification project (i.e., with a similar architecture, the same design concepts, the same development process, and the same certification approach).

3.2.2 Early coordination with the FAA to confirm the use of the applicant's previously recognized means of compliance is recommended.

3.3 Role of the IMA System Certification Plan.

3.3.1 DO-297 objectives can be met by using various organizational and work sharing concepts based on the sharing of roles, activities, and life cycle data. The strategy selected for demonstration of compliance with DO-297 and this AC should be defined by the applicant in their certification plans.

3.3.2 An IMA system certification plan should introduce the planning, organization, work share, and work packages, as well as the development, validation, integration, and verification activities of the IMA system.

3.3.3 Considerations regarding the content of an IMA system certification plan can be found in DO-297 Chapter 4.4.3. The certification plan should particularly emphasize the following topics:

- The scope covered by the IMA system certification plan and its relationship with other certification plans, including the certification plans of the aircraft functions hosted—totally or partially—on the IMA system.

- The strategy proposed by the applicant to demonstrate compliance with this AC, including:
  - The certification approach selected (see Chapter 3 of this AC);
  - The relationship and credit potentially taken from other standards or processes to satisfy the objectives of DO-297;
  - The nature and extent of credit claimed from previously approved components (i.e., having obtained a TSOA) or from activities performed on components reused from previous certification projects (see Chapter 4 of this AC); and
  - The identification of modules, platforms, and applications for which full or partial incremental compliance credit is sought.
- The industrial organization supporting the IMA system development and certification, including the roles, responsibilities, and work share between the stakeholders. The work share between stakeholders should particularly focus on:
  - The sharing of activities related to aircraft functions hosted on the IMA platform and the IMA system integration activities;
  - The tailoring and scope of the DO-297 tasks, or DO-297 life cycle data when applicable; and
  - The work package allocated to each IMA stakeholder, including the design, validation, verification, and integration activities, including environmental qualification under their responsibility and the credit claimed for the incremental certification.
- The activities planned for the integration of the IMA system and its installation on an aircraft with an emphasis on:
  - The establishment of full or partial incremental credit gained from the integration, validation, and verification activities conducted at each stage of the development with their associated transition criteria. If a future step cannot be planned by a stakeholder (who, for instance, would only perform the development of a function), then the interface to future steps and the assumptions made (e.g., on resources used) need to be identified;
  - The credit expected from the characteristics of the IMA platform to independently verify aircraft functions allocated or partially allocated to the IMA system;
  - The activities to be completed for the installation of a TSO-C153a or TSO-C214 article; and

  - The rationale for not performing some ground or flight tests when the IMA system is installed on the aircraft.

- A description of the development and verification environments, with emphasis on the tools used to generate data or automate the activities and the rationale for the qualification or non-qualification of the tools.

  Note: A dedicated IMA system certification plan may not be required, provided that its role is equivalently performed by a comprehensive set of documents in the applicant's data package.

CHAPTER 4. INCREMENTAL CERTIFICATION PROCESS

The incremental certification process is the process for which the FAA agrees to grant some credit to a component/module, application, or system, before that module, application, or system is configured, integrated, and certified as part of the final product.

The incremental certification process applies to the three following approaches. In all cases, the applicant should evaluate and substantiate the suitability and level of the credit sought:

a) Incremental component qualification: Credit is taken from activities performed during various steps of the development to reduce the effort during a subsequent phase (e.g., verification activities). This qualification is built up using the incremental verification approach.

Note: Activities should be under configuration control and conformed.

b) Reuse: Credit is taken from activities performed on components (e.g., modules, platforms, applications) reused from other projects. This approach encompasses the components reused from a previously approved TC or from legacy IMA systems.

c) Compliance credit: Formal credit claimed from a TSOA.

Note: A TSOA is not a mandatory step in the certification of an IMA system.

Table 4-1 of this AC identifies the certification responsibilities, activities, and evidence aspects of the incremental certification process.

The applicant is responsible for ensuring and demonstrating that each component is integrated and installed consistently with its function, interfaces, usage domain, and limitations, regardless of the recognition of the credit approach selected and the level of credit granted.

Table 4-1. Incremental Certification Evidence Table.

Approach		Demonstration of Compliance—Responsibilities	Applicant Activities	Evidence Supporting the Claim
(a)	Incremental component qualification See Chapter 4.1 of this AC.	Under the full responsibility of the applicant.*	Full compliance demonstration is expected from the applicant.	Evidence of review and acceptance by the applicant, covering all objectives for which credit is sought, including final review reports (at software, hardware, platform, and IMA system level(s), as applicable).
(b)	Reuse See Chapter 4.2 of this AC.	Under the full responsibility of the applicant.*	Compliance demonstration may be tailored depending on the agreement with the FAA.** **Note:** Demonstration of compliance for the IMA components may be reduced (e.g., no software development and verification reviews as part of Task 2).	Previous set of evidence. Evidence of review and acceptance by the applicant, covering all objectives for which credit is sought, including final review reports (at software, hardware, platform, and IMA system level(s), as applicable).
(c)	Compliance credit See Chapter 4.3 of this AC.	Shared between the: • TSOA holder for the scope covered by the TSOA (e.g., module/platform). • Applicant* for the completion of integration activities, installation activities, or both.	Compliance demonstration is reduced according to the certification credit claimed from the TSOA.	TSOA

* "Applicant" refers to the applicant developing the IMA system, installing the IMA system, or both.

** Discussions are held on a case-by-case basis based on the information provided through the certification plan.

4.1 **Incremental Component Qualification.**

4.1.1 One main characteristic of IMA systems and the DO-297 task framework is that they allow a high level of independence in the design and verification activities between:

- The functional level (application) and the resource level (module/platform); and
- Different applications (except for possible functional coupling between applications).

4.1.2 In addition, DO-297, Chapter 2.2.e introduces the concept of "composability," where the integration of a new application does not invalidate any of the verified requirements of an already integrated application. When an IMA system is "composable," credit can be taken from its properties (e.g., robust partitioning) regarding two aspects:

- During the development of the application itself, when credit may be taken from the module/platform development activities.
- During the integration and verification activities, when credit may be taken from the integration of the application and from the absence of impact on other already verified and installed applications.

4.1.3 These principles drive a modular approach, which can be used to support an incremental component qualification process, provided the following considerations are fulfilled:

- The applicant should define criteria and supporting evidence to demonstrate the achievement of all objectives for which credit is sought.
- The applicant should assess, and record through a formal review, the achievement and acceptance of a set of objectives for a given component. For instance, a final software and hardware review on the components of a module and the acceptance of the corresponding software and hardware accomplishment summaries could support the completion of DO-297 Task 1.

4.1.4 Depending on the framework and organization, strict AC 20-115() or DO-178C compliance may not, on its own, be sufficient to show the achievement of a given task. Complementary accomplishment summaries should be provided and encompassed in the applicant's review.

4.2 **Reuse of Components.**

The applicant remains fully responsible for the contents of the associated data, which are assessed through the applicant's activities as being reusable in the context of the current certification project.

4.2.1 Reuse from a Legacy IMA System.

Components that were previously approved may be reused if the applicant shows that the reuse of the component is appropriate. If changes are necessary, a change impact analysis should be performed to identify the scope of the changes and the necessary activities to re-engage to cover the changes.

4.2.2 Reuse from a Previous DO-297 Project.

The management of reused components is addressed through DO-297 Task 6 (DO-297 Chapter 4.7). If changes are intended, they should be managed through DO-297 Task 5 (DO-297 Chapter 4.6).

Note: To facilitate the reuse of a component, DO-297 recommends developers anticipate such reuse during the initial development through dedicated objectives that are part of Tasks 1 and 2 (e.g., the module acceptance plan providing the data listed in Chapter 4.2.3.h).

4.3 Compliance Credit from IMA TSOA.

Formal certification credit is offered from a TSOA granted to platform(s) or module(s) through TSO-C153a and application(s) integrated with a TSO-C153a module/platform through TSO-C214.

4.3.1 Use of a TSO-C153a Authorization.

A TSO-C153a authorization can be granted for a platform(s)/module(s) to facilitate its use in an IMA system. According to TSO-C153a paragraph 3.2.2.1, the IMA module or platform should meet the DO-297 Task 1 objectives. Compliance credit could be claimed by an applicant for the demonstration of compliance with DO-297 Task 1, provided the TSOA applicant obtained a TSO-C153a authorization for the platform(s)/module(s) beforehand.

Nevertheless, the TSOA does not by itself ensure that the platform(s)/module(s) is technically adequate to be integrated into the IMA system. The applicant remains responsible for all the activities to ensure the proper integration of the TSO-C153a platform(s)/module(s) into the IMA system.

The applicant should substantiate the scope of the TSOA compliance credit and define the complementary certification activities based on the data provided (e.g., user/installation manuals). Additionally, the applicant should demonstrate the correct use of the platform(s)/module(s), including compliance:

- With the platform/module integration requirements/user requirements, and the IMA system and safety requirements.

- Of the use, the partitioning, the health monitoring, the configuration of the resources, and the installation of the items with the platform or module's user guide/manual, installation manual, or equivalent data as documented per TSO-C153a Appendix 3. This also includes the deactivation or disabling of unused TSO-C153a functions/modules, when available, or the means to ensure that the intended function is performed without any interference from unused TSO-C153a functions/modules.

This section only addresses the use of FAA TSO-C153a, and its use cannot be extended to any other authority or TSO standards on IMA platforms and modules that are not equivalent to their technical requirements.

4.3.2 Use of a Functional TSO-C214 Authorization.

Through a functional TSO-C214 (referred to as an F-TSO in TSO-C214), authorization can be granted to application(s) integrated with a TSO-C153a module/platform. As per TSO-C214, compliance with the DO-297 Task 2 and 3 objectives has to be demonstrated. Compliance credit could hence be claimed by an applicant for the demonstration of compliance with DO-297 Tasks 2 and 3, provided that the functional TSO-C214 authorization had been obtained beforehand.

Nevertheless, the functional TSO authorization does not by itself ensure that the TSO article is technically adequate to be installed in the product. The applicant remains responsible for all the activities to ensure the proper integration of the application(s)/module(s)/platform(s) into the IMA system, and the applicant should:

- Substantiate the scope of the TSOA compliance credit and define the complementary certification activities.

- Complete the demonstration that the aircraft function covered by the functional TSO-C214 authorization complies with the IMA system and safety requirements.

If the article is authorized as TSO-C214 "open" class and the applicant intends to perform incremental development on the TSO article (e.g., to add an application), the considerations of this AC apply to the new and affected items. The applicant should ensure the integrity and continuity of the system configuration and, in particular, should show that the resource allocation, partitioning, and health monitoring are not impaired by the intended changes to the TSO article. The level of credit that can be obtained from the previously authorized TSO-C214 article, and the certification activities to be completed in the frame of this AC, will vary depending on the scope of the changes made to the initial article.

If the article is authorized as TSO-C214 "closed" class, then it no longer offers any capability for IMA development. Credit can be taken for DO-297 Tasks 2 and 3. This closed class is equivalent to a conventional TSO article.

4.3.3 Summary of TSO Compliance Credit

Table 4-2 of this AC summarizes the credit that can be claimed from TSO-C153a and TSO-C214, as well as the remaining certification activities to support the demonstration of compliance with AC 20-170A.

Table 4-2. TSO Compliance Credit for AC 20-170A.

TSO	Credit	Remaining activities
TSO-C153a	Acceptance of the platform/module (DO-297 Task 1).	Substantiation of the scope of TSOA compliance credit. All subsequent activities (DO-297 Tasks 2 and 3, plus those deferred to Task 4).
TSO-C214 “open” class	Acceptance of the platform/module (DO-297 Task 1). Acceptance of the non-impacted Hosted application(s) (DO-297 Task 2).	Substantiation of the scope of TSOA compliance credit. Demonstration that the functional TSO-C214 article complies with the IMA systems and safety requirements. All activities impacted by the incremental development, such as on the modified or a new hosted application (DO-297 Task 2), and IMA configuration and integration (DO-297 Task 3 plus those deferred to Task 4).
TSO–C214 “closed” class	Acceptance of the platform/module (DO-297 Task 1). Acceptance of the hosted application(s) (DO-297 Task 2). IMA configuration and integration (DO-297 Task 3).	Substantiation of the scope of TSOA compliance credit.

CHAPTER 5. ADDITIONAL RECOMMENDATIONS FOR IMA SYSTEM CERTIFICATION

5.1 Fault Management and Human Factors.

5.1.1 DO-297 Chapter 3.6.5 deals with the annunciation of failures to the crew. Flightcrew alerting systems and warning, caution, and advisory lights are specifically addressed in 14 CFR 23.2605(b), 25.1322, 27.1322, 29.1322, and their associated ACs. If an inconsistency is identified, the text in the applicable 14 CFR part prevails.

5.1.2 Similarly, if an inconsistency is identified between DO-297 Chapter 3.10, *Human Factors Considerations,* and any 14 CFR part that addresses human factors or flightcrew interface, such as § 25.1302, the text in the applicable 14 CFR part prevails.

5.2 Configuration Data/Parameter Data Items.

5.2.1 Guidance on IMA configuration data is provided in DO-297 Chapter 3.7.1.1 at the IMA system level and in Chapter 3.7.1.2 at the application level. These data items are currently described as "parameter data items" as defined in DO-178C and should be treated in the same way as other elements of the software. Depending on how a parameter data item will be used in the IMA system or application, it needs to be defined, managed, and documented at the appropriate level (e.g., platform, module, application) and to comply with the guidance in AC 20-115D or later version, including the process to ensure intermixability and compatibility during the post-TC period as indicated in DO-297. In particular, any parameter data item should be assigned the same software level as the component using it. Configuration identification is the applicant's responsibility.

5.3 Use of Tools and the Need for Qualification.

5.3.1 IMA system development may be supported by the use, at the system level, of tools to eliminate, reduce, or automate the activities associated with the DO-297 objectives. If a tool could introduce an error or fail to detect an error, and there are no other alternative means to detect the issue, then qualification of the tool is needed.

5.3.2 For instance, a tool may be used to generate or verify IMA configuration data and may produce an erroneous configuration that is not easily detectable at a subsequent integration/verification step.

5.3.3 The objectives of tool qualification are to:

- Ensure an equivalent level of confidence in the non-automated process/activities.
- Demonstrate that the tool complies, and its qualification is commensurate with the intended use.

5.3.4 Adequate guidance for tool qualification is provided in DO-330, *Software Tool Qualification Considerations,* and should be followed when a tool is intended to be qualified to support the IMA system development.

5.3.5 Both the impact of the tool and the item development assurance level (IDAL) of the IMA component supported by the tool are used to determine the appropriate tool qualification level (TQL). The following criteria should be used to determine the appropriate TQL according to its intended use:

- Impact of the tool:

  Criterion 1: A tool whose output is part of the IMA system and thus could introduce an error.

  Criterion 2: A tool that automates verification process(s) and thus could fail to detect an error, and whose output is used to justify the elimination or reduction of:

  - Verification process(es) other than that (those) automated by the tool; or
  - Development process(es) that could have an impact on the IMA system.

  Criterion 3: A tool that, within the scope of its intended use, could fail to detect an error.

- IDAL of the IMA component supported by the tool:

Table 5-1. IDAL Criteria.

IDAL	**Criteria**		
	1	**2**	**3**
A	TQL-1	TQL-4	TQL-5
B	TQL-2	TQL-4	TQL-5
C	TQL-3	TQL-5	TQL-5
D	TQL-4	TQL-5	TQL-5

5.4 **Change Management.**

5.4.1 This section deals not only with changes to components that were previously accepted through a type certificate (TC), supplemental type certificate (STC), or TSOA, but also with changes during the development as soon as components are delivered for use in a subsequent stage of the process and a formal baseline is established for these components.

5.4.2 The main objectives of the change management process are to conduct and document a change impact analysis and to reintegrate the changed component into the IMA system, performing all the necessary verification, validation, and integration activities, including regression analysis and testing.

5.4.3 Since there are various levels of development and integration in an IMA system, and potentially various stakeholders (i.e., module/platform developers, application developers, IMA system integrators, aircraft designers, etc.), agreements should be concluded between stakeholders to establish the way to communicate changes to any application and to perform impact analyses at each level.

5.4.4 A change impact analysis should consider the possible impacts to be reported at each relevant level:

- Changes at the resource allocation level.
- Changes at the module/platform level.
- Changes at the application level.

5.4.5 Impacts on incremental compliance credit, if applicable, should also be considered.

5.4.6 The changes should be documented in the appropriate life cycle data, including the trace data, configuration indexes, and accomplishment summaries.

5.5 **Management of Problem Reports.**

5.5.1 IMA systems contain multiple applications hosted on the same IMA module/platform, therefore any OPR related to a module/platform or application, collected at any level, could affect one or several aircraft functions directly or indirectly.

5.5.2 Considering the diversity of stakeholders in an IMA system, the management of problem reports can be more complex compared to federated systems. In addition to the applicable guidance on OPR management for IMA systems, the applicant should organize the management of OPRs, focusing on:

- The evaluation of the potential effect of each OPR on any shared resources and IMA services, and the evaluation of those OPRs for impact on any aircraft function that uses the affected shared resources and IMA services.
- The verification that necessary workarounds, including limitations, at the application level, system level, or both, are documented within the IMA documentation (e.g., user guide/manual). In such cases, the efficiency of a

workaround should be substantiated, and the successful (i.e., complete and correct) deployment of the workaround should be ensured.

Note: In order to facilitate the assessment and communication between stakeholders, the use of a harmonized classification scale for OPRs is recommended.

5.6 **Environmental Qualification.**

5.6.1 The scope of this section is to provide environmental qualification guidance complementary to DO-297 Chapter 5.2.6 for the environmental qualification of an IMA system. It can be an IMA platform composed of only one LRU or various modules in a given configuration. The platform is qualified in conditions of the same severity as those expected when installed on the aircraft, interfaced with its peripherals through the aircraft or equivalent harnesses, and loaded with its set of applications. The acceptance criteria to qualify the platform are driven by the operational requirements of a given aircraft.

5.6.2 Level of Qualification Testing Activities.

The modularity of an IMA platform makes it possible to conduct qualification testing activities at various stages:

- IMA module testing: The testing is performed on an IMA module, involving the shared resources (hardware, software, or both) and, when relevant, with a representative set of software applications loaded onto the module. In the case of a cabinet, the module can be a chassis, a backplane, or both.
- IMA platform testing: The testing is performed on the platform or cabinet (chassis and backplane) equipped with its modules and, when relevant, loaded with a representative set of software applications.
- System testing: The testing is performed on a set of modules, the backplane installed in the cabinet, or both, with system peripherals interfaced with the cabinet, and with representative software applications loaded onto the modules.
- Aircraft testing: The testing is performed with the systems installed on the aircraft.

The modularity of the IMA platform, combined with the variety of its possible configurations, leads to the establishment of principles to reuse qualification credit for IMA modules in the context of qualifying a desired IMA platform for a given aircraft:

- The environmental usage domain of an IMA module is the set of environmental conditions for which it is qualified. This is documented in the module user guide/manual.

- For an IMA module integrated within a cabinet, its environmental qualification conditions should consider:
  - The envelope of environmental conditions encountered inside the cabinet when in use on the aircraft (i.e., thermal, electromagnetic, vibration, lightning, etc.).
  - All its possible arrangements in the cabinet (i.e., different IMA platform configurations).

5.6.3 Incremental Environmental Qualification.

Incremental environmental qualification is an approach used in qualifying a cabinet populated with modules in a known configuration for a given aircraft, relying on existing qualification credit for IMA modules in their environmental usage domain, and identifying any complementary qualification substantiation that would be necessary to cover the envelope of the environmental conditions of the aircraft. Thus, it provides the latitude to populate a cabinet with already qualified modules, to qualify it without having to perform a full reassessment of the qualification of each module, and the capability to reuse its existing qualification dossier.

All the substantiation data recorded in the qualification plan should be based on dedicated tests or on equivalence with the reuse of existing qualification results or existing authorizations such as TSO-C153a. The representativeness of the substantiation should consider the testing configuration, the testing conditions (including electrical, thermal, mechanical interfaces, etc.), the qualification testing level, the application software used for the testing, the test scenario, and the level of stress applied.

When an IMA system change is implemented, a change impact analysis should be conducted against the qualified configuration to assess the complementary qualification substantiation to be provided for each of its modules.

APPENDIX A. DEFINITION OF KEY TERMS

A.1 The following definitions apply to this AC.

Term	Meaning
Aircraft function	A capability of the aircraft that is provided by the hardware and software of the systems on the aircraft. [DO-297]
Application	Software and/or application-specific hardware with a defined set of interfaces that, when integrated with a platform(s), performs a function. [DO-297]
Cabinet	Result of the integration of hardware modules mounted within one rack. [TSO-C153a]
Compliance credit	Evidence that a set of objectives related to certification requirements has been reached for a component or a set of components. Credit can be full or partial, meaning that, in case of partial credit, some objectives allocated to the component were not yet satisfied and should be completed at another stage.
Component	A self-contained hardware part, software part, database, or combination of them that is configuration-controlled. A component does not provide an aircraft function by itself. [DO-297 Chapter 2.1.1]
Core software	The operating system and support software that manage resources to provide an environment in which applications can execute. Core software is a necessary component of a platform and is typically comprised of one or more modules (such as: libraries, drivers, kernel, data-loading, boot, etc.). [DO-297]
Federated system	Aircraft equipment architecture consisting of primarily line replaceable units that perform a specific function, connected by dedicated interfaces or aircraft system data buses. [DO-297]
IMA system	Consists of an IMA platform(s) and a defined set of hosted applications. [TSO-C153a]
Incremental certification	Process by which the FAA agrees to grant compliance credit to IMA modules/platforms or hosted applications considered independently, based on activities performed at intermediate steps.
Intermixability	The capability to intermix software and/or hardware of different versions and/or modification standards. [DO-297]
Interoperability	The capability of several modules to operate together to accomplish a specific goal or function. [DO-297]
Module	A component or collection of components that may be accepted by themselves or in the context of an IMA system. A module may also

Term	Meaning
	comprise other modules. A module may be software, hardware, or a combination of hardware and software, which provides resources to the IMA system hosted applications. [DO-297]
Module/ platform configuration	The action of setting some adjustable characteristics of the module/platform in order to adapt it to the user context. By extension, the result of this action. NOTE: A configuration table is one way but not the only way to configure a module/platform.
Partitioning and robust partitioning	Partitioning is "An architectural technique to provide the necessary separation and independence of functions or applications to ensure that only intended coupling occurs." [DO-297] Robust partitioning is a means for assuring the intended isolation in all circumstances (including hardware failures, hardware and software design errors, or anomalous behavior) of aircraft functions and hosted applications using shared resources. The objective of robust partitioning is to provide a level of functional isolation and independence equivalent to that of a federated system implementation.
Platform	A module or group of modules, including core software that manages resources in a manner sufficient to support at least one application. [DO-297]
Resource	Any object (processor, memory, software, data, etc.) or component used by a processor, IMA platform, core software or application. A resource may be shared by multiple applications or dedicated to a specific application. A resource may be physical (a hardware device) or logical (a piece of information). [DO-297]
Support software	Embedded software necessary as a complement to the operating system to provide general services such as contributing to the intended function of resources sharing, handling hardware, drivers, software loading, health monitoring, boot strap, etc. [TSO-C153a]
Usage domain	An exhaustive list of conditions (such as configuration settings, usage rules, etc.) to be respected by the user(s) to ensure that the IMA module continues to meet its characteristics. Compliance with the usage domain ensures that: • The module is compliant with its functional, performance, safety and environmental requirements specified for all implemented intended functions. • The module characteristics documented in the user guide/manual remain at the levels guaranteed by the manufacturer. • The module remains compliant with the applicable airworthiness requirements (including continuing airworthiness aspects).

Term	Meaning
	[Adapted from TSO-C153a, without reference to the TSO Minimum Performance Standard]

APPENDIX B. ACRONYMS

B.1 **The following acronyms are referenced in this AC.**

Abbreviation	Meaning
AC	Advisory Circular
AEH	Airborne Electronic Hardware
AMC	Acceptable Means of Compliance
API	Application Programming Interface
ATA	Air Transport Association of America
CFR	Code of Federal Regulations
CS	Certification Specification
EASA	European Union Aviation Safety Agency
FAA	Federal Aviation Administration
F-TSO	Functional TSO
I/O	Input/Output
IDAL	Item Development Assurance Level
IMA	Integrated Modular Avionics
LRU	Line Replaceable Unit
MMEL	Master Minimum Equipment List
OPR	Open Problem Report
STC	Supplemental Type Certificate
SW	Software
TC	Type Certificate
TQL	Tool Qualification Level
TSO	Technical Standard Order
TSOA	Technical Standard Order Authorization

APPENDIX C. RELATED REGULATIONS AND GUIDANCE MATERIAL

C.1 Title 14, Code of Federal Regulations (14 CFR).

The following 14 CFR regulations are related to this AC. You can download the full text of these regulations from the Federal Register website at www.ecfr.gov.

- Section 21 subpart O, *Technical Standard Order Approvals.*
- Section 23.2500, *Airplane level systems requirements.*
- Section 23.2505, *Function and installation.*
- Section 23.2510, *Equipment, systems, and installations.*
- Section 25.1301, *Function and installation.*
- Section 25.1309, *Equipment, systems, and installations.*
- Section 27.1301, *Function and installation.*
- Section 27.1309, *Equipment, systems, and installations.*
- Section 29.1301, *Function and installation.*
- Section 29.1309, *Equipment, systems, and installations.*
- Section 33.28, *Engine control systems.*
- Section 35.23, *Propeller control systems.*

C.2 FAA Advisory Circulars.

The following ACs are related to the guidance in this AC. The latest version of each AC referenced in this document is available on the FAA website at FAA Advisory Circulars and on the Dynamic Regulatory System.

- AC 20-115, *Airborne Software Development Assurance Using EUROCAE ED-12( ) and RTCA DO-178( ).*
- AC 20-152, *Development Assurance for Airborne Electronic Hardware (AEH).*
- AC 20-171, *Alternatives to RTCA/DO-178B for Software in Airborne Systems and Equipment.*
- AC 20-174, *Development of Civil Aircraft and Systems.*
- AC 20-189, *Management of Open Problem Reports (OPRs).*
- AC 21-16G, *RTCA Document DO-160 versions D, E, F, and G, "Environmental Conditions and Test Procedures for Airborne Equipment."*
- AC 21-46, *Technical Standard Order Program.*
- AC 21-50, *Installation of TSOA Articles and LODA Appliances.*
- AC 23.1309-1, *System Safety Analysis and Assessment for Part 23 Airplanes.*

- AC 23.2010-1, *FAA Accepted Means of Compliance Process for 14 CFR Part 23.*
- AC 25.1309-1, *System Design and Analysis.*
- AC 27-1, *Certification of Normal Category Rotorcraft.*
- AC 29-2, *Certification of Transport Category Rotorcraft.*
- AC 33.28-1, *Compliance Criteria for 14 CFR § 33.28, Aircraft Engines, Electrical and Electronic Engine Control Systems.*
- AC 33.28-2, *Guidance Material for 14 CFR § 33.28, Reciprocating Engines, Electrical and Electronic Engine Control Systems.*
- AC 33.28-3, *Guidance Material for 14 CFR § 33.28, Engine Control Systems.*
- AC 35.23-1, *Guidance Material for 14 CFR § 35.23, Propeller Control Systems.*

C.3 **European Union Aviation Safety Agency (EASA).**

The following certification specification (CS) documents can be obtained online at https://www.easa.europa.eu/home.

- AMC 20-115( ), *Airborne Software Development Assurance Using EUROCAE ED-12 and RTCA DO-178.*
- AMC 20-152( ), *Development Assurance for Airborne Electronic Hardware (AEH).*
- AMC 20-170, *Integrated Modular Avionics (IMA).*

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