European Aviation Safety Agency

Notice of Proposed Amendment 2017-11

INTEGRATED MODULAR AVIONICS — PHASE 2

RMT.0456 (RMT.0621, RMT.0622)

EXECUTIVE SUMMARY

The objective of this NPA is to maintain a high level of safety, while promoting a level playing field in certification and the use of integrated modular avionics (IMA).

This NPA proposes to:

— offer to integrators of aircraft functions on already-authorised IMA platforms the possibility to obtain ETSO authorisations, independent from any aircraft on which the platforms might be installed (covered in ETSO-2C516);
— provide guidance for the incremental certification of IMA, starting from platform modules, culminating with the installation of the IMA on an aircraft, and covering all the related aspects (in AMC 20-170).

The proposed changes are expected to contribute to more efficient and transparent certification processes, while bringing positive impacts, in particular with their economic, social and environmental benefits.

Action area:	Efficiency/proportionality		
Affected rules:	AMC-20: General Acceptable Means of Compliance for airworthiness of products, parts and appliance CS-ETSO: European Technical Standard Orders		
Affected stakeholders:	Manufacturers (IMA system integrators, application suppliers, platform and module suppliers)		
Driver:	Efficiency/Proportionality	**Rulemaking group:**	No
Impact assessment:	Light	**Rulemaking Procedure:**	Standard

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1. About this NPA

1.1. How this NPA was developed

EASA developed this NPA in line with Regulation (EC) No 216/2008[1] (hereinafter referred to as the 'Basic Regulation') and the Rulemaking Procedure[2]. This rulemaking activity is included in the EASA 2017-2021 Rulemaking and Safety Promotion Programme[3] under rulemaking task (RMT).0456.

It is hereby submitted to all interested parties[4] for consultation.

1.2. How to comment on this NPA

Please submit your comments using the automated **Comment-Response Tool (CRT)** available at **http://hub.easa.europa.eu/crt/**[5].

The deadline for submission of comments is **29 September 2017.**

1.3. The next steps

Following the closing of the public commenting period, EASA will review all comments.

Based on the comments received, EASA will develop a decision amending AMC-20 and CS-ETSO.

The comments received and EASA's responses thereto will be reflected in a comment-response document (CRD). The CRD will be annexed to the decision.

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1 Regulation (EC) No 216/2008 of the European Parliament and of the Council of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency, and repealing Council Directive 91/670/EEC, Regulation (EC) No 1592/2002 and Directive 2004/36/EC (OJ L 79, 19.3.2008, p. 1) (http://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1467719701894&uri=CELEX:32008R0216).

2 EASA is bound to follow a structured rulemaking process as required by Article 52(1) of Regulation (EC) No 216/2008. Such a process has been adopted by the EASA Management Board (MB) and is referred to as the 'Rulemaking Procedure'. See MB Decision No 18-2015 of 15 December 2015 replacing Decision 01/2012 concerning the procedure to be applied by EASA for the issuing of opinions, certification specifications and guidance material (http://www.easa.europa.eu/the-agency/management-board/decisions/easa-mb-decision-18-2015-rulemaking-procedure).

3 http://easa.europa.eu/rulemaking/annual-programme-and-planning.php

4 In accordance with Article 52 of Regulation (EC) No 216/2008 and Articles 6(3) and 7) of the Rulemaking Procedure.

5 In case of technical problems, please contact the CRT webmaster (crt@easa.europa.eu).

2. In summary — why and what

2.1. Why we need to change the rules — issue/rationale

The use of Integrated Modular Avionics (IMA) has expanded in the last two decades and is expected to grow even more in the future. Nowadays, IMA can be found in all categories of aircraft.

IMA is commonly defined as a shared set of flexible, reusable and interoperable hardware and software resources that, when integrated, form a 'system' that provides computing resources and services, designed and verified to meet a defined set of functional, safety and performance requirements, as well as to host applications performing aircraft functions.

The concept 'one computer – one function' is now replaced by a set of non-system-specific and highly configurable computers. Multiple system applications are executed on the same platform and network. IMA would allow recurrent development and maintenance cost savings, which could be tailored to the needs of the TC/STC holders and aircraft operators. Additionally, it could generate indirect cost savings due to reductions in aircraft weights and power consumptions.

As there were no specific requirements (even in CS-ETSO or the AMC-20 series) for the certification of IMA in Europe, RMT.0456 was initiated in 2012. The purpose of the RMT was to consider the issuance of provisions to address the various aspects of IMA certification at:

(a) platform level (i.e. the design and production of the IMA platform integrating hardware and software, but not yet including applications performing aircraft functions);

(b) system level (i.e. when applications performing aircraft functions are integrated on the IMA platform, but not yet in the aircraft); and

(c) aircraft level when the IMA platform and all the aircraft functions hosted by it are installed and integrated on the airframe.

The US Federal Aviation Administration (FAA) had already covered the aspects of (a) and (c) by issuing TSO-C153 in 2002 and AC 20-170 in 2010. This situation had created a regulatory 'gap', which was a disadvantage for EU avionics manufacturers and an administrative burden for EASA, since the IMA certification process in the EU:

— was based on CRIs with interpretative materials, which are, however, (S)TC-specific and therefore not publicly available to other interested parties;

— was dedicated to IMA development and installation in a specific aircraft in the frame of a TC or an STC process;

— did not approve the platform independently of the aircraft, whereas IMA platforms are composed of modules which are designed to be reusable on several aircraft types and independent of the aircraft;

— did not allow the delivery of platforms and components accompanied by an ETSO authorisation, which penalises European manufacturers in comparison with US ones.

In April 2016, EASA issued ETS0-2C153[6] on IMA platforms and modules, offering to IMA platform/module manufacturers the possibility to obtain ETSO authorisations at the

[6] https://www.easa.europa.eu/download/etso/ETSO-2C153_CS-ETSO_10.pdf

platform/module level, independent of the aircraft on which the IMA may be installed (aspect (a) above). This has contributed to improving the efficiency and the transparency of the certification process and has partially reduced the disadvantage of European manufacturers compared to US manufacturers.

With this NPA, EASA intends to address points b) and c) listed above.

2.2. What we want to achieve — objectives

The overall objectives of the EASA system are defined in Article 2 of the Basic Regulation.

The specific objectives are to:

— ensure the periodical updating of rules, taking into account worldwide in-service aircraft experience, and scientific and technological progress, as required by article 5.6(b) of the Basic Regulation, including CS-ETSO for parts and appliances,

— contribute to more cost-efficient and transparent certification processes covering IMA certification at system and aircraft level,

— cover the regulatory 'gap' on the EASA side in comparison with the US FAA that would continue to penalise industry and require more effort from both EASA and industry during the certification process.

2.3. How we want to achieve it — overview of the proposals

2.3.1. Proposed amendments to CS-ETSO

The amendments proposed to CS-ETSO are intended to offer to integrators of aircraft functions on already-authorised IMA platforms the possibility to obtain ETSO authorisations, independently from the aircraft on which the platforms will be installed (covered in ETSO-2C516).

In more detail, it is proposed to:

— amend CS-ETSO Subpart A in order to introduce the concept of a functional ETSO article, which is applicable to equipment implementing applications on an ETSO-2C153-authorised IMA platform/module.

— introduce the new ETSO-2C516, which is applicable to any equipment presented for an ETSO authorisation to a functional[7] ETSO standard, where the equipment implements applications on a ETSO-2C153-authorised IMA platform/module and from which the applicant seeks compliance credit from these ETSO authorisations to demonstrate compliance with a functional ETSO.

The proposed ETSO-2C516 is an incremental step between ETSO-2C153 and the complete IMA systems certified during aircraft type certification.

Depending on the approach selected by the applicant regarding the future evolutions of the F-ETSO[8] equipment, two classes have been envisaged by EASA:

[7] functional ETSO standard: any ETSO standard of CS-ETSO describing an aircraft function, currently all standard except ETSO-2C153 and this current 2C516 standard.

[8] F-ETSO equipment: is the integrated equipment seeking for this ETSO standard approval, using ETSO-2C153 platform(s)/module(s).

— Class 'Open',

— Class 'Closed'.

Class '**Open**' refers to equipment that has been integrated so as to take into account a future evolution in an IMA context. That means that there are still shared resources available, that the constraints for future evolution of the equipment are defined, and that the performance of the remaining resources has been characterised. Additional provisions for Class Open equipment are provided in Appendix 1 of the proposed ETSO.

Class '**Closed**' refers to equipment that has been integrated and where no evolution has been anticipated, the performance of the remaining resources are not characterised, and therefore all IMA-related activities are considered closed.

The approach described above is completely new in the (E)TSO context. Since for the time being there is no equivalent FAA TSO, a new number from the index 2C5XX has been assigned to this ETSO (i.e. 2C516).

2.3.2. Proposed amendments to AMC-20

The amendments proposed to AMC-20 are intended to provide guidance to support IMA system certification, starting from platform modules and culminating with IMA installation on aircraft and covering all the connected aspects. In order to achieve this objective, a new AMC, namely 20-170 'IMA' has been developed.

The newly proposed AMC provides a means that can be used to demonstrate that the safety aspects of IMA systems and equipment comply with the airworthiness requirements when such systems are integrated in a product, a part or an appliance submitted to EASA.

In more detail, the proposed AMC 20-170 document:

— provides an overview and background on IMA systems and concerns related to their certification (refer to AMC 20-170 Section 2),

— presents the EASA policy for IMA certification by recognising the use of EUROCAE document ED-124, Integrated Modular Avionics (IMA) Development Guidance and Certification Considerations, as an acceptable means of compliance for the development and certification of IMA systems, or permits the use of alternative means of compliance instead of that document,

— clarifies and amends the intent, scope, and use of ED-124 (refer to AMC 20-170 Section 3), and additionally highlights some significant differences between the EASA and FAA systems,

— introduces the incremental certification approach and introduces the link to ETSO authorisations (ref to AMC 20-170 Section 4),

— complements ED-124 with additional considerations on dedicated topics, such as OPRs, and configuration files (ref to AMC 20-170 Section 5).

2.4. What are the expected benefits and drawbacks of the proposals

Overall, the proposed amendment would provide for a more efficient and transparent certification process, while bringing positive impacts, in particular with its economic, social and environmental benefits. No drawbacks are expected.

3. Proposed amendments and rationale in detail

The text of the amendment is arranged to show deleted text, new or amended text as shown below:

— deleted text is ~~struck through~~;

— new or amended text is highlighted in grey;

— an ellipsis '[…]' indicates that the rest of the text is unchanged.

3.1. Draft certification specifications (Draft EASA decision)

CS ETSO

SUBPART A - GENERAL

1. APPLICABILITY

1.1 Requirements for the issue of European Technical Standard Order (ETSO) authorisations are found in Part-21, Section A, Subpart O.

1.2 Marking requirements for the issue of European Technical Standard Order authorisations are found in Part-21, Section A, Subpart Q.

2. ~~ENVIRONMENTAL AND SOFTWARE~~ STANDARDS TO MEET TECHNICAL CONDITIONS

2.1 Environmental standards

Unless otherwise stated in ~~the~~ paragraph 3.1.2 of the specific ETSO, the applicable environmental standards are contained in EUROCAE/RTCA document ED-14D Change 3/DO-160D 'Environmental Conditions and Test Procedures for Airborne Equipment', Change 3 dated December 2002, ED-14E/DO-160E dated March 2005, ED-14F/DO-160F dated March 2008, ED-14G/DO-160G dated December 2010 or ED-14G Change 1/DO-160G Change 1 dated January 2015.

It is not permissible to mix versions within a given qualification programme.

2.2 Software standards

When the equipment includes airborne software, unless otherwise stated in paragraph 3.1.3 of the specific ETSO, one acceptable means of compliance for the development of the airborne software is outlined in the latest revision of AMC 20-115 entitled ~~on~~ Software Considerations in Airborne Systems and Equipment Certification.

The ~~S~~software level, also ~~called~~ known as the item development assurance level (IDAL), may be determined by using the guidance proposed in S~~s~~ection 2.4. The applicant must declare the software level(s) to which the software has been developed and verified.

2.3 Airborne electronic hardware (AEH)

If the article contains a complex ~~A~~application ~~S~~specific ~~I~~integrated ~~C~~circuit (ASIC) or a complex programmable logic device ~~(~~such as ~~e.g.~~ a ~~P~~programmable ~~A~~array ~~L~~logic components (PAL), a ~~F~~field-~~P~~programmable ~~G~~gate ~~A~~array components (FPGA), a ~~G~~general ~~A~~array ~~L~~logic components (GAL), or an ~~E~~erasable ~~P~~programmable ~~L~~logic ~~D~~device (EPLD), ~~summarised~~ all of which are known as '~~C~~complex ~~E~~electronic hardware' to accomplish the function, develop the component according to EUROCAE/RTCA document ED-80/DO-254 'Design Assurance Guidance for Airborne Electronic Hardware', dated April 2000.

Supplemental guidance material for all other airborne electronic hardware (including boards, simple electronic hardware ~~or~~ ~~SEH~~, ~~and simple~~ use of COTS devices) included in the ETSO article may be found in 'EASA CM-SWCEH-001 Development Assurance of Airborne Electronic Hardware' Issue 01, revision 01, dated March 2012.

The ~~D~~design ~~A~~assurance ~~L~~level, also ~~called~~ known as the Iitem ~~D~~development ~~A~~assurance ~~L~~level (IDAL) for ~~A~~airborne ~~E~~electronic ~~H~~hardware (AEH), may be determined by using the guidance proposed in Section 2.4. The applicant must declare the ~~D~~design ~~A~~assurance ~~L~~level(s) to which the AEH has been developed and verified.

2.4 Failure conditions classification and development assurance

During the development of equipment, consideration should be given to failure conditions, and the equipment should then be developed in accordance with the~~ir~~ possible effects of those failure conditions at the system and aircraft levels (see AMC CSxx.1309 for further guidance, for CS-23 aircraft further guidance can be found in FAA AC 23.1309-1E).

The equipment shall be developed according to, at least, the development assurance level appropriate to the failure condition classifications expected for the intended installation.

Where the effects at system or aircraft level are not known, due to the non-availability of aircraft or system design data, assumed failure classifications may be used but at a minimum to the level required in the ETSO.

Classification of failure conditions at equipment level may change as a result of particular aircraft installation architecture and characteristics.

EUROCAE/SAE document ED-79A/ARP 4754A, 'Guidelines for Development of Civil Aircraft and Systems', dated December 2010, may be used to assign the development assurance level of the equipment, software and AEH. The document may be used as well as guidance to ensure a proper development, validation and verification of the ETSO and the functional equipment requirements.

2.5 Functional ETSO article using an ETSO-2C153-authorised IMA platform or module

When the equipment implements one (or several) ETSO-2C153-authorised Integrated Modular Avionics (IMA) platforms/modules and for which the applicant seeks compliance credit from

this/these ETSOA authorisation/s to demonstrate compliance with the functional ETSO standard, the applicant shall apply for authorisation to the ETSO-2C516 standard, together with the intended functional ETSO standard.

Note: a functional ETSO standard is any ETSO standard of CS-ETSO describing an 'aircraft' function, excluding ETSO-2C153 and ETSO-2C516.

3. ADDITIONAL INFORMATION

3.1 In some ETSOs, reference is made to an associated FAA standard. In these cases the corresponding FAA technical standard order (TSO) can be consulted on http://rgl.faa.gov/Regulatory_and_Guidance_Library/rgTSO.nsf/Frameset?OpenPage.

3.2 ~~The following addresses are provided below~~ Industry standards referred to in this CS-ETSO may be purchased or obtained from the following organisations:

— EUROCAE documents may be purchased from:
European Organisation for Civil Aviation Equipment
102 rue Etienne Dolet, 92240 Malakoff, France
Telephone: +33 1 40 92 79 30; Fax +33 1 46 55 62 65;
(E-mail: eurocae@eurocae.net, website: www.eurocae.net)

— RTCA documents may be purchased from:
Radio Technical Commission for Aeronautics, Inc.
1828 L Street NW, Suite 805, Washington DC 20036, USA
(Website: www.rtca.org)

— SAE documents may be purchased from:
Society of Automotive Engineers, Inc.
400 Commonwealth Drive, WARRENDALE, PA 15096-001, USA
(Website: www.sae.org)

— NAS specifications may be obtained from:
Aerospace Industries Association (AIA)
1327 Jones Drive, Ann Arbor, MI 48105, USA
(Website: www.techstreet.com)

— FAA Standards may be purchased from:
Superintendent of Documents, Government Printing Office
732N Capitol Street NW, Washington DC 20401, USA
(Website: www.gpoaccess.gov)

— MIL Specifications may be obtained from:
DODSSP, Standardization Documents Order Desk
Building 4D, 700 Robbins Avenue, PHILADELPHIA, PA 19111-5094, USA
or from the ASSIST Customer Service Desk, telephone (215) 697-6396.
(Website: ~~http://dodssp.daps.mil/~~ http://quicksearch.dla.mil/)

— ASTM documents may be purchased from:
American Society for Testing and Materials, ASTM International,

100 Barr Harbor Drive, PO Box C700, West Conshohocken, Pennsylvania 19428-2959, USA
(Website: www.astm.org)

SUBPART B – LIST OF ETSOs (INDEX 1 AND INDEX 2)

[…]

Index 2 (*)

EASA ETSO Ref	Title	Last amended by
ETSO-2C11e	Power Plant Fire Detection Instruments (Thermal and Flame Contact Types)	CS-ETSO/Initial Issue
ETSO-2C19c	Portable Water-Solution Type Hand Fire Extinguishers	CS-ETSO/12
ETSO-2C34f	ILS Glide Slope Receiving Equipment Operating within the Radio Frequency Range of 328.6–335.4 Megahertz (MHz)	CS-ETSO/Initial Issue
ETSO-2C35d	Radar Marker Receiving Equipment	CS-ETSO/Initial Issue
ETSO-2C36f	Airborne ILS Localizer Receiving Equipment Operating within the Radio Frequency Range 108–112 Megahertz	CS-ETSO/Initial Issue
ETSO-2C40c	VOR Receiving Equipment Operating within the Radio Frequency Range of 108–117.95 Megahertz	CS-ETSO/Initial Issue
ETSO-2C41d	Airborne Automatic Direction Finding (ADF) Equipment	CS-ETSO/Initial Issue
ETSO-2C48a	Carbon Monoxide Detector Instruments	CS-ETSO/6
ETSO-2C66b	Distance Measuring Equipment (DME) Operating within the Radio Frequency Range 960–1215 Megahertz	CS-ETSO/Initial Issue
ETSO-2C75	Hydraulic Hose Assembly	CS-ETSO/Initial Issue
ETSO-2C93b	Airborne Interim Standard Microwave Landing System Converter Equipment	CS-ETSO/Initial Issue
ETSO-2C104a	Microwave Landing System (MLS) Airborne Receiving Equipment	CS-ETSO/Initial Issue
ETSO-2C122	Devices That Prevent Blocked Channels Used in Two-Way Radio Communications Due to Simultaneous Transmissions	CS-ETSO/Initial Issue
ETSO-2C128	Devices That Prevent Blocked Channels Used in Two-Way Radio Communications Due to Unintentional Transmissions	CS-ETSO/Initial Issue
ETSO-2C153	Integrated Modular Avionics (IMA) Platform and Modules	CS-ETSO/10
ETSO-2C169a	VHF Radio Communications Transceiver Equipment Operating within the Radio Frequency Range 117.975 to 137 Megahertz	CS-ETSO/6
ETSO-2C197	Information Collection and Monitoring Systems	CS-ETSO/7
ETSO-2C500a	Combined ILS/MLS Airborne Receiving Equipment	CS-ETSO/Initial Issue
ETSO-2C501	Mode S Aircraft Data Link Processor	CS-ETSO/Initial Issue
ETSO-2C502	Helicopter Crew and Passenger Integrated Immersion Suits	CS-ETSO/1
ETSO-2C503	Helicopter Crew and Passenger Immersion Suits for Operations to or from Helidecks Located in a Hostile Sea Area	CS-ETSO/1

EASA ETSO Ref	Title	Last amended by
ETSO-2C504	Helicopter Constant-Wear Life Jackets for Operations to or from Helidecks Located in a Hostile Sea Area	CS-ETSO/1
ETSO-2C505	Helicopter Life Rafts for Operations to or from Helidecks Located in a Hostile Sea Area	CS-ETSO/1
ETSO-2C509	Light Aviation Secondary Surveillance Transponders (LAST)	CS-ETSO/2
ETSO-2C512	Portable Gaseous Oxygen Supply (PGOS)	CS-ETSO/3
ETSO-2C513	Tow Release	CS-ETSO/3
ETSO-2C514a	Airborne Systems for Non-Required Telecommunication Services (in Non-Aeronautical Frequency Bands) (ASNRT)	CS-ETSO/13
ETSO-2C515	Aircraft Halocarbon Clean Agent — Hand Held Fire Extinguishers	CS-ETSO/11
ETSO-2C516	Functional-ETSO equipment using an ETSO-2C153 authorised IMA platform or module	CS-ETSO/14

(*) = this index is prepared on the basis of the changes proposed by NPA 2017-08 related to regular update of CS-ETSO

ETSO-2C516
Date: xx.xx.2017

European

Aviation

Safety

Agency

European Technical Standard Order

Subject: FUNCTIONAL-ETSO EQUIPMENT USING AN ETSO-2C153-AUTHORISED IMA PLATFORM OR MODULE

1 - Applicability

This ETSO standard is applicable to any equipment presented for an ETSO authorisation to a functional[9] ETSO standard, where the equipment implements one (or several) ETSO-2C153-authorised IMA platforms/modules for which the applicant seeks compliance credit from these ETSOA authorisations to demonstrate compliance with a functional ETSO.

Note: This ETSO standard is also applicable to any equipment for which an applicant is seeking an ETSO authorisation of a functional ETSO standard where the applicant performs additional development on an already-authorised ETSO-2C516 Class Open article and intends to take compliance credit from this authorisation to demonstrate compliance with further functional ETSO standards.

This ETSO provides the requirements which functional ETSO equipment using an ETSO-2C153-authorised IMA platform or module or integrating further an ETSO-2C516-authorised article that is designed and manufactured on or after the date of this ETSO must meet in order to be identified with the applicable ETSO marking.

EUROCAE ED-124 and RTCA DO-297 recognise an incremental IMA system approval by introducing intermediate acceptance steps. ETSO-2C153 authorisation is the first step in the ETSO IMA authorisation process. This ETSO standard, 2C516, is an intermediate step to authorise functional ETSO equipment[10] implementing an ETSO-2C153-authorised IMA platform or IMA modules, when the applicant is seeking compliance credit from these preceding authorisations to demonstrate

[9] functional ETSO standard: any ETSO standard of CS-ETSO describing an aircraft function, currently all standard except ETSO-2C153 and this current 2C516 standard

[10] F-ETSO equipment: is the integrated equipment seeking for this ETSO standard approval, using ETSO-2C153 platform(s)/module(s).

compliance with a functional ETSO standard. This ETSO standard defines the requirements and delta activities that shall be performed for the authorisation of the integrated F-ETSO equipment.

Note: this ETSO standard does not define the minimum operational performance specifications of the defined function; these are defined by the individual 'functional' [1] ETSO standard, with which the applicant may elect to comply (refer to CS-ETSO Subpart A, Section 2.5).

2 - Procedures

2.1 - General

The applicable procedures are detailed in CS-ETSO Subpart A.

2.2 - Specific

2.2.1 - Access to the information of the selected ETSO-2C153 platforms/modules

The applicant is responsible for establishing the necessary communication channels with the ETSO-2C153 holder company.

The applicant shall have access to all necessary design data as a 'user' of the ETSO-2C153 platform (for instance the DDP, user's guide/manual per ETSO-2C153 Appendix 3, installation manual, environmental qualification plans/reports …).

The applicant's organisation shall establish a communication means to obtain timely notifications of design changes, open problem reports (at least the ones impacting the usage of the platform), and occurrence reports (including Airworthiness Directives) that affect or relate to the ETSO-2C153 platform/modules.

2.2.2 - Assessment of design changes

The applicant shall perform an impact analysis on ETSO-2C153 platform design evolutions on the functional ETSO equipment, and shall perform the necessary development life cycle activities that are impacted by the ETSO-2C153 changes.

Note: the functional ETSO holder is responsible for assessing the classification of the changes to the F-ETSO equipment as minor or major as per Part 21.A.611 and for providing the necessary associated justification.

Change management processes shall be compliant with AMC 20-170 Section 5.4.

2.2.3 - Assessment and reporting of Open Problem Reports

The management, analysis and classification of open problem reports shall be performed by the applicant following the objectives of AMC 20-170 Section 5.5, for which objective a) of that section is adapted to the F-ETSO context as follows:

a) The reporting of open problem reports (OPRs) between the different ETSO-2C153 platforms/modules and the F-ETSO equipment shall be established and assessed by the F-ETSO applicant.

3 - Technical Conditions
3.1 – Basic

3.1.1 - Minimum Performance Standard

This section provides the minimum performance standard requirements for the process of further development of equipment using an ETSO-2C153-authorised platform(s)/module(s) for which a functional ETSO authorisation (defined as the F-ETSO equipment) is sought.

The process requirements will cover the environmental qualification, the hardware development assurance, software development assurance and finally the integration of these developed items into the F-ETSO equipment to demonstrate compliance for the intended function, using the credit of the authorised ETSO-2C153 platform/modules.

Definition of classes

This ETSO is an incremental step between ETSO-2C153 and complete IMA systems certified during an aircraft type certification. Depending on the future evolution of the F-ETSO equipment, two classes have been defined:

— Class 'Open'

— Class 'Closed'

Class Open refers to ETSO article that has been integrated taking into account a future evolution of the equipment in an IMA context. That means that there are still shared resources available, that the constraints for future evolution of the equipment are defined, and that the performance of the remaining resources has been characterised.

Class Closed refers to ETSO article that have been integrated and where no evolution has been anticipated (apart from minor changes per 21.A.611), and the performance of the remaining resources is not characterised. All IMA-related activities are considered closed, meaning no additional functionality on the IMA platform/module under the concept of modular avionics is foreseen.

Class	Minimum Performance Standard
Open	Section 3 of this document and Appendix 1
Closed	Section 3 of this document

3.1.1.1 - Use of 'ETSO-2C153' authorised platforms/modules

Identification of the ETSO-2C153 platforms/modules used

(a) The applicant shall clearly define the ETSO-2C153 platforms/modules used in the design and the associated ETSO-2C153 authorisation credit that is intended to be used for the F-ETSO

equipment compliance demonstration.

(b) The ETSO approval and the part number including issue/minor revisions of the ETSO-2C153 platforms/modules used shall be clearly referenced in the certification plan and in the DDP.

(c) Any components/functions included in the ETSO-2C153 platforms/modules but unused in the current F-ETSO equipment shall be clearly identified.

(d) The applicant shall identify and quantify the usage (used and unused features) of the ETSO-2C153 platform resources, including usage of its health monitoring and fault management resources.

Proper use of the ETSO-2C153 platform(s)/module(s)

(e) The applicant shall demonstrate the proper use of the ETSO-2C153 platform(s)/module(s), including compliance with the platform integration requirements/user requirements and with the requirements for the correct use of platform safety features. In particular, the applicant shall demonstrate that the use, the partitioning, the configuration of the resources and the installation of the items are performed on the ETSO-2C153 platform/modules in compliance with the ETSO-2C153 user manual, installation manual or equivalent data (as documented per ETSO-2C153 Appendix 3). This also includes the deactivation of unused ETSO-2C153 functions/modules.

3.1.1.2 - Equipment/Hardware/Software Development

The ETSO certification plan shall describe the F-ETSO equipment and its structural breakdown. This shall include the use and integration of the ETSO-2C153-authorised platform(s)/module(s) within the F-ETSO equipment. The F-ETSO equipment certification plan shall introduce the planning, the organisation, the division of tasks and the development, validation, integration, and verification activities conducted on the IMA system, including the tool environment used for those activities.

Considerations regarding the content of this certification plan, and guidance on IMA certification plans can be found in ED-124 Chapter 4.4.3.

In particular, the ETSO certification plan shall indicate the structure of the life cycle data that will support the compliance demonstration with the ETSO requirements.

Non-ETSO functions

Any non-ETSO function embedded in the equipment shall be developed and integrated in conformance to the requirements of this section, in order to be able to demonstrate that it does not interfere with the ETSO functions.

Any non-ETSO functions embedded in the equipment shall be clearly identified as non-ETSO functions in the certification plan.

3.1.1.2.1 - Hardware Development

(a) The applicant shall clearly define the additional hardware part that will be developed and integrated with the ETSO-2C153 platforms/modules that are used.

(b) The development of the hardware shall be compliant with CS-ETSO, Subpart A 2.3.

3.1.1.2.2 - Software/Application Development

(a) The applicant shall clearly define the software applications that will be developed and integrated with the ETSO-2C153 platforms/modules that are used and with any possible additional hardware.

(b) The development of software components/hosted applications shall be compliant with subpart A 2.2.

(c) The development of the hosted applications executing on an ETSO-2C153 platform shall comply with the Task 2 objectives defined in ED-124/DO-297 Table A-2 and Chapter 4.3.1, except Objective 4.3.1 d., and with the following adaptation for Objective 4.3.1 a., where the ED-124/DO-297 text is replaced by:

Objective 4.3.1 a.:
'Demonstrate that each application performs its intended function and satisfies the related ETSO standard and subpart A 2.2 requirements and the ETSO article requirements while properly utilising the appropriate platform resources and interfacing with other modules and/or applications.' Particularly it shall be demonstrated that the hosted application on the ETSO-2C153 platform/module complies with the user requirements provided by the ETSO-2C153 provider (see the CS-ETSO/ETSO-2C153 standard - Appendix 3).

(d) Any non-ETSO application embedded in the equipment shall be developed in conformance to the above requirements (b) and (c) in order to be able to demonstrate that it does not interfere with the ETSO functions.

The associated life cycle data to demonstrate the above requirements shall be produced and organised to support the functional ETSO system integration objectives, and to show that the applications are executing correctly within the platform and module requirements and limitations.

Even though the objectives for the development of hosted applications remain applicable, when relevant, some activities/life cycle data might be combined with F-ETSO equipment activities/data (next section).

3.1.1.2.3 - Equipment Integration Process

There are several levels of integration that are possible for functional ETSO equipment using ETSO-2C153 authorised platforms/modules, of which some examples are listed here:

— The integration of software applications on an ETSO-2C153 LRU platform;

— The integration of several ETSO-2C153 modules to build an integrated LRU equipment and its software applications; and

— The integration of additional hardware simultaneously with software applications, together with an ETSO-2C153 platform/module or additional hardware, into an ETSO-2C153 rack platform.

General Objective

a) The applicant shall perform the integration of the ETSO-2C153 platform(s) and modules used with any additional hardware and the hosted software applications. These integration activities have to be compliant with the ED-124/DO-297 Task 3 objectives defined in ED-124/DO-297 Table A-3 and Chapter 4.4.1, except Objective 4.4.1 a., and with the following adaptation for Objective 4.4.1 d. where the ED-124/DO-297 text is replaced by:

Objective 4.4.1 d.:

Demonstrate compliance with the applicable functional ETSO standards and related MOPS.

Note: Even though the integration activities have their own objectives, when relevant, some activities/data might be combined with some activities/life cycle data of the development of the hosted applications (see Section 3.1.1.2.2).

Health Monitoring and fault management

b) The applicant shall describe how the ETSO-2C153 health monitoring and fault management resources are used and integrated with the other platform/modules/application features, resulting in the health monitoring and fault management of the functional ETSO equipment.

In particular:

Principles and mechanisms shall be defined in order to allow the consistent sharing of fault management data between ETSO-2C153 module/platform resources and the ETSO functions.
Recovery mechanisms shall be defined to ensure the continuity of the ETSO functions when needed.

Guidance on health monitoring and fault management can be found in ED-124 Chapters 3.6.1 to 3.6.7.

Guidance about health monitoring and fault management at the platform and application levels respectively can also be found in ED-124 Chapters 3.1.1 b. 5) and 3.1.2 d.

Configuration Data / Parameter Data Items

c) The guidance of AMC 20-170 Section 5.2 shall be followed.

Use of tools and tool qualification

d) The guidance of AMC 20-170 Section 5.3 shall be followed.

3.1.1.2.4 - Safety Assessment

The safety assessment of the F-ETSO shall consider the possible failures in the ETSO-2C153 platform/modules used in the equipment that are described by the platform provider in their failure modes and effect analysis and the safety assessment of the F-ETSO equipment. If any assumptions have been made at the ETSO-2C153 platform/modules level, they shall be validated by the F-ETSO safety assessment process.

Note: if additional hardware is added to a ETSO-2C153 platform/module, it shall also be considered in the safety assessment.

3.1.2 - Environmental Standard

The applicant shall demonstrate the compliance of the integrated F-ETSO equipment with the environmental requirements identified in CS-ETSO Subpart A, paragraph 2.1.

If the applicant intends to reuse evidence from an earlier demonstration of compliance achieved by the ETSO-2C153 platform/module, an assessment of the achieved performance shall be performed so as to identify any gaps between the earlier qualification of the ETSO-2C153 platform/module and the intended F-ETSO environment, in compliance with the requirements of Subpart A, Section 2.1. The qualification test plan of the F-ETSO shall clearly identify any additional qualification activities and any tests that need to be re-performed considering the integration of several hardware platforms/modules and the possible differences between the intended environment of the F-ETSO equipment and the environment for which the ETSO-2C153 platform/modules were qualified.

The impact of the integration of the different platform/modules and additional hardware/software shall be taken into account in the establishment of the qualification test plan.

3.1.3 – Software

See CS-ETSO Subpart A, paragraph 2.2, and Section 3.1.1.2.2 of this ETSO standard.

3.1.4 – Airborne Electronic Hardware

See CS-ETSO Subpart A, paragraph 2.3, and Section 3.1.1.2.1 of this ETSO standard.

3.2 - Specific

The installation manual shall include all the data necessary for the proper installation and use of the F-ETSO equipment.

The installation manual shall document a means to ensure the compatibility between the ETSO-2C153 module authorisation and the F-ETSO authorisation.

The installation manual shall provide compatibility and mixability information between the IMA modules, software and hardware components composing the platform and the IMA application.

3.2.1 Failure Condition Classification

See CS-ETSO Subpart A, paragraph 2.4.

The failure condition classification that is appropriate for the equipment will not be driven by this ETSO standard, but driven by the intended aircraft function and the minimum classification indicated in the functional ETSO standard to which the equipment intends to comply.

4 - Marking

4.1 - General

See CS-ETSO Subpart A, paragraph 1.2.

4.2 - Specific

The applicant shall mark the ETSO article with ETSO-2C516 associated with the selected class of the equipment:

— ETSO-2C516 Open, or

— ETSO-2C516 Closed.

The applicant shall maintain the original ETSO marking of the ETSO-2C153 platform and modules used in the F-ETSO equipment. When electronic marking was used, this electronic marking shall remain available, even after having developed additional software.

5 - Availability of Referenced Document

See CS-ETSO Subpart A, paragraph 3.

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Appendix 1 for Class Open IMA equipment

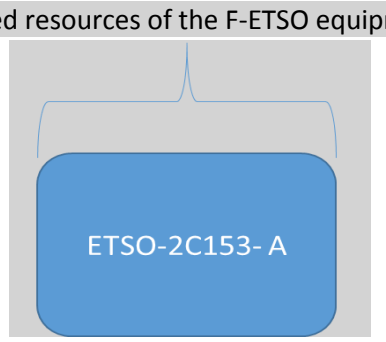
This appendix is additional is applicable to class Open equipment.

1-Open platform IMA resources

When the 2C516-ETSO platform is of class Open, the F-ETSO applicant needs to properly characterise and document the resulting platform resources and partitioning features for the next user.

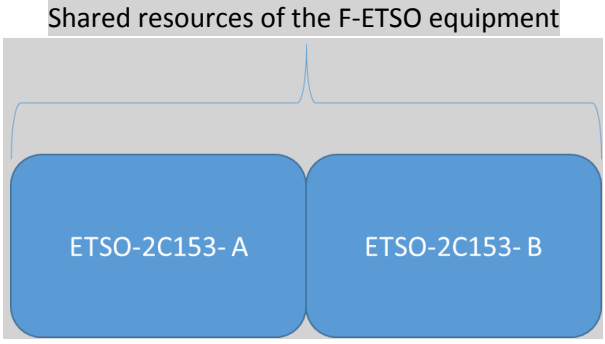
Three main cases of Open platforms are distinguished in order to adapt the requirements to their needs as follows:

a) When the applicant uses only one ETSO-2C153 platform and does not augment its resources, as illustrated below



then the applicant shall describe the use of the original ETSO-2C153 platform with regards to the ETSO-2C153 Appendix 3 data (such as the user guide) and describe the remaining resources with respect to that Appendix 3 data so that it is clear which shared resources remain available for future incremental development by an independent user or aircraft manufacturer. In particular, the resources that are used and allocated shall be described, and quantified.

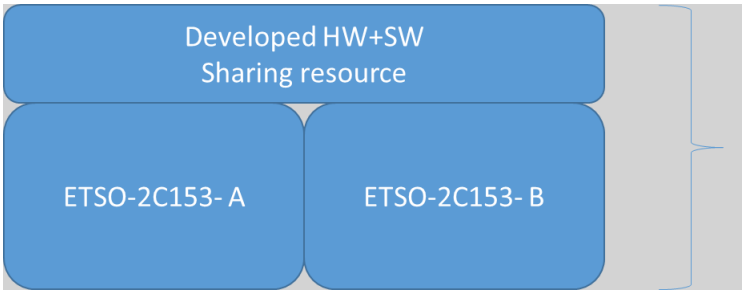
When the F-ETSO equipment integrates multiple ETSO-2C153-authorised resources without augmenting the IMA sharing capability, as illustrated below,



the F-ETSO applicant shall characterise the resulting platform using the individual characterisation of the ETSO-2C153 platform and document the resulting ETSO-2C516 open platform in compliance with ETSO-2C153 Appendix 3.

ETSO-2C516
Date: xx.xx.2017

b) When the F-ETSO equipment augments the IMA sharing resources with additional development (hardware and/or software), as illustrated below



the equipment development shall comply with ETSO-2C153 Appendix 2 and the related classes and document the augmented open platform 2C516 in compliance with ETSO-2C153 Appendix 3.
The applicant can use the Appendix 3 ETSO-2C153 data of the ETSO-2C153 platform/modules that are used and augment or amend them to elaborate the 2Cxx Open platform user data, in compliance with ETSO-2C153 Appendix 3.

2-Continuous Health Monitoring capability

As a user of an ETSO-2C153 platform/modules, the F-ETSO applicant should pay particular attention to ensuring that there is a continuous health monitoring capability. Health monitoring features provided in an 'Open' class platform shall be continuously maintained and characterised throughout the integration process, and the health monitoring capability shall be made available for any potential further incremental development.

AMC 20-170
'IMA'

1. Introduction

1.1. Purpose

This acceptable means of compliance (AMC) provides a means that can be used to demonstrate that the safety aspects of integrated modular avionics (IMA) systems and equipment comply with the airworthiness requirements when such systems are integrated in a product, a part or an appliance submitted to EASA.

Compliance with this AMC is not mandatory and hence an applicant may elect to use alternative means of compliance. However, those alternative means of compliance must meet the relevant certification specifications, ensure an equivalent level of safety and be accepted by EASA on a product basis.

1.2. Scope and applicability

The guidance contained in this AMC applies to any TC or STC applicants seeking approval from EASA for IMA systems installed in aircraft or rotorcraft.

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 [ED-124].

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 LRUs.

This AMC addresses certification considerations for IMA systems, and should apply when:

— Hosted applications* on the same platform are designed, verified and integrated independently (at application level**) from each other, and

— The platform/modules provide shared resources (typically designed, verified and integrated independently from the hosted applications),

OR

— A process for obtaining incremental certification*** credit is anticipated or applied.

* A single application hosted on an independently developed platform is considered to be a traditional federated architecture and thus is not subject to this AMC. However, if additional application(s) that is (are) independently developed is (are) hosted on the same platform at a later stage (e.g. through a major change), this AMC should be applied.

** Software integration/verification activities are not performed on the whole set of integrated software as in a federated architecture.

*** Credit for incremental certification in an IMA context as detailed in Section 4.

An applicant may choose to apply this AMC for a system which would not fulfil the conditions above. In that case, early discussions should take place between the applicant and EASA in order to confirm whether this AMC should be followed or not.

1.3. Document overview

This document:

a) provides an overview and background information on IMA systems and concerns related to their certification (Section 2),

b) presents the EASA policy for IMA certification by recognising the use of EUROCAE document ED-124, 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 (in Section 3),

c) introduces the incremental certification approach, and introduces the link to ETSO authorisations (in Section 4),

d) complements ED-124 with additional considerations on dedicated topics, such as cybersecurity, open problem reports (OPRs), and configuration files (in Section 5).

1.4. Documents to be used with this AMC

This AMC should be used together with the following documents. The applicable version of the documents for a given project will be established in the certification basis or in the applicable CRIs.

Reference	Title
ED-124/DO-297	Integrated Modular Avionics (IMA) Development Guidance and Certification Considerations
*ED-79/ARP4754	Certification Considerations for Highly-Integrated or Complex Aircraft Systems
ED-79A/ARP4754A	Guidelines for Development of Civil Aircraft and Systems
ED-12()/DO-178()	Software Considerations in Airborne Systems and Equipment Certification
ED-80/DO-254	Design Assurance Guidance for Airborne Electronic Hardware
ARP4761()	Guidelines and Methods for Conducting the Safety Assessment Process on Airborne Systems and Equipment
ED-14()/DO-160()	Environmental Conditions And Test Procedures For Airborne Equipment
ED-215/DO-330	Software Tool Qualification Considerations

* ED-79A should be used, unless ED-79 is the applicable document in the given project.

1.5. Referenced Material

1.5.1. Certification Specifications and AMC

Reference	Title
CS-XX.1301	Function and installation
CS-XX.1302	Installed systems and equipment for use by the flight crew
CS-XX.1309	Equipment, systems and installations
AC 23.1309-1()	System safety analysis and assessment for Part 23 airplanes
AMC 25.1309	System Design and Analysis
AC 27.1309	Equipment, systems and installations
AC 29.1309	Equipment, systems and installations
CS-XX.1322	Flight Crew Alerting
CS-E 50	Engine Control System
AMC E 50	Engine Control System
AMC 20-3	Certification of Engines Equipped with Electronic Engine Control Systems
AMC 20-115()	Software Considerations for Certification of Airborne Systems and Equipment
ETSO-2C153	Integrated Modular Avionics (IMA) Platform and Modules
ETSO-2C516	Functional-ETSO Equipment using authorised ETSO-2C153 IMA Platform or Module

The applicable version of the documents for a given project will be established in the certification basis or in the applicable CRIs.

1.5.2. Referenced documents

Reference	Title
ARINC 653	Avionics Application Software Standard Interface
ED-94C	Supporting Information for ED-12C and ED-109A

1.6. Definitions and Abbreviations

1.6.1. Definitions

Definition	Meaning
Aircraft Function	A capability of the aircraft that is provided by the hardware and software of the systems on the aircraft. [ED-124]
Application	Software and/or application-specific hardware with a defined set of interfaces that, when integrated with a platform(s), performs a function. [ED-124]
Cabinet	Result of the integration of hardware modules mounted within one rack. [ETSO-2C153]
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 thereof that is configuration controlled. A component does not provide an aircraft function by itself. [ED-124 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, for example, libraries, drivers, kernel, data-loading, boot, etc.) [ED-124]
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. [ED-124]
IMA System	Consists of (an) IMA platform(s) and a defined set of hosted applications. [ETSO-2C153]
Incremental certification	The incremental certification process is the process by which EASA 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 [ED-124]
Interoperability	The capability of several modules to operate together to accomplish a specific goal or function. [ED-124]
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 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. [ED-124]

Definition	Meaning
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.' [ED-124] Robust partitioning is a means for assuring the intended isolation in all circumstances (including hardware failures, hardware and software design errors, or anomalous behaviour) 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. [ED-124]
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). [ED-124]
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. [ETSO-2C153]
Usage Domain	The usage domain of an IMA module is defined as 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 remain at the levels guaranteed by the manufacturer. — the module remains compliant with the applicable airworthiness requirements (including continuing airworthiness aspects). [Adapted from ETSO-2C153, without reference to the ETSO Minimum Performance Standard]

1.6.2. Abbreviations

Abbreviation	Meaning
AEH	airborne electronic hardware
AMC	acceptable means of compliance
APEX	application programming interface called application executive as per ARINC 653
API	application programming interface
ATA	air transport association of America
CRI	certification review item
CS	certification specification

Abbreviation	Meaning
EASA	European aviation safety agency
ETSO	European technical standard order
ETSOA	European technical standard order authorisation
F-ETSO	functional ETSO
HW	hardware
IDAL	item development assurance level
I/O	input/output
IMA	integrated modular avionics
LRU	line replaceable unit
MMEL	master minimum equipment list
OPR	open problem report
RSC	reusable software component
SOI	stage of involvement
STC	supplemental type certificate
SW	software
TC	type certificate
TQL	tool qualification level
TSO	technical standard order
TSOA	technical standard order authorisation

2. Background-

The use of IMA has rapidly expanded in the last two decades and is expected to progress even more in the future in all types of products, parts and appliances. Additional guidance is hence needed to address specific aspects at the application, component, platform, system, and aircraft levels.

2.1. IMA Overview

A representation of an IMA architecture is illustrated in Figure 1:

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

— The platform consists of:

- a hardware layer offering resources shared by the applications; and
- a software layer, so-called ‘middleware’, including the operating system, health monitoring, various kinds of services and hardware drivers (core software [ED-124] and support software [ETSO-2C153]).

— Through the middleware, the platform mainly:

- provides services to the software applications;
- manages the interfaces between software applications;
- manages the internal/external resources shared between software applications; and
- ensures isolation between applications.

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

— 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).

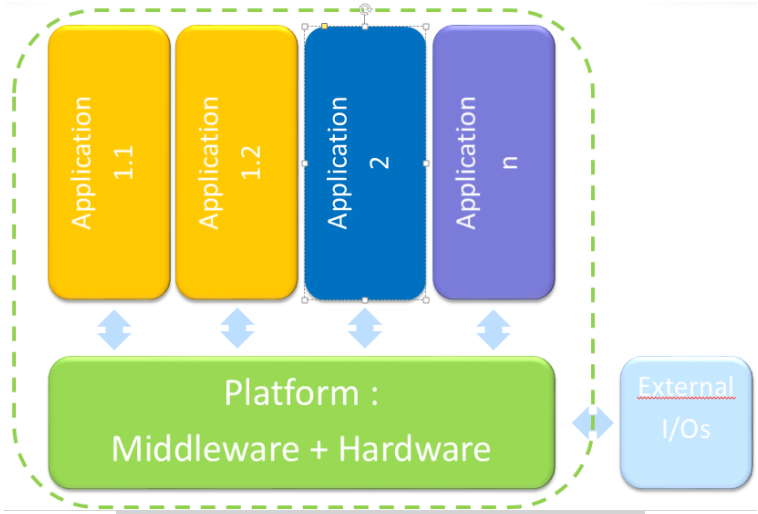


Figure 1 – Illustration of an IMA architecture

Figure 2 shows a functional projection of an IMA architecture at aircraft level:

— Each aircraft function may have its own set of LRUs connected to the platform (which provides/gets the data to/from the application).

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

- Input Items: data from sensors, control panels, data received from other applications/systems.
- Output Items: data to actuators, displays, and data transmitted to other applications/systems.

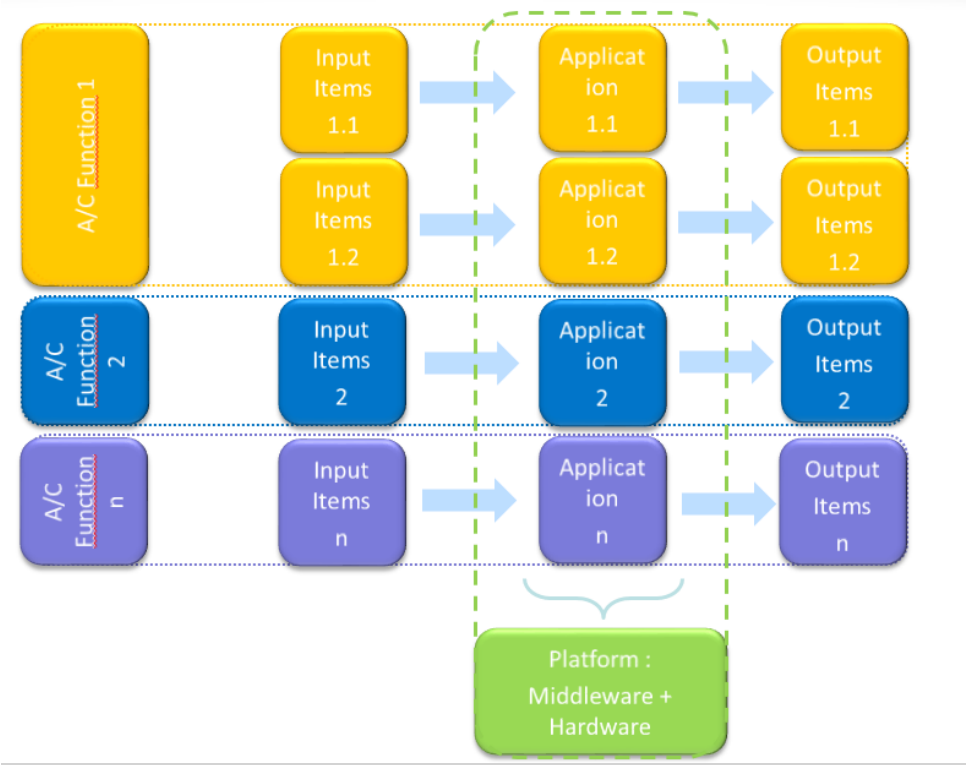


Figure 2 – Functional projection of an IMA architecture at aircraft level

A simplified view of an IMA architecture is illustrated in Figure 3.

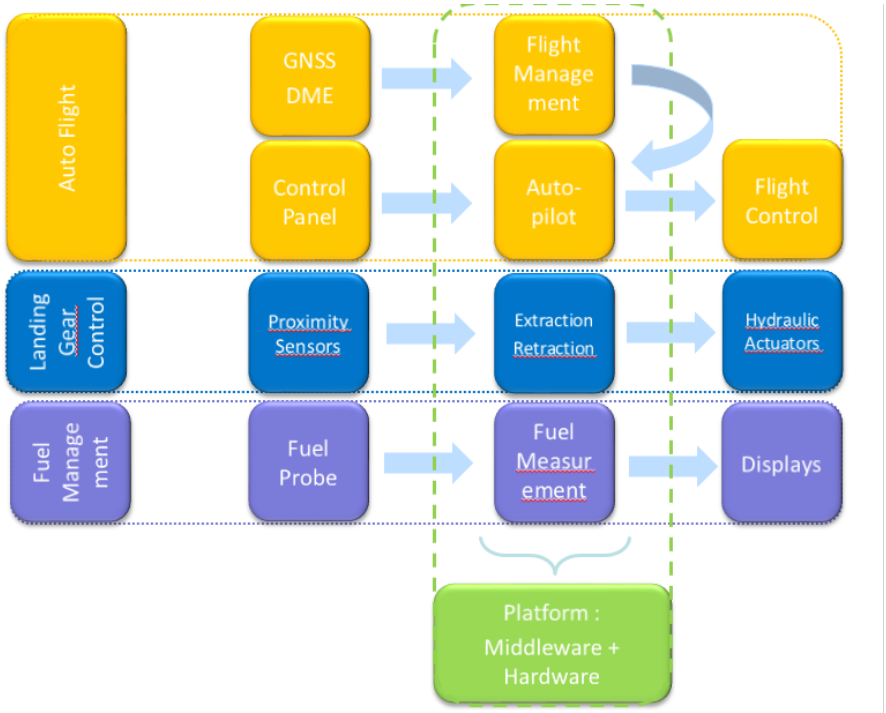


Figure 3 – Illustration of an IMA architecture

2.2. IMA system breakdown into aircraft systems (ATA Chapters)

The organisation of an IMA system into aircraft systems (e.g. ATA Chapters) provides structure to a certification project and to the methods used to establish the showing of compliance. This breakdown may depend on (this list is not exhaustive):

— the aircraft and systems architecture;

— the industrial organisation and work sharing;

— the applicant development methods; and/or

— the aircraft maintenance principles and procedures (closely linked to ATA-XX chaptering).

2.3. IMA Certification Concerns

From a certification viewpoint, the use of an IMA architecture raises the following concerns:

— 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 some failures to propagate and create multiple failure conditions;

— the 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 lack of determinism or unexpected system behaviour; and

— improper isolation mechanisms or configuration not ensuring correct partitioning between functions.

3. Policy for IMA system certification

This section provides guidance to be used for the certification of an IMA system. Considering the IMA architecture, industrial organisation, and the experience in IMA system development of the applicant, several approaches are considered:

— Use of the ED-124 standard

— Use of previously recognised IMA certification processes

— Use of an alternative means of compliance

3.1. Use of ED-124

3.1.1. Recognition of ED-124

EUROCAE document ED-124 on Integrated Modular Avionics (IMA) Development Guidance and Certification Considerations, published in July 2007 (equivalent to the RTCA document DO-297) provides guidance for the development and certification of IMA systems.

The use of ED-124 is acceptable to EASA to support the certification of IMA systems when it is used in conjunction with the additional considerations described in this AMC.

3.1.2. Scope of this AMC with respect to ED-124

ED-124 encompasses various aspects and some concepts which are not compatible with the EASA system or which are considered to be out of scope of this AMC:

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

— It is not the intent of this AMC to cover operational aspects of master minimum equipment lists (MMELs) (ED-124 Chapter 3.9), considerations for continued airworthiness (ED-124 Chapter 6) or the safety assessment process (ED-124 Chapter 5.1).

— Regarding the incremental certification process presented in ED-124:

  - The ‘letter of acceptance’ concept is not feasible in the EASA context. The certification given by EASA is limited to only a specific aircraft type certification (TC), or to a subsequent aircraft level certification of a system change or in the frame of a supplemental type certificate (STC), or granted through an ETSO Authorisation.
  - The alternate concept of reusable software component (RSC) acceptance as described in ED-124 Chapter 4, Table 4, with reference to FAA AC 20-148, is not feasible in the EASA context as it makes use of acceptance letters for software parts.

3.1.3. Clarification and use of ED-124

ED-124 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, ED-124 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 ED-124 may overlap or may be considered to be addressed by other applicable guidance documents (e.g. ED-79).

The way in which ED-124 was written, e.g. by allocating objectives, activities and life cycle data to the various 'tasks', should therefore not be interpreted:

— as imposing a unique scheme in terms of the project organisation, sequencing of activities and expected life cycle data required to meet the objectives; or

— as requesting the duplication of activities or life cycle data.

The following sections further explain the flexibility which is inherent in the ED-124 approach and which is fully recognised by EASA.

3.1.3.1. The ED-124 task framework

ED-124 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 4 illustrates a mapping between the architecture of an IMA system and Tasks 1 to 4 of ED-124:

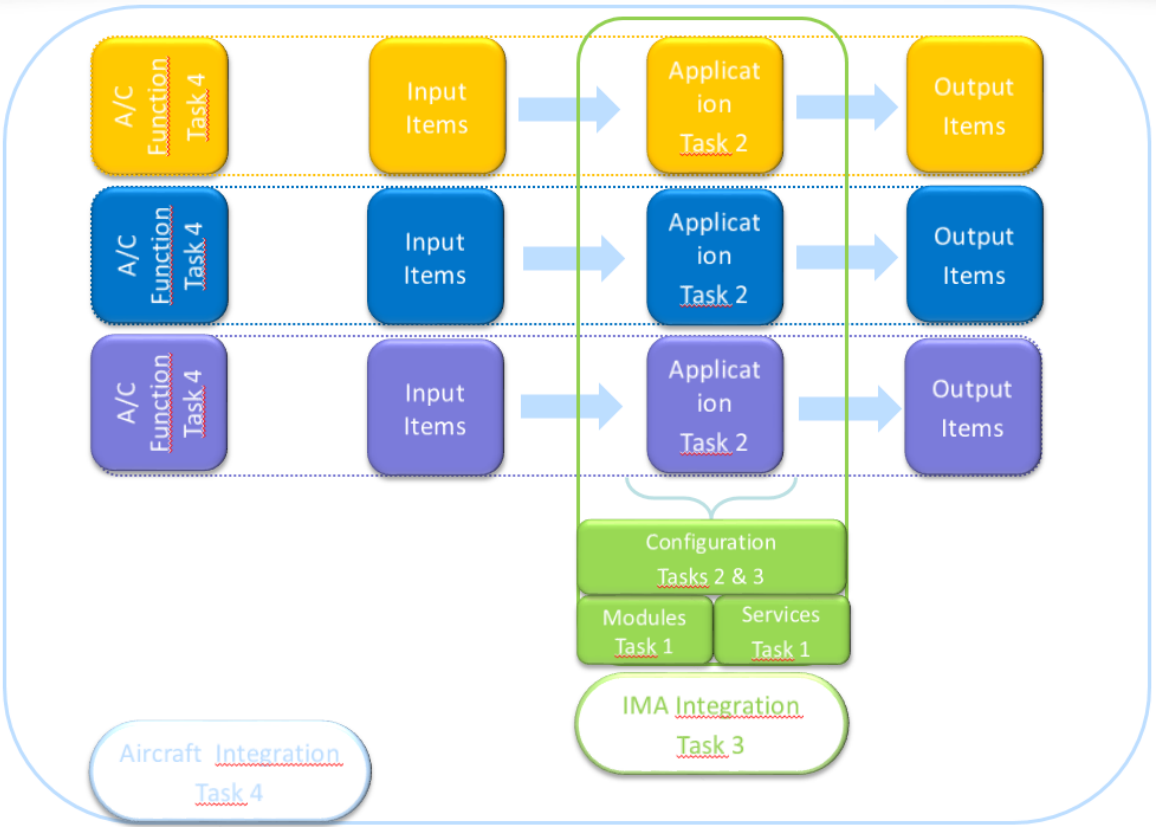


Figure 4 – Breakdown of an IMA system and mapping to ED-124 tasks

Among the considerations detailed in the ED-124 tasks, the key IMA specificities are:

— Task 1: the need to develop resources/services to be shared by applications and the adequate associated mechanisms (partitioning, health monitoring, etc.), and the need to document these resources, services and mechanisms for the IMA platform users;

— Task 2: the need to characterise the applications in terms of their resource usage and execution constraints, and the need to verify that the applications satisfy the usage domain of the platform ;

— Task 3: the need to verify that the whole set of applications complies with the platform usage domain;

— Task 4: has little specificity in comparison with non-IMA systems.

3.1.3.2. Relationship with other guidelines

In order to maximise the credit taken from other standards and existing processes, two certification approaches based on the ED-124 tasks and objectives are considered eligible to support an IMA system certification:

(a) IMA system perspective: by considering the application of ED-124 as a complete and consistent set of objectives.

(b) Aircraft perspective: where the IMA system certification and its specificities are addressed within the global framework of the aircraft certification and its related processes. This means that ED-124 considerations/objectives may be covered by other aircraft system processes and activities.

As ED-79 provides guidance and acceptable means of compliance for the development of systems, ED-79 processes may be used to cover ED-124 objectives and activities. However, the use of ED-79 will not ensure exhaustive coverage of the ED-124 objectives. Consequently, the IMA-specific objectives and activities of ED-124 will remain to be addressed separately from the ED-79 objectives.

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

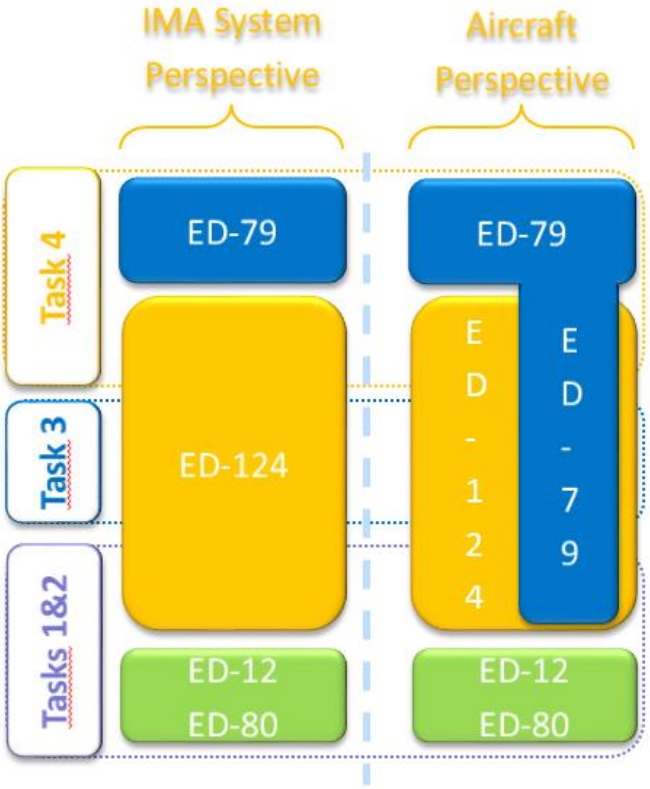


Figure 5 – Links between ED-124 tasks and other guidelines

3.1.3.3. Tailoring of ED-124 tasks

A task framework is proposed by ED-124, but it is not the purpose of this AMC 20-170 to enforce this division of tasks. The allocation of the ED-124 objectives to the ED-124 tasks can be tailored by the applicant. For instance,

— Some Task 3 objectives may be already anticipated and accomplished during Task 2, or they may be deferred to Task 4.

— ED-124 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, taking into account the platform properties (e.g. robust partitioning and resource management).

When the applicant intends to develop an IMA system and the supported aircraft functions by tailoring the ED-124 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 are mapped to the ED-124 objectives in order to ensure that the objectives of ED-124 are met within the alternative framework presented by the applicant. The ED-124 life cycle data can be also adapted to the division of tasks and work packages defined by the applicant.

Moreover, ED-124 Task 4 may have few IMA specificities compared to a federated architecture. The achievement of Task 4 to support compliance demonstration in the frame of this AMC could be deemed out of the scope of this AMC, 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 or covered by Task 4.

Another area where tailoring can be performed is requirement validation. ED-124 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's guide (Chapter 4.2.12 e.) are fulfilled, and that they satisfy the IMA system requirements.

3.1.4. Use of alternative means of compliance

If an applicant elects to comply with an alternative means of compliance, consistency with the ED-124 acceptance objectives in Annex A tables [A1-A6] (IMA module/platform development process objectives) should be demonstrated.

Early coordination with EASA should be ensured.

3.2. Use of previously recognised means of compliance

Applicants who did not use this AMC in their past IMA certifications and who successfully used other means of compliance that were:

— discussed in specific CRI(s);

— previously recognised as equivalent to the ED-124 objectives; and

— previously accepted by EASA for covering IMA certification concerns,

may use the same means of compliance for their certification project, provided that the IMA system is similar to the previously certified one (i.e. with a similar architecture, the same design concepts, the same development process, and the same certification approach).

Early coordination with EASA to confirm the use of the applicant's previously recognised means of compliance should be ensured.

3.3. Role of the certification plan

ED-124 objectives can be met by using various industrial mappings, based on the sharing of roles, activities and life cycle data. The strategy selected for showing compliance with this AMC should be defined by the applicant in their certification plans.

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

Considerations regarding the content of an IMA certification plan can be found in ED-124 Chapter 4.4.3. The certification plan should particularly emphasise 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 show compliance with this AMC including:
  - the certification approach selected (see paragraph 3);
  - the relationship and credit potentially taken from other standards or processes to satisfy the objectives of ED-124;
  - the nature and extent of credit claimed from previously approved components (.i.e. having obtained an ETSO Authorisation) or from activities performed on components reused from previous certification projects (see paragraph 4);
  - the identification of modules, platforms and applications for which full or partial incremental compliance credit is sought.

— The industrial organisation supporting the IMA system development and certification, including the roles, responsibilities and work share between the stakeholders, with, in particular:
  - the sharing of activities related to aircraft functions hosted on the IMA platform and the IMA system integration activities;
  - when applicable, the tailoring and scope of the ED-124 tasks; or ED-124 life cycle data;
  - 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, 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 an ETSO-2C153 or 2C516 equipment;
- 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.

4. Incremental Certification Process

As indicated in Section 3.2.1, the concepts of a 'letter of acceptance' or of a reusable software component (RSC) are not compatible with the EASA system.

Furthermore, within the EASA system there is currently no means to benefit from the certification credit granted within a TC or an STC in the frame of another product certification. Formal compliance credit can only be claimed from an ETSO authorisation.

However, the lack of a TSO authorisation (TSOA) , a letter of acceptance etc. does not prevent an applicant from incrementally building confidence and showing the compliance of IMA components during the development flow (as per the ED-124 task framework), nor does it prevent the reuse of previous certification artefacts and activities for a new showing of compliance.

The incremental certification process is the process to certify a product for which EASA 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 following approaches:

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

(b) Re-use: credit is taken from activities performed on components (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 is claimed from an ETSOA.

In all cases, the applicant should evaluate and substantiate the suitability and level of the credit sought. Early coordination with EASA should be ensured.

Note: An ETSOA is not a mandatory step in the certification of an IMA system.

Approach		Responsibility*	Applicant activities	Evidence supporting the credit
1	Incremental component qualification See paragraph 4.1	Full responsibility under the applicant's DOA.	Full compliance demonstration is expected from the applicant.	Software and hardware final review (SOI#4). Complementary accomplishment summaries for any objectives not covered by the software and hardware activities.
2	Re-use from previous TC See paragraph 4.2	Full responsibility under the applicant's DOA.	Compliance demonstration may be tailored depending on the agreement with EASA**. Note: showing of compliance for the IMA components may be reduced (e.g. no software development and verification reviews (SOI#2&3) as part of Task 2).	Previous set of evidence. Software and hardware final review (SOI#4), if the component has been modified. Complementary accomplishment summaries for any objectives not covered by the previous activities.
3	Compliance credit See paragraph 4.3	Shared between the: — ETSO holder for the scope covered by the ETSOA (e.g. module/platform). — applicant for the completion of integration and/or installation activities.	Compliance demonstration is reduced according to the certification credit claimed from the ETSOA.	ETSOA

* Applicant stands for the applicant developing and/or installing the IMA system.

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

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

4.1. Incremental component qualification

One main characteristic of IMA systems and the ED-124 task framework is that they introduce a high level of independence in the design and verification activities:

— between the functional (application) level and the resource (module/platform) level, i.e. resource axis independence,
— between different applications (except for possible functional interactions between applications), i.e. application axis independence.

This characteristic drives a modular approach and it can be exploited for an incremental certification approach. Chapter 2.2 e. of ED-124 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. Some clarification is needed here, which is that when IMA equipment has 'composability', it means that it is possible to take credit from the robust partitioning regarding two aspects:

— during the development of the application itself, credit may be taken from module/platform design activities,
— during the verification activities, credit may be taken from the integration of the application and from the lack of impact on other already verified and installed applications.

The achievement and acceptance of a set of activities could be supported by a formal review directly performed by EASA or by the applicant under DOA. The applicant should define their criteria and evidence to demonstrate the achievement of a task for a given IMA component (e.g. the completion of Task 2 for a software application).
For instance, a final software and hardware review (SOI#4) on the components of a module and the acceptance of the corresponding software and hardware accomplishment summaries could support the completion of ED-124 Task 1.

4.2. Reuse of components

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

4.2.1. Re-use from a legacy IMA system

If some changes are necessary, a change impact analysis should be performed to identify the scope of the changes and the necessary activities to be re-engaged in order to cover the changes.

4.2.2. Re-use from a previous ED-124 project

The management of reused components is addressed through ED-124 Task 6 (ED-124 Chapter 4.7). If changes are intended, they should be managed through ED-124 Task 5 (ED-124 Chapter 4.6).

Note: To facilitate the reuse of a component, ED-124 recommends developers to anticipate that reuse during the initial development through dedicated objectives that are part of Tasks 1 & 2 (e.g. the module acceptance plan providing the data listed in Chapter 4.2.3 h).

4.3. Compliance credit

In the frame of this AMC, formal certification credit is offered from an ETSOA granted to:

— Platform(s)/module(s): ETSO-2C153,
— Application(s) coupled with an ETSO-2C153 module/platform: ETSO-2C516.

4.3.1. Use of an ETSO-2C153 Authorisation

An ETSO-2C153 can be granted to a platform(s)/module(s) in order to facilitate its use in an IMA system. As per ETSO-2C153 paragraph 3.2.2.1, the IMA module or platform should meet the ED-124 Task 1 objectives. Compliance credit could be hence claimed by an applicant for the showing of compliance with ED-124 Task 1, provided the platform(s)/module(s) had obtained beforehand an ETSO-2C153 authorisation.

Nevertheless, the ETSOA does not by itself ensure that the platform(s)/module(s) is/are technically adequate to be integrated into the IMA system. The applicant remains responsible for all the activities to ensure the proper integration of the ETSO-2C153 platform(s)/module(s) into the IMA system, and the applicant should:

— substantiate the compliance credit that they claim and define the complementary certification activities based on the data provided (e.g. user/installation manuals).

— 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/module user manual, installation manual, or equivalent data (as documented per ETSO-2C153 Appendix 3). This also includes the deactivation of any unused functions/modules.

This section only addresses the use of EASA ETSO-2C153, and its use cannot be extended to any other authority TSO standards on IMA platforms and modules that are not equivalent in their technical requirements.

4.3.2. Use of a Functional ETSO-2C516 Authorisation

Through a functional ETSO-2C516 (F-ETSO), an authorisation can be granted to application(s) coupled with an ETSO-2C153 module/platform. As per ETSO-2C516, compliance with the ED-124 Task 2 & 3 objectives has to be demonstrated. Compliance credit could hence be claimed by an applicant for the showing of compliance with ED-124 Tasks 2 & 3, provided that the F-ETSO-2C516 authorisation had been obtained beforehand.

Nevertheless, the functional ETSOA 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 application(s)/module(s)/platform(s) into the IMA system, and they should:

— substantiate the compliance credit that they claim, and define the complementary certification activities.

— complete the demonstration that the function covered by the F-ETSO complies with the IMA system and safety requirements.

If the F-ETSO is in the ‘Open’ Class and the applicant intends to perform incremental development on the ETSOA article (e.g. to add an application), the considerations of this AMC 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 ETSOA article.

5. Additional recommendations for IMA system certification

5.1. Fault management and human factors

ED-124 Chapter 3.6.5 deals with the annunciation of failures to the crew. CS-XX.1322 and the associated AMC address flight crew alerting systems and warning, caution, or advisory lights. In any case where an inconsistency is identified between the text in ED-124 and the text in CS-XX.1322 and the associated AMC, the text in CS-XX.1322 and the associated AMC should prevail.

Similarly, for any inconsistency between the text in ED-124 Chapter 3.10 dealing with human factors and the text in CS-XX.1302 and associated AMC, the text in CS-XX.1302 and the associated AMC should prevail.

5.2. Configuration data/parameter data items

Guidance on IMA configuration data is provided in ED-124 Chapter 3.7.1.1 at the IMA system level and 3.7.1.2 at the application level. These data items are nowadays described as 'parameter data items' in ED-12C and should be treated in the same way as other elements of the software. Depending on how a parameter data item is to be used in the IMA system or application, it needs to be defined, managed and documented at the appropriate level (platform, module, application) and to comply with the ED-12C[11] guidance, including the process to ensure intermixability and compatibility during the post-TC period as indicated in ED-124. In particular, any parameter data item should be assigned the same software level as the component using it.

5.3. Use of tools and the need for qualification

IMA system development may be supported by the use of tools in order to eliminate, reduce, or automate the activities associated with the ED-124 objectives. If a tool could introduce an error or could fail to detect an error, and there are no other alternative means to detect the issue, qualification of the tool is needed.

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

The objectives of tool qualification are:

— to ensure an equivalent level of confidence to the non-automated process/activities,

— to demonstrate that the tool complies, and its qualification is commensurate, with the intended use.

Adequate guidance for tool qualification is provided in ED-215, Software Tool Qualification Considerations, and should be followed when a tool is intended to be qualified to support the IMA system development.

The following criteria should be used to determine the appropriate tool qualification level (TQL), according to its intended use:

(a) Impact of the Tool:

(1) Criteria 1: a tool whose output is part of the IMA system and thus could insert an error.

(2) Criteria 2: a tool that automates verification process(es) 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 automated by the tool, or

— development process(es) that could have an impact on the IMA system.

(3) Criteria 3: a tool that, within the scope of its intended use, could fail to detect an error.

[11] In this particular case, guidance can only be found in ED-12C. Nevertheless, the use of ED-12C in this particular case does not imply the introduction of ED-12C into the certification basis.

(b) IDAL of the IMA component supported by the tool:

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

This section deals not only with changes to components that were previously accepted through a TC, STC or ETSOA, 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.

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

(a) Since there are various levels of development and integration in an IMA system, and potentially various stakeholders (the module/platform developer, application developer, IMA system integrator, aircraft designer), agreements between stakeholders on the way to communicate changes and to perform impact analyses at each level should be established.

(b) 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.

(c) Impacts on incremental compliance credit (if applicable) also need to be considered.

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

5.5. Management of open problem reports

IMA systems contain multiple applications hosted on the same IMA module/platform, therefore any open problem report related to a module/platform or application, collected at any level, could affect one or several aircraft functions in a direct or indirect manner.

(a) The reporting of open problem reports (OPRs) between the different IMA stakeholders should be established.

(b) The applicant should properly organise the management of open problem reports, focusing on:

— the initial evaluation of each open problem report by the module developer, precisely describing the effect of the OPR on resource use;

— the evaluation of each open problem report for its possible impacts on any aircraft function that uses the affected resource, using a harmonised classification scale;

— the evaluation of the cumulated effect of each open problem report on all affected aircraft functions;

— the assessment in the context of the targeted aircraft operational environment;

— potential workarounds at the application, system or aircraft levels. 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;

— justification for acceptance if the problem remains unresolved at the time of certification.

The applicant should ensure the completeness of the problem report assessment.

The applicant should document this problem report assessment for EASA.

NOTE: A classification scheme should be established in order to assess the OPRs at each level. In order to facilitate the assessment and the communication between stakeholders, the use of a harmonised classification scale is recommended (see, for example, the classification provided in discussion paper DP#9 of ED-94C, Supporting Information for ED-12C and ED-109A).

5.6. Cybersecurity

Although there is no specific IMA objective regarding cybersecurity, applicants should consider the potential threats and vulnerabilities of their systems.

However, the security aspects described in ED-124 Chapter 5.1.5.8 are not adequate and should be replaced by the applicable cybersecurity standards.

5.7. Environmental qualification

The scope of this section is to provide environmental qualification guidance complementary to ED-124 Chapter 5.2.6 for the environmental qualification of an IMA platform. 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 experienced when installed on the aircraft, interfaced with its peripherals through the aircraft harnesses, and loaded with its set of applications. The acceptance criteria to qualify the platform are driven by the operational requirements of the given aircraft.

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 and/or software), 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 and/or a backplane.

— **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 and/or the backplane installed in the cabinet, 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:

(a) 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's guide.

(b) For an IMA module integrated within a cabinet, its environmental qualification conditions should consider:

— its environmental conditions (i.e. the envelope of thermal, electromagnetic, vibration, lightning, etc. conditions) encountered inside the cabinet when in use on the aircraft,

— all its possible arrangements in the cabinet (i.e. different IMA platform configurations).

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 authorisations such as ETSO-2C153. 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, an impact analysis should be conducted against the qualified configuration to assess the complementary qualification substantiation to be provided for each of its modules.

4. Impact assessment (IA)

4.1. What is the issue

The issue is detailed in chapter 2 of this NPA.

4.2. Who is affected

The stakeholders involved in the airworthiness approval of IMA are mainly design organisations and production organisations both at aircraft level and at equipment level.

Stakeholders particularly affected are:

— certification authorities (i.e. EASA for aircraft whose design is in its scope);

— applicants/holders of type certificates (TCs) or supplemental type certificates (STCs) for the aircraft;

— IMA system integrators;

— application suppliers;

— platform and module suppliers.

4.3. How could the issue/problem evolve

The continuing existence of the highlighted regulatory 'gap' in comparison with the US would continue to penalise industry (primarily European, but also IMA manufacturers around the world) and would require more effort for EASA during the certification process.

The situation would progressively become worse, since the cost, mass and volume benefits achievable through IMA will be applied to a significant number of future aircraft types or variants. Other consequences could be:

— a possible increased lack of harmonisation on this topic, considering further development of IMA;

— that rules would continue to be inadequate and outdated considering the evolution of worldwide aircraft experience in service, and scientific and technological progress;

— that an IMA certification at system and aircraft level would still not be covered.

4.4. What we want to achieve — objectives

The general and specific objectives of this proposal are described in Chapter 2.2.

4.5. How it could be achieved — options

Table 1: Selected policy options

Option No	**Description**
0	No policy change (no change to the rules; risks remain as outlined in the issue analysis).
1	Develop AMC 20-170 for incremental certification of IMA (from platform module up to aircraft level); and

	Develop ETSO-2C516 for ETSO equipment authorisation, based on already authorised IMA platforms or modules (ETSO-2C153)

4.6. What are the impacts

Safety impact

With Option 0, a uniform safety level may not be achieved across different aircraft certification projects, due to the lack of common and publicly available regulatory material.

Additionally Option 1 would provide for more transparency in certification projects, thereby slightly contributing to safety thanks to the exploitation of state-of-the-art technologies.

Environmental impact

Option 1 would allow faster spreading of the IMA concept across the fleet than Option 0, with gains in terms of reductions in aircraft mass, thus producing less emissions. Therefore, Option 1 would have a positive impact on the environment, compared to Option 0.

Social impact

As a result of a loss of competitiveness, a number of qualified jobs could be lost with Option 0; whereas Option 1 would at a minimum allow these jobs to be preserved or it could contribute to increasing the number of jobs with the development of IMA technologies in Europe.

Economic impact

Option 0: In a framework offering little flexibility on the IMA concept, EU industry would continue to be penalised compared to US Industry. The resource efforts during a certification project would be significant, both for the applicant and for EASA. This option could ultimately lead to a loss of competitiveness for EU industry on the worldwide market.

Option 1 would propose provisions that are even more recent than the corresponding US ones. A number of authorities may also decide to apply EASA's approach. The following positive economic impacts are expected:

— For aircraft manufacturers: this would increase the competitiveness of EU Industry, and positively contribute to exports. Moreover, companies might benefit from having the possibility to implement new technologies.
— For airline operators: further development of IMA at system and aircraft levels would reduce direct operational costs by simplifying maintenance activities and introducing cost savings linked to the possibility of having integrated systems instead of having several isolated systems. Additionally, indirect cost savings could be generated due to reductions in aircraft weights and power consumptions.

General Aviation and proportionality issues

Both the use of AMC-20 and its application for ETSO authorisation are voluntary, therefore, both Options could be considered as having a minor impact.

However Option 1 may facilitate the further spread of IMA towards lighter airframes, taking benefits from the possibility to reduce the mass of aircraft systems. Additionally, this option would facilitate the use of IMA on aircraft produced by small to medium-sized enterprises (SMEs).

4.7. Conclusion

Comparison of options

Impact	Option 0	Option 1
Safety	0	+
Social	0	+
Economic	0	++
Environmental	0	+
GA and Proportionality	0	+
Total	*0*	*+ / ++*

The overall impact of Option 0 is negative, while Option 1 is expected to have an overall positive impact, in particular with its economic, social and environmental benefits.

It is, therefore, proposed to present Option 1 as the best option in the NPA.

5. Proposed actions to support implementation

EASA has created a specific link within the EASA internet page[12] in order to simplify the identification and the download of the current ETSO articles.

For consultation purposes, EASA has also created a specific webpage[13] listing all (current & historic) ETSOs.

No additional actions are foreseen to support the implementation of new and amended ETSO articles.

[12] https://www.easa.europa.eu/easa-and-you/aircraft-products/etso-authorisations/list-of-current-etso
[13] https://www.easa.europa.eu/easa-and-you/aircraft-products/etso-authorisations/list-of-all-etso

6. References

6.1. Affected/Related regulations

— None.

6.2. Affected decisions

— Decision No. 2003/10/RM of the Executive Director of the Agency of 24 October 2003 on certification specifications, including airworthiness codes and acceptable means of compliance, for European Technical Standard Orders (« CS-ETSO »)

— Decision No. 2003/12/RM of the Executive Director of the Agency of 5 November 2003 on general acceptable means of compliance for airworthiness of products, parts and appliances (« AMC-20 »)

6.3. Other reference documents

— None.