

SESAR 2020 PJ.14-W2-84d - Phase Overlay for ADS-B - Final TS/IRS - TRL6

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PJ.14 W2 I-CNSS

INTEGRATED COMMUNICATION, NAVIGATION AND SURVEILLANCE SYSTEMS

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Abstract

SESAR2020 Wave-2 Technical Solution PJ.14-W2-84d "*Phase Overlay for ADS-B*" addresses Phase Overlay technology for ADS-B and Mode S features.

This document is focused on the Final Technical Specifications and Interface Requirement Specifications (Final TS/IRS) aspects of the Phase Overlay, based on ED-73F / DO-181F and ED-102B / DO-260C regulations, and, in the other hand, on the Initial TS/IRS document [16] and the conclusions extracted from the Validation Exercises exposed in the TVALR document [20].

The objective of this Solution is to guarantee the performance and interoperability of Phase Overlay modulation with the current standard for ADS-B, Pulse Position Modulation (PPM).

The target of this Solution is to achieve TRL6 for Phase Overlay at the end of SESAR2020 Wave-2.

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1 Executive summary

Technological Solution PJ.14-W2-84d addresses Phase Overlay for ADS-B and Mode S feature, whose requirements are based on the regulations ED-73F/DO-181F [15] and ED-102B/DO-260C [14]. This document specifies the waveform, message format and performances required for the transmitter and the receiver based on the ED-73F/DO-181F and ED-102B/DO-260C regulations and the results extracted from the Validation Exercises defined in the TVALR document [20], with the intention of achieving TRL6 at the end of SESAR2020 Wave 2.

This specification can be considered as an input for standardization working groups (Combined Surveillance Committee, which merges RTCA's SC-186 and SC-209 with EUROCAE's WG49 and WG-51), which are in charge of the Minimum Operational Performance Standards (MOPS) development. Besides, this document can also be considered as an input to future projects based on Phase Overlay technology.

2 Introduction

The objective of this document is to provide functional, performance and interface requirements related to the SESAR2020 Technological Solution PJ.14-W2-84d.

2.1 Purpose of the document

This document provides the Updated Technical Specifications and Interface Requirements Specifications (Updated TS/IRS) for Phase Overlay technology with the objective to support the Solution 84 gate.

While PPM modulation currently used for Mode S replies and ADS-B permits to transmit 112 bits in one message, Phase Overlay waveform extends the message capacity until 448 bits. This ADS-B new feature enables the introduction of potential important applications such as the transmission of new data (e.g., weather information), the reduction of the 1090 MHz frequency spectrum congestion or the encryption of data.

The main objectives of the TRL6 validation are the dedicated evaluations of the Phase Overlay and its surveillance performance as well as the initial evaluation of its operational acceptability and interoperability.

2.2 Scope

This document covers the functional, performance and interface requirements for Phase Overlay, related to SESAR2020 Technological Solution PJ.14-W2-84d for TRL6.

2.3 Intended readership

The audience of this document includes:

- SESAR 2020 Solution 84.
- SESAR 2020 PJ 19.
- EUROCAE WG51-SG1 and SG4 and other groups involved in surveillance activities.
- EUROCONTROL GEN-SUR SEC.
- Any other SJU project that may require the information included in this document for their activities.

2.4 Background

Phase Overlay is an extension of current PPM waveform used which is the current standard for Mode S replies and ADS-B. The Phase Overlay were proposed in ICAO Technical Group in June 2008 in a first time.

First feasibility studies were conducted during SESAR-1 until V1 level. However, standardization study for Mode S and ADS-B started in 2016 in the frame of the Combined Surveillance Committee group.

Technically, Phase Overlay re-uses current PPM ADS-B waveform which allows for maintaining interoperability with the current standard. But pulses of the PPM messages are phase modulated in order to transmit 3 new bits for each PPM pulse. Consequently, it is possible with this solution to add 3 new messages superposed in the current ADS-B message.

During SESAR 2020 Wave 1, in the frame of PJ14-04-03 Task 06, Phase Overlay was studied reaching a V2/TRL4 level, developing a transmitter and a receiver prototype that were validated. The conclusion of these activities was that the use of phase overlay receivers was a good candidate to increase the capacity of the ADS-B data link and they can co-exist with existing ADS-B ground stations. Anyway, there was recognised that future activities were needed to demonstrate the viability of the technology in real operation environment.

2.5 Structure of the document

The Updated TS/IRS template is composed of different parts.

This document corresponds to the **Part I** for the PJ.14-W2-84d's Updated TS/IRS, whose structure is composed of the following sections:

- **Section 1:** Executive Summary.
- **Section 2:** This section introduces the document.
- **Section 3:** Provides general context of the project.
- **Section 4:** Details Functional and non-Functional requirements.
- **Section 5:** Provides some recommendation for implementation.
- **Section 6:** Provides the assumptions considered in the Technical Specification.
- **Section 7:** Lists the relevant references used within this document.

2.6 Glossary of terms

Term	Definition	Source of the definition
Phase Overlay	A means of increasing the throughput on 1090MHz frequency by overlaying 8PSK phase modulated information onto the PPM messages. Such messages contain additional information without changing the time occupancy of the frequency and remaining within the defined spectrum characteristics.	EUROCAE/RTCA ED-73F / DO-181F
PPM	Modulation technique used for Mode S replies where a pulse transmitted in the first half of the bit position interval represents a binary ONE, whereas a pulse transmitted in the second half represents a binary ZERO	ICAO (2004) Doc. 9684 – Manual of the Secondary Surveillance Radar (SSR) Systems
Automatic Dependent Surveillance Broadcast (ADS-B)	A means by which aircraft, aerodrome vehicles and other objects can automatically transmit and/or receive data such as identification, position and additional data, as appropriate, in a broadcast mode via a data link.	ICAO Doc. 4444 PANS-ATM
Mode Selective (Mode S)	A means by which interrogator can require from an aircraft thanks to its specific address, data such as identification, position and additional data, as appropriate, in a broadcast mode via a data link.	ICAO (2004) Doc. 9684 – Manual of the Secondary Surveillance Radar (SSR) Systems

Table 1: Glossary

2.7 Acronyms and Terminology

Term	Definition
ACAS	Airborne Collision Avoidance System
ADS-B	Automatic Dependent Surveillance – Broadcast
ATC	Air Traffic Control
ATCRBS	Air Traffic Control Radar Beacon System
ATM	Air Traffic Management
ATS	Air Traffic Services
CC	Capability Configuration
CNS	Communication, Navigation & Surveillance
DF	Downlink Format
EATMA	European ATM Architecture
EU	European Union
EUROCAE	European Organization for Civil Aviation Equipment
GICB	Ground Initiated Comm-B
GNSS	Global Navigation Satellite System
I-CNSS	Integrated CNS & Spectrum
ICAO	International Civil Aviation Organization
ID	Identification
IRM	Interrogation/Reply Monitor
IRS	Interface Requirements Specification
LDPC	Low Density Parity Check
LSB	Least Significant Bit
MLAT	Multilateration
MOPS	Minimum Operational Performance Standard
MSB	Most Significant Bit
MSG	Message
MTL	Minimum Trigger Level
NAF	NATO Architecture Framework
NSV	NAF System View
PO	Phase Overlay
PPM	Pulse Position Modulation

Ppm	Parts per million
PSK	Phase Shift Keying
RF	Radiofrequency
RMS	Root Mean Square
RS	Reed Solomon
RTCA	Radio Technical Commission for Aeronautics
SDD	Service Description Document
S3JU	SESAR3 Joint Undertaking (Agency of the European Commission)
SESAR	Single European Sky ATM Research Programme
TMA	Terminal Manoeuvring Area
TRL	Technology readiness Level
TS	Technical Specification
UF	Uplink Format
WAM	Wide Area Multilateration

Table 2: Acronyms and terminology

3 SESAR Solution Impacts on Architecture

3.1 Target Solution Architecture

3.1.1 SESAR Solution(s) Overview

SESAR Solution ID and Title	Functional Blocks/Role impacted by the SESAR Solution (from EATMA)	Enabler ID (from EATMA)	Enabler Title (from EATMA)	Enabler coverage
PJ.14-W2-84d: Phase Overlay for ADS-B	<i>ADS-B Out (PJ14-04-03)</i>	A/C-48b	Air broadcast of aircraft data (ADS-B OUT) compliant with new ED-102B/DO-260C standard	Fully
PJ.14-W2-84d: Phase Overlay for ADS-B	<i>Future ADS-B Communication</i>	CTE-S03c	New ADS-B station for future ADS-B applications	Fully

Table 3: SESAR Solution PJ.14-W2-84d Scope and related Functional Blocks/roles & Enablers

3.1.1.1 Deviations with respect to the SESAR Solution(s) definition

Not applicable

3.1.1.2 Relevant Use Cases

The Phase Overlay waveform has been standardized in ED-73F/DO-181F and ED-102B/DO-260C regulations, but the standardization of its potential applications is still open.

The PJ.14-W2-84d Solution proposes three different classifications of Phase Overlay applications:

- **The first category concerns to the spectrum congestion reduction thanks to the capability to compact in only one squitter or Mode S message, 4 already existing messages.**

For example, ATC ground station which interrogates a Phase Overlay equipped Transponder will reduce by 4 the interrogation and reply rate related to this transponder. For WAM or MLAT station, this will permit to reduce ADS-B spectrum.

- **A second category concerns to the addition of new information like weather data which could permit to transmit this information from an aircraft to another through ADS-B messages.**

Interrogation Reply Monitor function, which permits to transmit in real time to the ground station, interrogation rate detected by the transponder.

- **A third category concerns to secure ADS-B and the possibility offered by the extended data available in the Phase Overlay message to encrypt information like Flight Number or GNSS position. Secure ADS-B transmission will improve data integrity and it is a good candidate for ADS-B ground station (WAM and MLAT) application.**

It could be also useful for ACAS-X in order to reduce the use of UF0/UF16 interrogations necessary today to confirm ADS-B information.

This TS/IRS proposes an implementation compatible with all these categories, but the laboratory and flight tests will be performed only in ADS-B configuration because it will be easier to validate Phase Overlay performances.

3.1.1.3 Applicable standards and regulations

A list of the applicable standards and regulations is shown hereunder:

- Commission Implementing Regulation (EU) No 1207/2011, published on 22/11/2011.
- Commission Implementing Regulation (EU) No 1028/2014, published on 26/09/2014, amending EU Regulation 1207/2011.
- Commission Implementing Regulation (EU) No 2017/386, published on 06/03/2017 amending EU Regulation 1207/2011.
- Commission Implementing Regulation (EU) No 2020/587, published on 29/04/2020 amending EU Regulation 1207/2011.
- ICAO Annex 10 Volume 4, Surveillance Radar and Collision Avoidance System, up to Amendment 85.
- RTCA DO-260B/EUROCAE ED-102A Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B).
- RTCA DO-181E/EUROCAE ED-73E Minimum Operational Performance Standards for Air Traffic Control Radar Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment.
- RTCA DO-260C/EUROCAE ED-102B Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B).
- RTCA DO-181F/EUROCAE ED-73F Minimum Operational Performance Standards for Air Traffic Control Radar Beacon System/Mode Select (ATCRBS/Mode S) Airborne Equipment.

3.1.2 Capability Configurations required for the SESAR Solution

SESAR Solution ID and Title	Capability Configurations (CCs) (from EATMA)	Sub-Operating Environment(s) where the CCs operate	Capabilities (from EATMA)	Nodes (from EATMA)	Stakeholders (from EATMA)
PJ.14-W2-84d: Phase Overlay for ADS-B	Surveillance Infrastructure TMA	Terminal Airspace	Aircraft-to-Aircraft Separation Provision (airspace) Surface Guidance Provision	ATS	Air Navigation Service Provider

Table 4: List of Capability Configuration required for the SESAR Solution

3.2 Changes imposed by the SESAR Solution on the baseline Architecture

Enabler ID (from EATMA)	Enabler Title (from EATMA)	Changes
A/C-48b	Air broadcast of aircraft data (ADS-B OUT) compliant with new ED102B/DO260C standard	<u>Functional Blocks:</u> <ul style="list-style-type: none"> A/C-48b: ADS-B Out (PJ14-04-03), CTE-S03c: Future ADS-B Communication
CTE-S03c	New ADS-B stations for future ABS-B applications	<u>Functions:</u> <ul style="list-style-type: none"> A/C-48b: Future ADS-B Transmission CTE-S03c: Future ADS-B Reception

Table 5: List of changes due to the SESAR Solution

4 Technical Specifications

4.1 Functional architecture overview (general introduction for all solutions)

This section contains the Technical Architecture designed by the solution including:

- High level diagrams as Resource Connectivity models (NSV-1).
- Infrastructure models (NSV-2).
- Orchestration models (NSV-4).

4.1.1 Resource Connectivity view (one section per NSV-1)

This section describes how the relevant resources interact in different (sub)-Operating Environments to achieve the needed Capabilities:

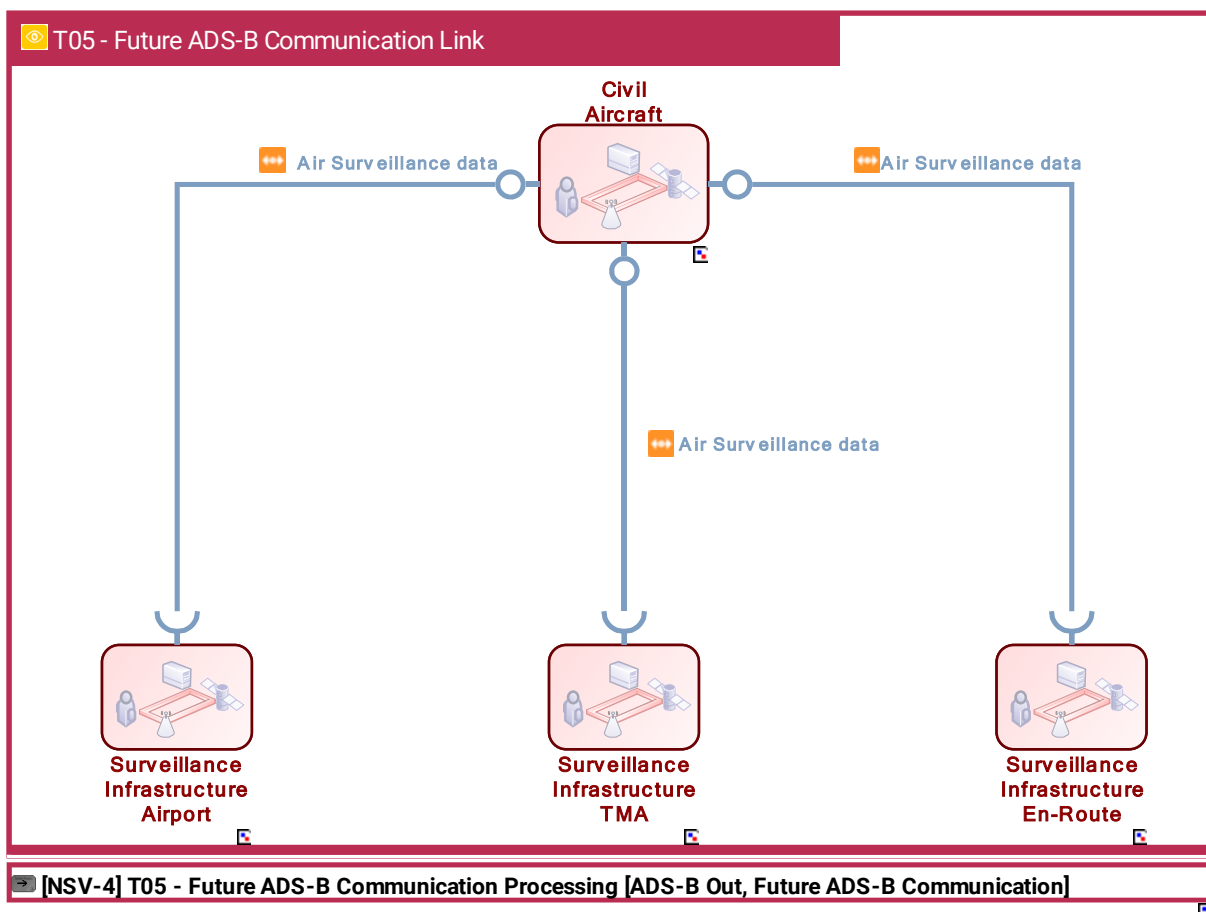


Figure 1. NSV-1 Diagram.

4.1.1.1 Resource Infrastructure view (of the NSV-2)

This diagram describes how the systems interact at the infrastructure level:

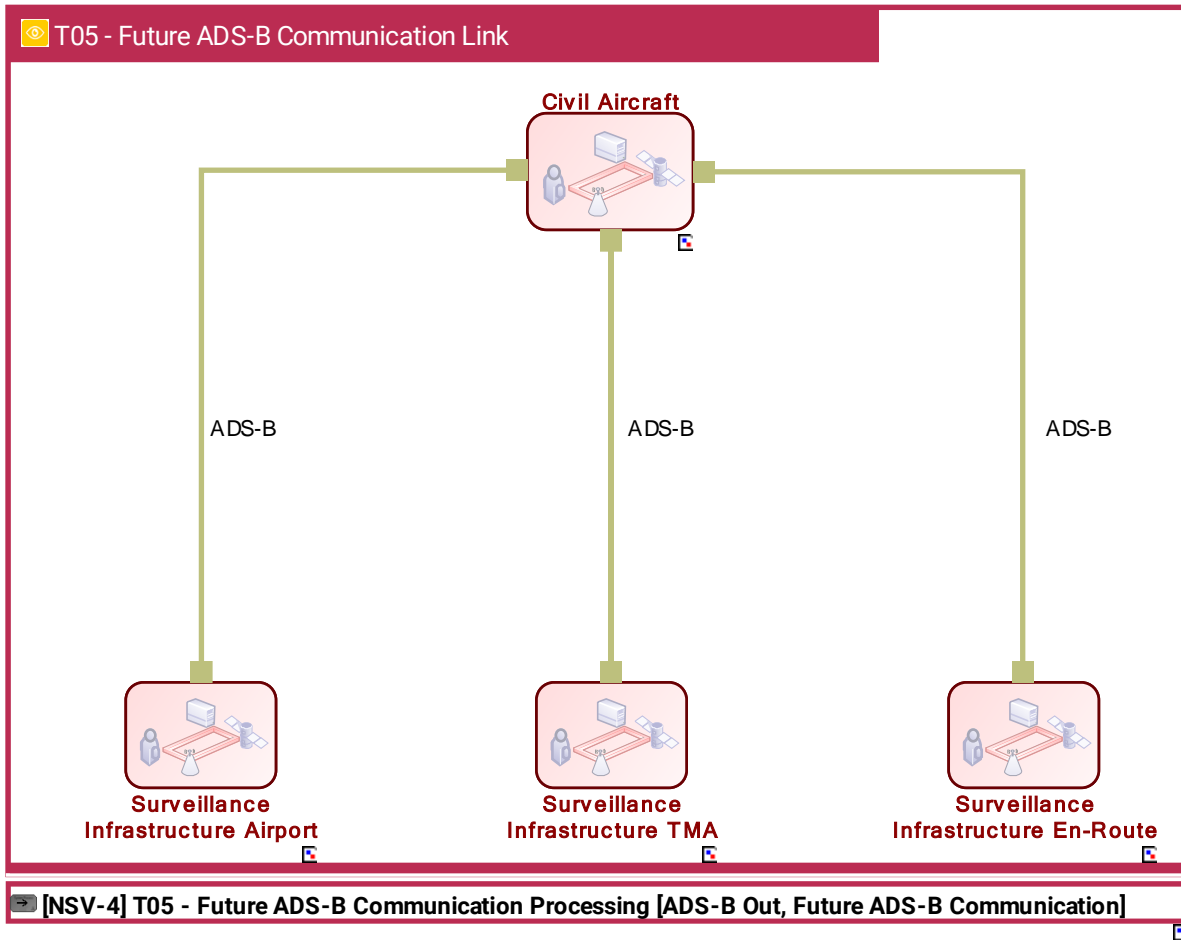


Figure 2. NSV-2 Diagram.

4.1.1.2 Resource Orchestration view (all NSV-4s linked to the NSV-1)

The diagram describes how the systems interact at the orchestration level:

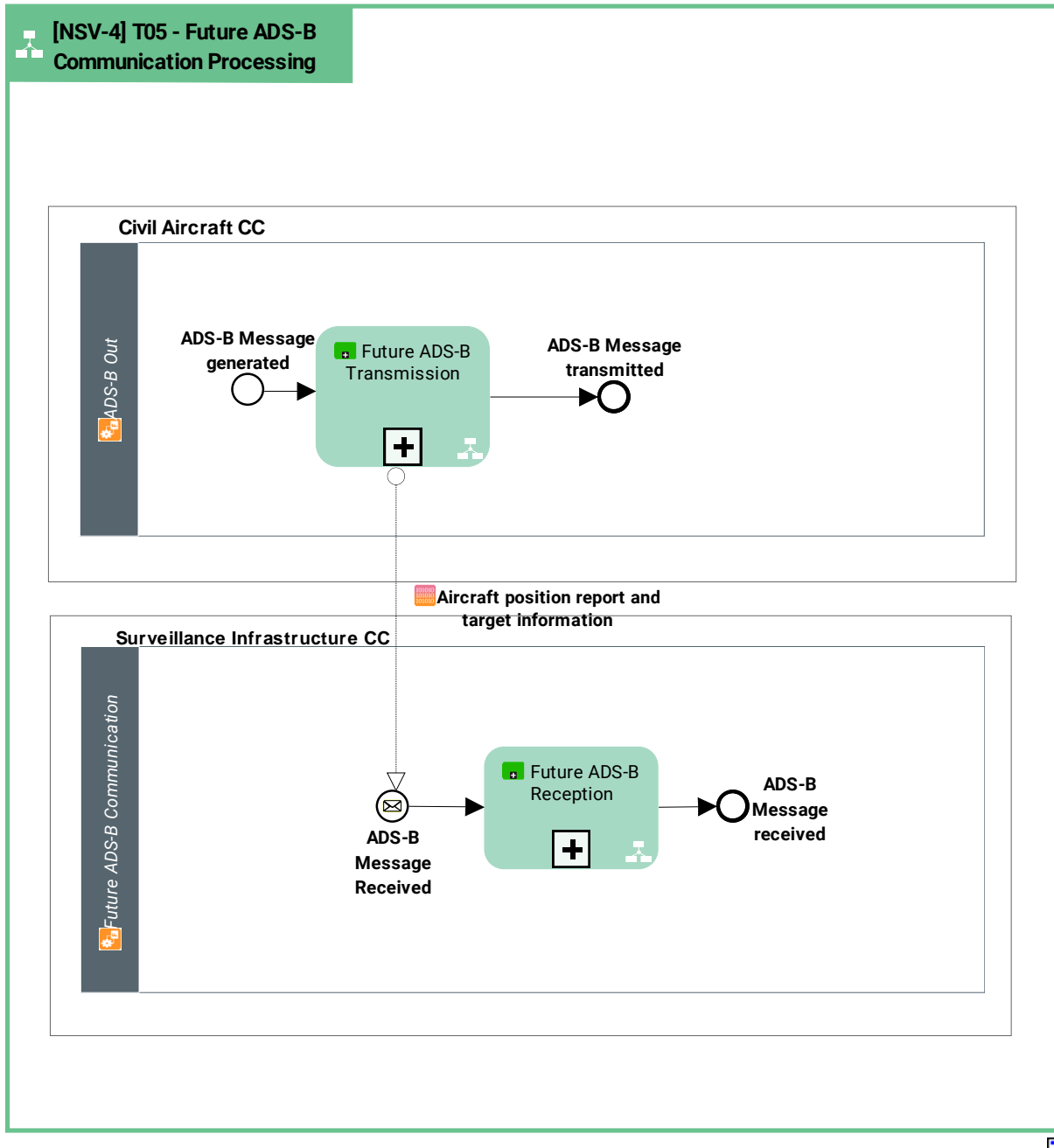


Figure 3. NSV-4 Diagram.

4.1.2 Resource Composition

Not applicable.

4.1.3 Service view

Not applicable.

4.2 Functional and non-Functional Requirements

The requirement identifier is composed as follows:

<Object type>-<Project code>-<Task code>-<Document code><Requirement type> <Reference number>

being an example REQ-XXb.YY-TS-UU01.0123, where:

- REQ is the <Object type> (i.e., requirement);
- XXb is the <Project code>;
- YY is the < task code>;
- TS is the <Document code> (i.e., technical specification);
- UU01 is the <Reference code> which is a combination of four alphanumeric characters. (i.e., TXPM for Phase Overlay Transmission requirements and RXPM for Phase Overlay Reception requirements); and
- uuuu is the <Reference number>.

Each requirement has a unique identifier. Besides, requirements specified as “**shall**” present mandatory requirements, whereas those specified as “**should**” are optional.

4.2.1 Transmission requirements

[REQ]

Identifier	REQ-14.84d-TS-TXPM.0010
Title	Transmission Frequency.
Requirement	The carrier frequency of all downlink transmissions from transponders with Mode S capabilities shall be 1090 MHz plus or minus 25 KHz.
Status	<Validated>
Rationale	Compatibility with the current Mode S and ADS-B standard.
Category	<Interoperability> <Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	A/C-48b
<ALLOCATED_TO>	<Functional block>	ADS-B Out

[REQ]

Identifier	REQ-14.84d-TS- TXPM-0020
Title	Phase Overlay
Requirement	The phase modulation transmission shall use 8PSK phase states to transmit 3 bits associated with a single phase state for each PPM data bit and in each of the four preamble pulses.
Status	<Validated>
Rationale	Allows for multiplying by 4 the transmission rate.
Category	<Design> <Interoperability>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	A/C-48b
<ALLOCATED_TO>	<Functional block>	ADS-B Out

[REQ]

Identifier	REQ-14.84d-TS-TXPM-0030
Title	Sync Phase Overlay Data.
Requirement	The reference sync phase shall be encoded in the four preamble pulses and the data pulses of the first four PPM data bits by maintaining constant phase for these pulses.
Status	<Validated>
Rationale	Phase synchronization purpose.
Category	<Design> <Interoperability>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	A/C-48b
<ALLOCATED_TO>	<Functional block>	ADS-B Out

[REQ]

Identifier	REQ-14.84d-TS-TXPM-0040
Title	Reference phase
Requirement	The reference phase shall represent zero degrees and is used to encode phase information for the remaining PPM data chips.
Status	<Validated>
Rationale	Phase synchronisation purpose.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	A/C-48b
<ALLOCATED_TO>	<Functional block>	ADS-B Out

[REQ]

Identifier	REQ-14.84d-TS-TXPM-0050																		
Title	Phase Overlay coding.																		
Requirement	<p>In addition to the binary ONE or binary ZERO represented by PPM, each data interval shall consist of 3 additional bit values representing the Phase Overlay reply data as determined by the encoded phase of the pulse in the bit interval as follows:</p> <table border="1"> <thead> <tr> <th>Phase Relative to Synchro (Degrees)</th> <th>Binary Value MSB – LSB</th> </tr> </thead> <tbody> <tr><td>0</td><td>000</td></tr> <tr><td>45</td><td>001</td></tr> <tr><td>90</td><td>010</td></tr> <tr><td>135</td><td>011</td></tr> <tr><td>180</td><td>100</td></tr> <tr><td>225</td><td>101</td></tr> <tr><td>270</td><td>110</td></tr> <tr><td>315</td><td>111</td></tr> </tbody> </table> <p><i>Note: Phase shifting is performed by adding the state phase to the reference phase.</i></p>	Phase Relative to Synchro (Degrees)	Binary Value MSB – LSB	0	000	45	001	90	010	135	011	180	100	225	101	270	110	315	111
Phase Relative to Synchro (Degrees)	Binary Value MSB – LSB																		
0	000																		
45	001																		
90	010																		
135	011																		
180	100																		
225	101																		
270	110																		
315	111																		
Status	<Validated>																		
Rationale	Allows for limiting error decoding.																		
Category	<Design> <Interoperability> <Data>																		

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	A/C-48b
<ALLOCATED_TO>	<Functional block>	ADS-B Out

[REQ]

Identifier	REQ-14.84d-TS-TXPM-0060
Title	Phase Error Tolerance 0.5 microsecond pulse
Requirement	The phase error of the transmitted phase information in any 0.5-microsecond PPM reply pulse, excluding the leading and trailing edges, shall not exceed 3.0 degrees RMS and 12.2 in the peak value.
Status	<Validated>
Rationale	Performances in line with the current transmitters and receivers' sources.
Category	<Performance>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	A/C-48b
<ALLOCATED_TO>	<Functional block>	ADS-B Out

[REQ]

Identifier	REQ-14.84d-TS-TXPM-0061
Title	Phase Error Tolerance 1 microsecond pulse
Requirement	<p>When a one-microsecond pulse is transmitted as a result of a PPM ZERO data bit in the second half of one PPM bit interval followed by a PPM ONE bit in the first half of the next interval, the phase error for the phase information for each of the two phase states shall not exceed 3.0 degrees RMS and 12.2 in the peak value except during the phase transition interval when a phase change is required between the two phase states and the leading and trailing edges of the one-microsecond pulse.</p> <p>The phase error tolerance is in addition to the average frequency tolerance specified in REQ-14.84d-TS-TXPM-0010.</p> <p><i>Note: During transmitter pulse turn-on and turn-off, the phase of the transmitted signal is typically not stable until the final RF output power is reached at the top portion of the pulse. It is not necessary to meet the accuracy requirement of the phase of the signal during the turn-on and turn-off portions of the pulse. The phase enhancement reception algorithm should not rely on a constant phase during the transient portions of the pulse.</i></p>
Status	<Validated>
Rationale	Performances in line with the current transmitters and receivers' sources.
Category	<Performance>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	A/C-48b
<ALLOCATED_TO>	<Functional block>	ADS-B Out

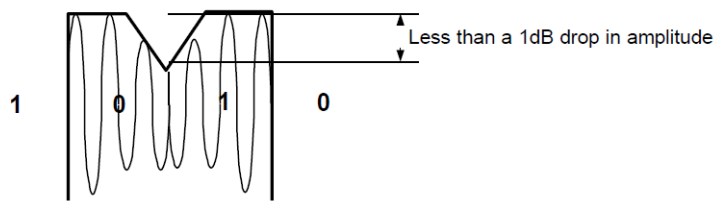
[REQ]

Identifier	REQ-14.84d-TS-TXPM-0070
Title	Phase transition interval
Requirement	The phase transition interval in the 400 nanosecond interval shall start no more than 200 nanoseconds prior to the PPM bit interval transition at the centre of the 1.0 microsecond pulse formed by a PPM ZERO data bit followed by a PPM ONE data bit.
Status	<Validated>
Rationale	Performances in line with the current transmitters and receivers' sources.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	A/C-48b
<ALLOCATED_TO>	<Functional block>	ADS-B Out

[REQ]

Identifier	REQ-14.84d-TS-TXPM-0071
Title	Pulse Amplitude during Transition Interval
Requirement	<p>The RF peak output power of any merged PPM pulses shall vary less than 1dB due to Phase Overlay for a receiver bandwidth of 8 MHz when linearly applying Phase Overlay across the 400 nanosecond phase transition interval.</p> <div style="text-align: center;"> <p>[BIT 5] [BIT 6]</p> <p>Double Pulse Phase Transition Area</p> <p>400 nSec</p>  </div>
Status	<Validated>
Rationale	Performances in line with the current transmitters and receivers' sources.
Category	<Design> <Interoperability> <Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	A/C-48b
<ALLOCATED_TO>	<Functional block>	ADS-B Out

[REQ]

Identifier	REQ-14.84d-TS-TXPM-0080
Title	Phase Overlay during the Phase Transition Interval.
Requirement	<p>Phase drift after the preamble and 4 sync phase pulses due to transmitter frequency drift shall not exceed 43 degrees for the entire remaining 108 microsecond message duration.</p> <p><i>Note: A frequency drift of 1 ppm (parts per million) through the message represents a phase error of $(1 \text{ Hz} / 10^6 \text{ Hz}) * 1090 \text{ Hz/usec} * 108 \text{ usec/message} * 360 \text{ deg/Hz} = 42.4 \text{ deg/message}$. The 1 ppm frequency drift includes typical sources of transmitter frequency reference drift during the message due to for example voltage shift and loading (pulling) of the transmitter reference oscillator.</i></p>
Status	<Validated>
Rationale	Performances in line with the current transmitters and receivers' sources.
Category	<Functional> <Interoperability> <Design>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	A/C-48b
<ALLOCATED_TO>	<Functional block>	ADS-B Out

[REQ]

Identifier	REQ-14.84d-TS-TXPM-0090
Title	Phase Overlay Transmitting Data Format
Requirement	<p>The following format shall be used for Phase Overlay Transmit message.</p>
Status	<Validated>
Rationale	Compatibility with the current ADS-B format.
Category	<Interoperability> <Data> <Interface>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	A/C-48b
<ALLOCATED_TO>	<Functional block>	ADS-B Out

[REQ]

Identifier	REQ-14.84d-TS-TXPM-0100																															
Title	Reed-Solomon Encoder																															
Requirement	<p>For Reed-Solomon encoding, ADS-B message corresponding to MSG type field of 1 shall be used as specified in the following table:</p> <table border="1" style="margin-left: 40px;"> <thead> <tr> <th>Value</th> <th>Forward Error Correction</th> <th>Meaning</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>N/A</td> <td>No Data</td> </tr> <tr> <td>1</td> <td rowspan="6">RS</td> <td>ADS-B State and Status Message</td> </tr> <tr> <td>2</td> <td>Mode S GICB Data</td> </tr> <tr> <td>3</td> <td>IRM message</td> </tr> <tr> <td>4</td> <td>Test Message</td> </tr> <tr> <td>5-6</td> <td>Undefined</td> </tr> <tr> <td>7</td> <td rowspan="5">LDPC</td> <td>ADS-B State and Status Message</td> </tr> <tr> <td>8</td> <td>Mode S GICB Data</td> </tr> <tr> <td>9</td> <td>IRM Message</td> </tr> <tr> <td>10</td> <td>Test Message</td> </tr> <tr> <td>11-12</td> <td>Undefined</td> </tr> <tr> <td>13-255</td> <td colspan="2">Reserved</td> </tr> </tbody> </table>	Value	Forward Error Correction	Meaning	0	N/A	No Data	1	RS	ADS-B State and Status Message	2	Mode S GICB Data	3	IRM message	4	Test Message	5-6	Undefined	7	LDPC	ADS-B State and Status Message	8	Mode S GICB Data	9	IRM Message	10	Test Message	11-12	Undefined	13-255	Reserved	
Value	Forward Error Correction	Meaning																														
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4		Test Message																														
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9	IRM Message																															
10	Test Message																															
11-12	Undefined																															
13-255	Reserved																															
Status	<Validated>																															
Rationale	This is in line with the content specified in the standard DO-260C Table §2.2.3.5.4.4.																															
Category	<Interoperability> <Data> <Interface>																															

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	A/C-48b
<ALLOCATED_TO>	<Functional block>	ADS-B Out

[REQ]

Identifier	REQ-14.84d-TS-TXPM-0101																															
Title	LDPC Encoder																															
Requirement	<p>For LDPC encoding, ADS-B message corresponding to MSG type field of 1 shall be used as specified in the following table:</p> <table border="1" style="margin-left: 40px;"> <thead> <tr> <th>Value</th> <th>Forward Error Correction</th> <th>Meaning</th> </tr> </thead> <tbody> <tr> <td>0</td> <td>N/A</td> <td>No Data</td> </tr> <tr> <td>1</td> <td rowspan="6">RS</td> <td>ADS-B State and Status Message</td> </tr> <tr> <td>2</td> <td>Mode S GICB Data</td> </tr> <tr> <td>3</td> <td>IRM message</td> </tr> <tr> <td>4</td> <td>Test Message</td> </tr> <tr> <td>5-6</td> <td>Undefined</td> </tr> <tr> <td>7</td> <td rowspan="6">LDPC</td> <td>ADS-B State and Status Message</td> </tr> <tr> <td>8</td> <td>Mode S GICB Data</td> </tr> <tr> <td>9</td> <td>IRM Message</td> </tr> <tr> <td>10</td> <td>Test Message</td> </tr> <tr> <td>11-12</td> <td>Undefined</td> </tr> <tr> <td>13-255</td> <td colspan="2">Reserved</td> </tr> </tbody> </table>	Value	Forward Error Correction	Meaning	0	N/A	No Data	1	RS	ADS-B State and Status Message	2	Mode S GICB Data	3	IRM message	4	Test Message	5-6	Undefined	7	LDPC	ADS-B State and Status Message	8	Mode S GICB Data	9	IRM Message	10	Test Message	11-12	Undefined	13-255	Reserved	
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3		IRM message																														
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13-255	Reserved																															
Status	<Validated>																															
Rationale	This is in line with the content specified in the standard DO-260C Table §2.2.3.5.4.4.																															
Category	<Interoperability> <Data> <Interface>																															

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	A/C-48b
<ALLOCATED_TO>	<Functional block>	ADS-B Out

[REQ]

Identifier	REQ-14.84d-TS-TXPM-0110
Title	Phase Overlay Activation.
Requirement	Phase Overlay function shall be activated by configuration setting.
Status	<Validated>
Rationale	Phase Overlay can be activated/deactivated for test purpose.
Category	<Functional>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	A/C-48b
<ALLOCATED_TO>	<Functional block>	ADS-B Out

[REQ]

Identifier	REQ-14.84d-TS-TXPM-0120
Title	Phase Overlay Transmission.
Requirement	Test Message TYPE=23 squitter shall be used for Phase Overlay function.
Status	<Validated>
Rationale	This Test Message defined in DO260C, permits to use Phase Overlay for Flight Test purpose.
Category	<Interface> <Interoperability> <Adaptability> <Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	A/C-48b
<ALLOCATED_TO>	<Functional block>	ADS-B Out

[REQ]

Identifier	REQ-14.84d-TS-TXPM-0121
Title	ADS-B Message Pulse amplitude variation between pulses
Requirement	The pulse amplitude variation between one pulse and any other pulse in a message transmission shall not exceed 2 dB.
Status	<Validated>
Rationale	Current DF17 message will be used in order to limit software evolutions. <i>Note: This requirement is consistent with the requirements of ICAO Annex 10, Volume IV, fourth edition, July 2007, §3.1.2.2, Table 3-2, and Figure 3-5, as well as with the requirements of RTCA DO-181E, §2.2.4.2.2 (EUROCAE ED-73E, §3.6.4).</i>
Category	<Performance>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	A/C-48b
<ALLOCATED_TO>	<Functional block>	ADS-B Out

[REQ]

Identifier	REQ-14.84d-TS-TXPM-0122
Title	ADS-B Message Pulse rise time
Requirement	The pulse rise time shall not be less than 0.05 microseconds or greater than 0.1 microsecond.
Status	<Validated>
Rationale	Current DF17 message will be used in order to limit software evolutions. <i>Note: This requirement is consistent with the requirements of ICAO Annex 10, Volume IV, fourth edition, July 2007, §3.1.2.2, Table 3-2, and Figure 3-5, as well as with the requirements of RTCA DO-181E, §2.2.4.2.2 (EUROCAE ED-73E, §3.6.4).</i>
Category	<Design>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	A/C-48b
<ALLOCATED_TO>	<Functional block>	ADS-B Out

[REQ]

Identifier	REQ-14.84d-TS-TXPM-0123
Title	ADS-B Message Pulse decay Time
Requirement	The pulse decay time shall not be less than 0.05 microseconds or greater than 0.2 microseconds.
Status	<Validated>
Rationale	Current DF17 message will be used in order to limit software evolutions. <i>Note: This requirement is consistent with the requirements of ICAO Annex 10, Volume IV, fourth edition, July 2007, §3.1.2.2, Table 3-2, and Figure 3-5, as well as with the requirements of RTCA DO-181E, §2.2.4.2.2 (EUROCAE ED-73E, §3.6.4).</i>
Category	<Design>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	A/C-48b
<ALLOCATED_TO>	<Functional block>	ADS-B Out

[REQ]

Identifier	REQ-14.84d-TS-TXPM-0124										
Title	ADS-B Message spectrum										
Requirement	<p>The spectrum of the message transmission shall not exceed the bounds in Table 2- 7:</p> <table border="1" style="margin-left: 40px;"> <thead> <tr> <th>Frequency Difference (MHz from 1090 MHz)</th> <th>Maximum Relative Response (dB down from peak)</th> </tr> </thead> <tbody> <tr> <td>> 1.3 and ≤ 7</td> <td>3</td> </tr> <tr> <td>> 7 and ≤ 23</td> <td>20</td> </tr> <tr> <td>> 23 and ≤ 78</td> <td>40</td> </tr> <tr> <td>> 78</td> <td>60</td> </tr> </tbody> </table>	Frequency Difference (MHz from 1090 MHz)	Maximum Relative Response (dB down from peak)	> 1.3 and ≤ 7	3	> 7 and ≤ 23	20	> 23 and ≤ 78	40	> 78	60
Frequency Difference (MHz from 1090 MHz)	Maximum Relative Response (dB down from peak)										
> 1.3 and ≤ 7	3										
> 7 and ≤ 23	20										
> 23 and ≤ 78	40										
> 78	60										
Status	<Validated>										
Rationale	<p>For interoperability purpose, Phase Overlay spectrum has to be compliant with the current ADS-B standard.</p> <p><i>Note: This requirement is consistent with the requirements of ICAO Annex 10, Volume IV, fourth edition, July 2007, §3.1.2.2, Table 3-2, and Figure 3-5, as well as with the requirements of RTCA DO-181E, §2.2.4.2.2 (EUROCAE ED-73E, §3.6.4).</i></p>										
Category	<Interoperability> <Safety>										

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	A/C-48b
<ALLOCATED_TO>	<Functional block>	ADS-B Out

4.2.2 Reception requirements

[REQ]

Identifier	REQ-14.84d-TS-RXPM-0130
Title	8PSK demodulation.
Requirement	<p>For phase modulated signals, the PPM modulated message pulse phases shall be 8PSK demodulated to provide an 8PSK state that represents three phase bits within the bit interval containing the PPM pulse. See waveform in this Figure:</p>
Status	<Validated>
Rationale	Same modulation than transmission waveform.
Category	<Design> <Interoperability>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	CTE-S03c
<ALLOCATED_TO>	<Functional block>	Future ADS-B Communication

[REQ]

Identifier	REQ-14.84d-TS-RXPM-0140
Title	Phase Reference Determination from Preamble and First 4 Data Pulses.
Requirement	The reference synchronization phase for the 8PSK signal shall be demodulated from the four preamble pulses and the data pulses of the first four PPM data bits. <i>Note: Phase shifting is performed by adding the state phase to the reference phase.</i>
Status	<Validated>
Rationale	Synchronization time for referencing phase.
Category	<Design> <Interoperability>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	CTE-S03c
<ALLOCATED_TO>	<Functional block>	Future ADS-B Communication

[REQ]

Identifier	REQ-14.84d-TS-RXPM-0141																		
Title	Phase Reference Determination from Preamble and First 4 Data Pulses.																		
Requirement	The reference sync phase shall represent zero degrees and is used to decode the 8PSK phase information for the remaining PPM data chips as shown in the figure below: <table border="1" style="margin-left: 40px;"> <thead> <tr> <th>Phase Relative to Synchro (Degrees)</th> <th>Binary Value MSB – LSB</th> </tr> </thead> <tbody> <tr><td>0</td><td>000</td></tr> <tr><td>45</td><td>001</td></tr> <tr><td>90</td><td>010</td></tr> <tr><td>135</td><td>011</td></tr> <tr><td>180</td><td>100</td></tr> <tr><td>225</td><td>101</td></tr> <tr><td>270</td><td>110</td></tr> <tr><td>315</td><td>111</td></tr> </tbody> </table>	Phase Relative to Synchro (Degrees)	Binary Value MSB – LSB	0	000	45	001	90	010	135	011	180	100	225	101	270	110	315	111
Phase Relative to Synchro (Degrees)	Binary Value MSB – LSB																		
0	000																		
45	001																		
90	010																		
135	011																		
180	100																		
225	101																		
270	110																		
315	111																		
Status	<Validated>																		
Rationale	Obtaining the reference phase for decoding remaining data. This requirement is in line with Table §2.2.4.3.4.8.2 of RTCA DO-260C.																		
Category	<Design> <Interoperability> <Data>																		

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	CTE-S03c
<ALLOCATED_TO>	<Functional block>	Future ADS-B Communication

[REQ]

Identifier	REQ-14.84d-TS-RXPM-0150
Title	Phase modulated received data essential fields
Requirement	Phase modulated received data shall be decoded by the phase state, each phase state producing a bit value for each of three data bits.
Status	<Validated>
Rationale	Decoding bit
Category	<Design> <Interoperability> <Data>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	CTE-S03c
<ALLOCATED_TO>	<Functional block>	Future ADS-B Communication

[REQ]

Identifier	REQ-14.84d-TS-RXPM-0160
Title	Phase Drift Error Compensation
Requirement	<p>Phase Overlay capable receivers shall be capable of compensating for transmitter carrier frequency offset and phase drift error within the reply messages, considering a maximum carrier frequency offset of 25 KHz, in addition to, a phase drift of 43 degrees for the entire data block and a PPM interval phase error tolerance peak of 12.2 degrees.</p> <p><i>Note: A method for determining carrier frequency offset prior to demodulation, as well as phase drift compensation, can greatly facilitate meeting this requirement.</i></p>
Status	<Validated>
Rationale	Phase drift compensation capability. This requirement is in line with RTCA DO-181F / EUROCAE ED-73F.
Category	<Functional> <Interoperability> <Design>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	CTE-S03c
<ALLOCATED_TO>	<Functional block>	Future ADS-B Communication

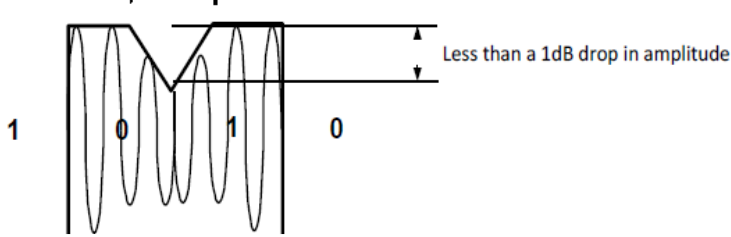
[REQ]

Identifier	REQ-14.84d-TS-RXPM-0161																		
Title	Phase Drift Error Computation																		
Requirement	<p>Phase error shall be computed for each PPM phase modulated pulse from the demodulated phase value relative to an exact phase value as specified in following Table:</p> <table border="1"> <thead> <tr> <th>Phase Relative to Synchro (Degrees)</th> <th>Binary Value MSB – LSB</th> </tr> </thead> <tbody> <tr><td>0</td><td>000</td></tr> <tr><td>45</td><td>001</td></tr> <tr><td>90</td><td>010</td></tr> <tr><td>135</td><td>011</td></tr> <tr><td>180</td><td>100</td></tr> <tr><td>225</td><td>101</td></tr> <tr><td>270</td><td>110</td></tr> <tr><td>315</td><td>111</td></tr> </tbody> </table> <p>This phase error shall then be used to compensate out any phase drift between PPM phase modulated pulses.</p>	Phase Relative to Synchro (Degrees)	Binary Value MSB – LSB	0	000	45	001	90	010	135	011	180	100	225	101	270	110	315	111
Phase Relative to Synchro (Degrees)	Binary Value MSB – LSB																		
0	000																		
45	001																		
90	010																		
135	011																		
180	100																		
225	101																		
270	110																		
315	111																		
Status	<Validated>																		
Rationale	Phase drift compensation capability. This requirement is in line with Table §2.2.4.3.4.8.2 of RTCA DO-260C.																		
Category	<Design>																		

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	CTE-S03c
<ALLOCATED_TO>	<Functional block>	Future ADS-B Communication

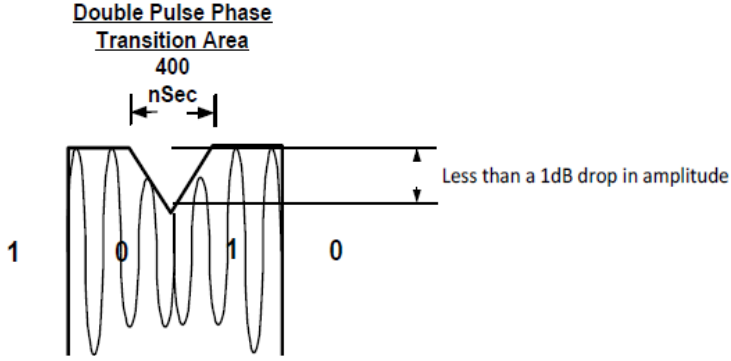
[REQ]

Identifier	REQ-14.84d-TS-RXPM-0170
Title	Valid Phase Data Demodulation Timing – 1.0 μs PPM pulse width
Requirement	<p>The timing interval to be used for phase determination for each PPM data bit is dependent on the PPM data pulse width associated with the data bit.</p> <p>For nominal 1.0 μsec pulses, the valid phase demodulation area for a wide PPM pulse (nominal 1.0 μsec) shall be from the 90% points (-0.5 dB from peak amplitude) of the leading and trailing edges and outside of the 400 nsec interval commencing 200 nsec prior to the PPM bit interval transition at the center of the 1.0 μsec pulse formed by a PPM zero data bit followed by a PPM one data bit.</p> <div style="text-align: center;"> <p>[PPM BIT 5] [PPM BIT 6]</p> <p><u>Double Pulse Phase Transition Area</u> 400 nSec</p>  </div>
Status	<Validated>
Rationale	Demodulation capability
Category	<Design> <Interoperability> <Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	CTE-S03c
<ALLOCATED_TO>	<Functional block>	Future ADS-B Communication

[REQ]

Identifier	REQ-14.84d-TS-RXPM-0171
Title	Valid Phase Data Demodulation Timing – 0.5 μs PPM pulse width
Requirement	<p>The timing interval to be used for phase determination for each PPM data bit is dependent on the PPM data pulse width associated with the data bit.</p> <p>For nominal 0.5 μsec pulses, the valid phase demodulation area for a single 0.5 μsec PPM pulse shall be from the 90% points (-0.5 dB from peak amplitude) of the leading and trailing edges of the PPM pulse.</p> <p style="text-align: center;">[PPM BIT 5] [PPM BIT 6]</p> <p style="text-align: center;"><u>Double Pulse Phase Transition Area</u> 400 nSec</p> 
Status	<Validated>
Rationale	Demodulation capability
Category	<Design> <Interoperability> <Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	CTE-S03c
<ALLOCATED_TO>	<Functional block>	Future ADS-B Communication

[REQ]

Identifier	REQ -14.84d-TS-RXPM-0180
Title	Receiver Sensitivity at MTL
Requirement	The Phase Overlay receiver sensitivity minimum trigger level for Phase Overlay signals shall be -79 dBm. The Phase Overlay MTL is defined as the RF level at which 90% of long Mode S replies or extended squitters received have valid Phase Overlay message decodes.
Status	<Validated>
Rationale	The MTL is defined as sensitivity level where 90% of PPM message are correctly decoded. <i>Note: 90% decoded of Phase Overlay messages from PPM messages decoded @ MTL equates to 81% of total messages received @ MTL.</i>
Category	<Performance> <Design>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	CTE-S03c
<ALLOCATED_TO>	<Functional block>	Future ADS-B Communication

[REQ]

Identifier	REQ-14.84d-TS-RXPM-0181
Title	Receiver Sensitivity – no interference
Requirement	In the absence of interference or overloads, each ADS-B receiver shall properly detect and decode at least 98% of all Phase Overlay messages overlaid on PPM messages received at an input signal level between the levels of -76 dBm and -21dBm.
Status	<Validated>
Rationale	Receiver Sensitivity. <i>Note: 99% decode of Phase Overlay messages from PPM messages decoded from signals received at levels between MTL + 3dB and -21dBm equates to 98% of total messages received at signal levels between MTL + 3 and -21dBm.</i>
Category	<Performance> <Design>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	CTE-S03c
<ALLOCATED_TO>	<Functional block>	Future ADS-B Communication

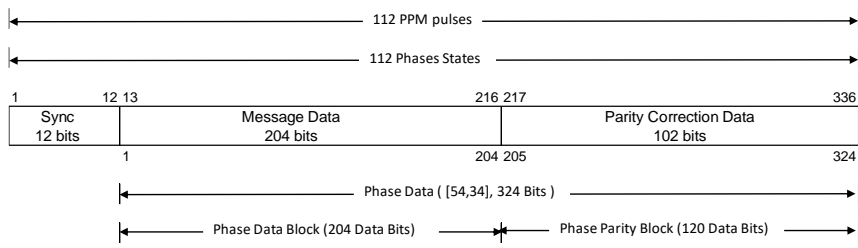
[REQ]

Identifier	REQ-14.84d-TS-RXPM-0190
Title	Decoder Performance
Requirement	The decoder performance shall be consistent with extended squitter PPM decoder performance per paragraph 2.4.4.4.2.5 of RTCA DO-260C.
Status	<Validated>
Rationale	<p>Successful decode performance includes test conditions for a desired signal with 1 to 5 overlapping ATCRBS signals at various amplitudes and timing conditions. Use of all of the specified test cases in the MOPS is recommended for phase decoding assessment.</p> <p><i>Note: Overlapping ATCRBS and Mode S signals on the 1090 MHz link creates distortion that can disrupt proper decoding of desired messages. Performance requirements for overlapping ATCRBS signals and overlapping extended squitter signal of the data block of the desired signal may be utilized for phase demodulation decoder performance.</i></p>
Category	<Performance> <Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	CTE-S03c
<ALLOCATED_TO>	<Functional block>	Future ADS-B Communication

[REQ]

Identifier	REQ-14.84d-TS-RXPM-0200
Title	Phase Overlay Received Data Format
Requirement	<p>The following format shall be used for Phase Overlay Receiver for decoding the Phase Overlay messages.</p> 
Status	<Validated>
Rationale	Compatibility with the current ADS-B format.
Category	<Interoperability> <Data> <Interface>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	CTE-S03c
<ALLOCATED_TO>	<Functional block>	Future ADS-B Communication

[REQ]

Identifier	REQ-14.84d-TS-RXPM-0210
Title	Reed-Solomon Decoder
Requirement	ADS-B Phase Overlay messages with an MSG type field value of 1 shall be decoded following the rules of Reed-Solomon messages encoding as specified in RTCA DO-260C §2.2.4.3.4.8.5.1
Status	<Validated>
Rationale	Message Type field for ADS-B PM Reed-Solomon messages.
Category	<Interoperability> <Data> <Interface>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	CTE-S03c
<ALLOCATED_TO>	<Functional block>	Future ADS-B Communication

[REQ]

Identifier	REQ-14.84d-TS-RXPM-0211
Title	LDPC Decoder
Requirement	ADS-B PO messages with an MSG type field value of 7 shall be decoded following the rules of LDPC messages encoding as specified in RTCA DO-260C §2.2.4.3.4.8.5.2
Status	<Validated>
Rationale	Message Type field for ADS-B PM LDPC messages.
Category	<Interoperability> <Data> <Interface>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	CTE-S03c
<ALLOCATED_TO>	<Functional block>	Future ADS-B Communication

[REQ]

Identifier	REQ-14.84d-TS-RXPM-0220
Title	Phase Overlay Reception Test Message
Requirement	Test Message TYPE=23 squitter shall be used for Phase Overlay function.
Status	<Validated>
Rationale	This Test Message, defined in ED-102B/DO-260C, enables the use of Phase Overlay for Flight Test purpose.
Category	<Interface> <Interoperability> <Adaptability> <Safety>

[REQ Trace]

Relationship	Linked Element Type	Identifier
<ALLOCATED_TO>	<SESAR Solution>	PJ.14-W2-84d
<ALLOCATED_TO>	<Enabler>	CTE-S03c
<ALLOCATED_TO>	<Functional block>	Future ADS-B Communication

5 Recommendation for Implementation

Since this technology is considered as optional in the ADS-B MOPS standards (ED-102B/DO-260C), the implementation should be performed as a local solution in order to bring more flexibility to:

- Aircraft operators.
- ANSPs

As this new technology is backwards compatible with the current ADS-B systems, it is not mandatory for Phase Overlay ADS-B technology to be globally deployed for maintaining the service in operation. However, it is needed to deploy the Phase Overlay capabilities in both stakeholders involved, e.g., avionics and ATC systems, to set up the operation properly.

Deployment area will depend on the application targeted for Phase Overlay (secure ADS-B, weather data, military applications). Therefore, the centralised implementation option would not be realistic nor feasible.

6 Assumptions

No assumptions are identified.

7 References and Applicable Documents

7.1 Applicable Documents

Content Integration

- [1] PJ19-W2 D2.15 EATMA Guidance Material (2020 edition), Ed.01.00.00, June 2021

Content Development

- [2] PJ19 D2.5 SESAR 2020 Concept Of Operations (2019 edition), Ed.01.00.00, May 2019

System and Service Development

- [3] PJ19 D3.14 Report of the progress on standardisation of Services, Information and Terminology (RSIT), Ed.00.01.00, October 2019

Performance Management

- [4] PJ19.04 D4.7 Performance Framework (2019 edition), Ed.01.00.01, November 2019

Validation

- [5] SESAR 2020 Requirements and Validation Guidelines, Ed.00.02.02, May 2021
 [6] PJ19 D2.6 Validation Strategy (VALS), Ed.00.01.00, October 2019

System Engineering

- [7] PJ22-03 D3.7 Updated V&VP, V&VI and Demonstration Platform Development Methodology (final release), Ed.00.01.00, June 2019

Safety

- [8] PJ19 D4.0.060 SESAR Safety Reference Material, Ed.00.04.01, December 2018
 [9] PJ19 D4.0.050 Guidance to Apply SESAR Safety Reference Material, Ed.00.03.01, December 2018

Human Performance

- [10] PJ19 D4.0.070 SESAR Human Performance Assessment Process V1 to V3 – including VLD, Ed.00.03.01, January 2020

Environment Assessment

- [11] PJ19 D4.0.080 SESAR Environment Assessment Process, Ed.04.00.00, September 2019

Security

- [12] Security Risk Assessment (SecRAM) methodology for SESAR 2020, Ed.02.00.00, September 2017

7.2 Reference Documents

The following documents were used to provide input / guidance / further information / other:

- [13] RTCA DO-260B / EUROCAE ED-102A Minimum Operational Performance Standards for 1090 MHz Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B), December 2009
- [14] RTCA DO-260C / EUROCAE ED-102B Minimum Operational Performance Standards (MOPS) for 1090 MHz Extended Squitter Automatic Dependent Surveillance – Broadcast (ADS-B) and Traffic Information Services – Broadcast (TIS-B), December 2020
- [15] RTCA DO-181F/EUROCAE ED-73F Minimum Operational Standards (MOPS) for Secondary Surveillance Radar Mode S Transponders, December 2020
- [16] SESAR2020 D12.4.110 PJ.14-W2-84d – TS/IRS, Ed.00.01.01, February 2021
- [17] SESAR2020 D12.4.200 PJ.14-W2-84d – TVALP Part I, Ed.00.01.02, April 2021
- [18] SESAR2020 D12.4.300 PJ.14-W2-84d – AN EXE#16, Ed.00.01.00, August 2021
- [19] SESAR2020 D12.4.310 PJ.14-W2-84d – Future ADS-B Communications Link – AN EXE#17, Ed.00.01.00, November 2021
- [20] SESAR2020 D12.4.400 PJ.14-W2-84d – Phase Overlay for ADS-B – TVALR – TRL6, Ed.00.01.00, April 2022

Appendix A Service Description Document (SDD)

Not applicable.



-END OF DOCUMENT-

