DRAFT 1 OF

supplement 5 to

ARINC characteristic 702A

ADVANCED FLIGHT MANAGEMENT COMPUTER SYSTEM

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A. PURPOSE OF THIS DOCUMENT

This supplement was prepared to align ARINC 702A with RTCA Standards for Performance Based Navigation (PBN) using Required Navigation Performance (RNP) standards. This document updates the FMS-datalink interface definition to support NextGen and SESAR airspace environments. Collectively, the changes introduced by Supplement 5 will enable Trajectory Based Operations (TBO) to enable 4D trajectory coordination with Air Traffic Control (ATC). The list of applicable reference documents was updated with this supplement.

B. ORGANIZATION OF THIS SUPPLEMENT

In this document blue bold text is used to indicate those areas of text changed by the current supplement only.

C. CHANGES TO ARINC CHARACTERISTIC 702A INTRODUCED BY THIS SUPPLEMENT

This section presents a complete listing of the changes to the document introduced by this supplement. Each change is identified by the section number and the title as it will appear in the complete document. Where necessary, a brief description of the change is included.

1.1 Purpose and Scope

This section was revised and expanded to set the tone of an ARINC Characteristic 702A. The document was written to describe airline desires that are expected to be supported by the implementers as requirement statements. Therefore, the use of the word “should” in this document carries the expectation that the functions described in this document will be implemented in a Flight Management System. References to ICAO and RTCA documents pertinent to Performance Based Navigation (PBN) were added.

1.2 Relationship to Other Documents

This section was expanded by a statement to direct the reader to a complete list of reference documents in Appendix A.

1.3 Functional Overview

All references to “great circle” paths were updated to be “geodesic paths”.

The description of Electronic Flight Instrument System was expanded to include an optional Vertical Situation Display (VSD). The terms Electronic Flight Instrument System (EFIS) and Cockpit Display System (CDS) are used to refer to the display system hardware and associated interfaces, as defined in ARINC Specification 661.

1.7 Integrity and Availability

Reference to Required Navigation Performance (RNP) added.

2.5.9 Ethernet Interface

This section updated to include the latest Ethernet interface reference. The reference to **ARINC Specification 664:** *Aircraft Data Network* was added.

3.1 System Configurations

This section was expanded to refer to the integration of the Flight Management Function (FMF) in an Integrated Modular Avionics (IMA) architecture, where the term FMF is equivalent to FMC.

3.1.1 Single System Configuration

This section was expanded to specify that the system should be capable of driving two flight control computers, two communication management units, and independently driving two navigation displays.

3.1.3 Dual System Configuration

A reference was added. Design considerations for dual systems is provided in Section 3.5.

3.4 FMC Performance

The title of this section is updated (formerly FMC Accuracy and Performance).

3.4.1 Accuracy, Integrity, and Continuity

This section was expanded. All references to “lateral navigation” were updated to “lateral guidance”. All references to “vertical navigation” were updated to “vertical guidance”. Data integrity standards added.

3.4.2 Response Time

This section was updated to reflect actual and expected performance of Flight Management Systems (FMS). Flight plan response times are specified for modifications to the active flight plan. The response times are intended to be from the completion of crew action until the output of data on the display. 4D Trajectory predictions include altitude, airspeed, time, and fuel.

4.2.2 Flight Plan Initialization and Activation

The list of methods for constructing a flight plan was expanded. Flight plans may be initialized by AOC/ATC uplink messages.

4.2.3 Performance and Predictions Initialization

This section was clarified. Gross weight (or zero fuel weight and block fuel), cost index, and cruise altitude are required as a minimum to initialize performance and trajectory prediction computations.

4.2.4 Lateral and Vertical Guidance Activation

Section title is updated to refer to Vertical Guidance rather that Vertical Navigation.

This section was expanded to specify that lateral and vertical guidance are independent selections on the AFS Control Panel, though in some, lateral guidance is a prerequisite for vertical guidance. In some systems, AFS control to the FMF vertical guidance speed target can be selected independent of vertical guidance.

4.3.1 Navigation

The list of navigation functional outputs was expanded to include Actual Navigation Performance (ANP) or Estimate of Position Uncertainty (EPU). For the purpose of ARINC 702A, ANP and EPU are intended to mean the same thing. Altitude computations operate upon inputs of smoothed inertial altitude from the Inertial Reference Units (IRUs), Air Data/Inertial Reference Units (ADIRUs), or Attitude and Heading Reference System AHRS.

4.3.1.1 Multi-Sensor Navigation

The list of sensors used to compute the navigation solution was modified to remove references to Vertical Gyros and Directional Gyros (VG/DG).

4.3.1.2 Navigation Modes

This section was updated to remove references to VG/DG and Microwave Landing Systems (MLS). Text was added to state that localizer may be used in the approach mode.

4.3.1.3 RNP-Based Navigation

This section was updated extensively. RNP determination could be made by manual RNP entry by the crew, Leg-Based RNP value from the navigation data base, or the default RNP value. The system should output the current RNP and ANP values on the general output buses. The system should support manual entry within a range of possible RNP values appropriate for the PBN operation to be flown. When an RNP approach procedure offers multiple lines of minima, the system should allow the flight crew to specify or pre-select the desired RNP value for the final approach segment.

Sections on Preplanned RNP Values and Leg-Based RNP Values added.

4.3.1.4 Navaid Data

This section was expanded with a reference to Section 9.2 providing additional details regarding the navigation database.

4.3.2 Flight Planning

This section was updated for clarity. Flight plan capacity should be a minimum of 150 waypoints in each flight plan. For long range aircraft, a minimum of 200 waypoints in each flight plan is highly encouraged.

4.3.2.1 Flight Plan States

This section was shortened by the deletion of material describing modified flight plans.

4.3.2.3 Supplemental and Temporary NDB Creation and Management

This section was expanded to describe the latest Navigation Data base (NDB) concepts. The system should support creation of new waypoints in the following ways: Point Bearing/Distance (PBD), Point Bearing/Point Bearing (PB/PB), Along Track Fix, Latitude/Longitude, Dir-To Abeam Waypoint(s). The system may support creation of new waypoints in the following ways: Latitude/Longitude Crossing, Unnamed Airway Intersection, Fix Intersection, Runway Extension, FIR/SUA Intersection.

4.3.2.4 Lateral Flight Planning

This section was extensively modified to support improvements in RNP. Navigation database procedures in the terminal area was expanded to include: Standard Instrument Departure (SID), Engine-Out SID, Standard Terminal Arrival Route (STAR), RNAV/RNP Approach including LP/LPV (SBAS), GPS (GNSS) Approach, ILS/LOC Approach, MLS Approach, GLS (GBAS) Approach. Recommendations on other types was provided. Waypoints may be entered at any point in the flight plan, provided it results in a valid leg combination. At a minimum, the following parameters for a holding pattern should be editable: inbound course, turn direction, leg time/length.

Material describing Flight Plan Editing using a Pointing Device and Flight Planning Support for ATM deleted by Supplement 5.

Missed approach procedures were clarified.

Lateral Offset Construction was expanded.

The subsection on Magnetic Variation was added.

4.3.2.5 Vertical Flight Planning

This section and its subsections was modified to support improvements in RNP. Vertical flight planning consists of entry and deletion of altitude and speed constraints at waypoints as well as other parameters which are used by the Vertical Guidance, Trajectory Predictions, and Performance Calculations functions. The list of performance parameters was expanded.

Wind, Temperature, and Atmospheric Model was expanded to allow for an entry of temperature and altitude at each waypoint in a flight plan.

Waypoint Altitude Constraint was added.

Waypoint Speed Constraint was added.

Temperature Compensation was added.

4.3.3 Lateral and Vertical Guidance

This section was updated to use the term “vertical guidance” rather than “vertical navigation.”

4.3.3.1 Lateral Guidance and Path Construction

This section was clarified. The lateral guidance of the aircraft is performed using the position data derived by the navigation function and a lateral reference path. For the active plan, the lateral guidance function generates the roll command to guide the aircraft. Lateral Leg Transitions was clarified.

Fly-By-Turns was added.

Fly-Over Turns was added.

Fix Radius Transition was added.

Special Lateral Path Construction was clarified.

Lateral Guidance Roll Command was clarified.

Lateral Guidance Output Parameters was expanded.

Localize/MLS Capture deleted by Supplement 5.

Subsection 4.3.3.1.8 Earth Reference Model was added

4.3.3.2 Trajectory Predictions

The subsections were extensively revised and expanded to support improvements in RNP.

Trajectory Predictions was completely revised. This includes new material on the topics of Take-off Phase Predictions, Climb Phase Predictions, Cruise Phase Predictions, Descent Phase Path Construction, Descent Phase Path Predictions, and Missed Approach Phase Predictions.

Vertical Guidance recommendations were added for climb, cruise and descent.

Altitude Constraint recommendations were provided.

Speed Restrictions was added.

Estimated Time of Arrival (ETA), Required Time of Arrival (RTA) and Time of Arrival Control was expanded.

4.3.3.3 Three-Dimensional RNAV Approach

The material in this section deleted by Supplement 5.

4.3.4.1 Performance Modes

Minor clarification of speed modes provided in Climb Mode, Cruise Mode, and Descent Mode.

4.3.4.2 Maximum and Optimum Altitudes Calculation

This section was clarified. The performance function should compute both optimum and maximum altitude for the aircraft/engine type, weight, atmospheric conditions, bleed air settings, and the other vertical flight planning parameters. The optimum altitude algorithm should compute the most cost effective operational altitude and the maximum altitude algorithm should compute the highest attainable altitude (up to maximum certified altitude) while satisfying maneuver margin and minimum climb rate(s) criterion.

4.3.4.4 Alternate Destinations Calculation

This section was clarified. The performance function computations are based on alternate destination flight plan routing, a direct route from current position to the alternate destination, or continuing to the current destination, followed by execution of a missed approach at the destination and then direct to the alternate destination.

4.3.4.6 Cruise Climb

This section was clarified. The performance function may compute cruise climb guidance which tracks the optimum altitude. It will take into account fuel burn and the predicted wind altitude profile.

4.3.4.7 Vertical Advisory Calculations

This section describing Top of Climb and Top of Descent calculations was renamed and expanded to include deceleration points and intercept points.

4.3.4.9 Takeoff Reference Data

This section was clarified. The performance function should provide for the entry of V1, VR, and V2 speeds. Computation of V-speeds for selected flap settings and runway, atmospheric, weight, and CG conditions may be implemented for the purpose of selection and/or reasonableness checks. The entered or selected   
V-speeds should be output for display on the flight instruments. Flap/slat retraction speeds may optionally be computed and displayed for reference.

4.3.4.11 Reserve Fuel Calculation

This section was clarified. When the system supports a default reserve fuel, the default reserve fuel should be computed based on the estimated fuel burn for the given flight plan, the entered or measured total fuel quantity, and additional entered parameters such as assumed fuel flow percent error. Manual entry of a reserve fuel quantity should be provided and should override the default value (if any). The system should provide an indication to the crew when the predicted fuel at destination is below the reserve fuel.

4.3.6 AOC Function

This section was clarified. The AOC interface should provide for the downlink of entered and computed data, including flight plan requests and waypoint reports. The Commentary was deleted.

4.3.7 ATS Datalink

This section and its subordinate sections were completely revised to recognize that Air Navigation Service Providers (ANSPs) are implementing, or have plans to implement, Air Traffic Services Datalink functions using existing and future data link systems. These include:

* Future Air Navigation System 1/A (FANS 1/A)

- Air Traffic Services Facilities Notification (AFN)

- Controller/Pilot Data Link Communication (CPDLC)

- Automatic Dependent Surveillance - Contract (ADS-C)

* Link 2000+

- Context Management (CM)

- Controller Pilot Data Link Communication (CPDLC)

* Baseline 2 (B2)

- Context Management (CM)

- Controller Pilot Data Link Communication (CPDLC)

- Automatic Dependent Surveillance (ADS-C)

4.3.8 Airport Surface Guidance

The material in this section deleted by Supplement 5.

4.3.9 Terrain and Obstacle Data

The material in this section deleted by Supplement 5.

4.3.10 Electronic Map Interfaces / Navigation Display

This section was clarified. The system should support an interface with a Navigation Display (ND) in order to provide lateral situational awareness (i.e., aircraft position, lateral route, nearby navaids, etc.). Based on the architecture, the FMC may provide data for use by an external symbol generator or may provide a series of drawing commands.

4.3.13 Precision-Like Approach Guidance

This section was re-named and completely revised (formerly named Approach Navigation Database Exchange).

4.3.13.1 LP/LPV Approach Guidance

This section added.

4.3.13.2 FMS Landing System (FLS)

This section added.

4.4 Training Simulator Support Functions

The reference to **ARINC Report 610:** *Guidance for Use of Avionics Equipment and Software in Simulators* was updated.

5.1.3 ILS/MMR Input Port

Commentary was added: These ports are used to support LP/LPV approaches when interfacing to an ARINC 755 MMR.

5.1.6 GNSS Input Ports

This section was expanded to include interfaces to the ARINC 755 MMR. Two ARINC 429 input ports should receive data from an ARINC 743A GNSS Sensor or ARINC 755 MMR. Commentary was added. These ports are used to support LP/LPV approaches when interfacing to an ARINC 743B GLSSU or an ARINC 755 MMR.

5.1.19 Pointing Device

Commentary was added: These ports are retained for compatibility with unknown systems should they exist. It is expected that all future systems will receive graphical user interface inputs via an ARINC 661 CDS interface.

5.2.2 General Data Output

This section was expanded. Two ARINC 429 outputs provide data to flight instruments, to radio receivers or frequency management unit for tuning, to the Thrust Control Computer System, Flight Control Computer System, and other users. They may also provide initialization data to the IRS. Optionally, they may include the FAS data block to an ARINC 743B GLSSU or ARINC 755 MMR.

5.2.12 Aircraft State and Intent Path Output (Trajectory Bus)

This section was expanded and revised to describe new data on the ARINC 429 bus and the use of ARINC 664 Ethernet for this purpose, as an option. Aircraft State and Trajectory output may be provided by an ARINC 664 Ethernet interface using the same data items defined for ARINC 429. There are no pin assignments in   
ARINC 702A for an ARINC 664 Ethernet bus. These interfaces may be aircraft specific.

New parameters added:

* Baro-Corrected Altitude (pass through from ADC)
* Pressure Altitude (pass through from ADC)
* Calibrated Airspeed (pass through from ADC)
* Mach (pass through from ADC)
* True Airspeed (pass through from ADC)
* Static Air Temperature (pass through from ADC)
* Data Type Extension
* Point Fuel
* Point Temperature
* Point Path Altitude
* Point Path Speed
* Speed Constraint Type
* Speed Constraint Value
* RTA Constraint Type
* RTA Constraint Value

5.5 Ethernet Interface (ARINC 646)

This section was updated to clarify the difference between ARINC 646 and   
ARINC 664 Ethernet Buses.

7.3 FMC Inputs from EFI

This section was clarified. The FMC provides two low-speed ARINC 429 data input ports through which map mode, scale and symbol option selections are transferred from the EFIS to the FMC. The Commentary was deleted.

7.4.5 Map Projection

The reference to “great circle” flight path was updated to “geodesic” flight path.

7.4.7 Symbol Repertoire

The reference to “primary” flight plan was updated to “active” flight plan.

The reference to “straight” lines was updated to “geodesic” lines.

7.4.9 Pointing Device

The material in this section deleted by Supplement 5.

7.4.10 Surface Map Mode

The material in this section deleted by Supplement 5.

7.5.1 Flight Plans

The reference to “great circle” flight path was updated to “geodesic” flight path.

7.5.3 Pointing Device

The material in this section deleted by Supplement 5.

7.6.3 Background Data Prioritizing

The reference to “primary” flight plan was updated to “active” flight plan.

9.2 Navigation Data Base

This section was expanded by the addition of Final Approach Segment (FAS) Data Block (for LP/LPV approaches).

9.5 Magnetic Variation Data Base

This section was expanded with Commentary that emphasizes the benefits of using harmonized MagVar data throughout the flight deck.

9.6 Terrain and Obstacle Data

The material in this section deleted by Supplement 5.

9.7 Airport Surface Map Data

The material in this section deleted by Supplement 5.

Attachment 4 – Data Input/Output FMC Outputs

This section was expanded to include:

* Selected Runway Heading
* FAS Data Block Message
* SBAS FAS Data Block Message

Attachment 6 – FMC/EFI Interface

This section was reduced to basic guidelines as this interface is technology driven and implementation dependent. Symbol word definitions were deleted by Supplement 5.

Attachment 7 – FMC/Datalink Interface

The list of downlink report Imbedded Message Identifiers (IMIs) was expanded to include:

EFB – Electronic Flight Bag.

The list of uplink Imbedded Element Identifiers (IEIs) was expanded to include:

RT - Required Time of Arrival (RTA).

The list of downlink Imbedded Element Identifiers (IEIs) was expanded to include:

FR – Forecast Report

PP – Performance Parameter Report

The WD and WM IEI’s were expanded to include Waypoint Tropopause Altitude.

The LO FPEI was updated to allow for uplink of an offset distance with a 0.1NM resolution.

Attachment 8 – Coding Examples of Trajectory Intent Data Files

This section deleted by Supplement 5.

Appendix A – Reference Documents

The list of reference documents was updated.

Appendix B – Acronyms

This list of acronyms was updated to reflect the technical content of Supplement 5.

Appendix C – Glossary

This section was added by Supplement 5

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This draft dated: January 20, 2018