



# Third iteration of ADS-B Ground Station Test Specifications for Trajectory Based Operations

## Document information

Project title	Surveillance Ground System Enhancements for ADS-B
Project N°	15.04.05.a
Project Manager	EUROCONTROL
Deliverable Name	Third iteration of ADS-B Ground Station Test Specifications for Trajectory Based Operations
Deliverable ID	D16
Edition	00.01.00
Template Version	02.00.00

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## Abstract

This Verification Plan addresses the ADS-B 1090 Ground Station Test Specifications within the functional ADS-B Ground Surveillance Domain as defined in task T12, ADS-B GS Test Specifications for iteration 3. It includes the following key information:

- Scope and context of the ADS-B Ground Station Tests.
- The Test Specifications applying to the Ground Station for Iteration 3 (derived from D20, D13 and D15).
- D20 contains additional requirements for the use of flight plan information to indicate the approval for ADS-B Operations. Those requirements are not tested in this document; hence their verifications are not included.

No particular physical implementation or architecture of the prototypes to be tested is assumed for the Ground Station Tests.

This specification will be revisited as appropriate in the course of the project work on a following iteration.

### Project 15.04.05a

Third iteration of ADS-B Ground Station Test Specifications for Trajectory Based Operations

Edition: 00.01.00

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## Document History

Edition	Date	Status	Author	Justification
00.00.01	23/10/2012	First Draft	Andreas Ehser (THALES)	
00.00.02	06/11/2012	Second Draft	Andreas Ehser (THALES)	Review comments on first draft
00.00.03	19/11/2012	Third Draft	Andreas Ehser (THALES) Luca Menè (SELEX)	Addition of exercise "ADS-B target report update by WAM system" and the contribution of SELEX
00.01.00	03/12/2012	First Issue	Andreas Ehser (THALES)	Review comments from EUROCONTROL and SELEX

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## Executive summary

This Verification Plan presents the Test Specifications to be performed to the ADS-B 1090 MHz Extended Squitter Ground Station (**1090 GS**) covering the different requirements captured and enhanced as described in the 15.4.5a Deliverables: D20 ADS-B Surveillance System Specifications, [2], D13 ADS-B Ground Station Specifications, [3] and D15 Interface Specifications [4]. Note that D20 contains additional requirements for the use of flight plan information to indicate the approval for ADS-B Operations. Those requirements are not tested in this document; hence their verifications are not included.

This document constitutes the third iteration of the test specifications for the 1090 GS, and it is intended to be used as input documentation for project 15.4.5b producing the test specifications for an ADS-B Ground Station.

The 1090 GS is part of a ground surveillance system that provides airspace and airport surface situational awareness to air traffic controllers and other users. The system provides services that are used by higher-level applications as described in [2]. It makes use of aircraft or vehicles broadcasted ADS-B data, which include position, velocity, status and other information obtained from on-board systems and sensors.

The primary function of the 1090 GS is to receive 1090 MHz Mode S Extended Squitter (1090 ES) messages, extract the data contained therein, create corresponding ASTERIX Category 021 reports and forward these reports as well as ASTERIX Category 023 status reports to client systems (typically SDPS) over a Ground Network.

These test specifications are intended to provide the means for verifying the compliance of the equipment to the different requirements not taking into account the physical architecture of the equipment. Hence, different ADS-B Ground Station architectures are allowed.

# 1 Introduction

## 1.1 Purpose and scope of the document

This document describes the specifications for the third iteration of tests for the ADS-B Ground Surveillance Station.

It is to be used as input documentation for project 15.4.5b producing the test specifications for an ADS-B Ground Station.

The tests shall be described at a high level and shall be refined and tailored in project 15.4.5b.

This document provides the Verification Plan for an ADS-B Ground Station. It describes how requirements defined in D20 ADS-B Surveillance System Specifications [2], D13 ADS-B Ground Station Specifications [3] and D15 Interface Specifications [4] are intended to be verified.

Note that D20 contains additional requirements for the use of flight plan information to indicate the approval for ADS-B Operations. Those requirements are not tested in this document; hence their verifications are not included.

## 1.2 Intended audience

The audience of this document includes

- Projects 15.04.05.a and b,
- Any other SJU projects that may require ADS-B Surveillance Systems for their verification activities.

## 1.3 Structure of the document

This section states how the document is organised.

- Chapter 1: Purpose and scope
- Chapter 2: Context of the Verification;
- Chapter 3: Verification Approach;
- Chapter 4: Verification Activities
- Chapter 5: Referenced documents
- Appendices with verification exercises and preliminary coverage matrix.

## 1.4 Acronyms and Terminology

Term	Definition
1090 ES	1090 MHz Mode S Extended Squitter
1090 GS	ADS-B 1090 MHz Extended Squitter Ground Station
ADD	Aircraft Derived Data
ADS	Automatic Dependent Surveillance
ADS-B	Automatic Dependent Surveillance - Broadcast
ASTERIX	All Purpose Structured EUROCONTROL Surveillance Information Exchange
ATC	Air Traffic Control

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ATM	Air Traffic Management
CMS	Control and Monitoring System
Comm-B	Short Downlink Communication Message (Mode S)
DF	Downlink Format
ES	Extended Squitter
EUROCAE	European Organisation for Civil Aviation Equipment
FTC	Format Type Code (ADS-B)
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
GS	Ground Station
Hz	Hertz
I/O	Input and/or Output
LSB	Least Significant Bit
MB	Message field in Comm-B (Mode S)
MHz	Megahertz
MOPS	Minimum Operational Performance Standards
MTL	Minimum Trigger Level
N/A	Not applicable
NRA	Non Radar Airspace
PUT/SUT	Product Under Test. This may be used to refer to both System Under Test and Concept Under Test.
RF	Radio Frequency
RTCA	Radio Technical Commission for Aeronautics
SDPD	Surveillance Data Processing and Distribution
SDPS	Surveillance Data Processing System
SESAR	Single European Sky ATM Research Programme
SESAR Programme	The programme which defines the Research and Development activities and Projects for the SJU.
SJU	SESAR Joint Undertaking (Agency of the European Commission)
SJU Work Programme	The programme which addresses all activities of the SESAR Joint Undertaking Agency.
SNMP	Simple Network Management Protocol
SPI	Special Position Identification
SS	Short Squitter
SSR	Secondary Surveillance Radar
TDOA	Time Difference of Arrival
TIS-B	Traffic Information System Broadcast
TOA	Time of Applicability
UTC	Universal Time Coordinated
VP	Validation Plan
WAM	Wide Area Multilateration

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## 2 Context of the Verification

The scope of this Verification Plan is addressed to the ADS-B Ground Station developed in Project 15.4.5b under the requirements defined in D20 ADS-B Surveillance System Specifications [2], D13 ADS-B Ground Station Specifications [3] and D15 Interface Specifications [4].

Note that D20 contains additional requirements for the use of flight plan information to indicate the approval for ADS-B Operations. Those requirements are not tested in this document; hence their verifications are not included.

Main addressed stakeholders are manufacturers of the ADS-B Ground Station prototypes, ANSPs and ATM organizations, such as EUROCONTROL.

Project 15.4.5a has developed these test specifications in order to provide Project 15.4.5b with a main input to produce the test specifications for an ADS-B installation. Project 15.4.5b will take this document as an input and will refine and perform a tailoring of it to suit Project 15.4.5b's needs.

Therefore, the Verification activities will be performed in Project 15.4.5b.

## 3 Verification Approach

### 3.1 Verification Overview

Verification activities will take place in Project 15.4.5b, using this document as a ramp-up for a refined verification document to be completed within the project.

Requirements addressed by D20 ADS-B Surveillance System Specifications [2], D13 ADS-B Ground Station Specifications [3] and D15 Interface Specifications [4] will be verified using different methods (tests, analysis, inspection and design reviews). The methods will be properly identified in the preliminary coverage matrix, which can be found in Appendix C.

Note that D20 contains additional requirements for the use of flight plan information to indicate the approval for ADS-B operations. Those requirements are not tested in this document; hence their verifications are not included.

Objectives and tests exercises have been developed according to the SESAR requirements and V&V guidelines [5].

They are broken down into the following categories:

- Functional requirements;
- Performance;
- Interoperability;
- Security.

The layout follows the description in [6].

In accordance with the guidelines in [6] requirement identifiers follow the scheme:

**ID-15.04.05.a-TS-00xx.yyyy**, where

**ID** is either **OBJ** for objective or **EXE** for test exercise.

xx	Meaning
10	ADS-B RAD functional requirements
12	ADS-B APT functional requirements
13	ADS-B ADD functional requirements
14 - 19	Reserved for SESAR applications functional requirements
20	ADS-B RAD performance requirements
22	ADS-B APT performance requirements
23	ADS-B ADD performance requirements
24 - 29	Reserved for SESAR applications performance requirements
30	WAM integration requirements
40	Security requirement
50	Civil/Military requirements
60	1090ES technology requirements
00	Other

Table 1: Identifier Allocation

## 3.2 Verification Objectives

[OBJ]

Identifier	OBJ-15.04.05.a-TS.0030.0001
Objective	In case of missing ADS-B target report updates, the ADS-B system <b>shall</b> use available WAM system target report updates (position) as target position report.
Title	ADS-B target report update by WAM system
Status	<In Progress>

[OBJ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<COVERS>	<ATMS Requirement>	REQ-15.04.05.a-D20-0030.0001	<Full>

[OBJ Suc]

Identifier	Success Criterion

[OBJ]

Identifier	OBJ-15.04.05.a-TS.0040.0001
Objective	The ADS-B Ground Surveillance Domain <b>should</b> be equipped with a 1030 MHz interrogator, capable of interrogating ADS-B targets according to all relevant ICAO Annex 10 requirements.
Title	1030 MHz interrogation capability
Status	<In Progress>

[OBJ Trace]

Relationship	Linked Element Type	Identifier	Compliance
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<COVERS>	<ATMS Requirement>	REQ-15.04.05.a-D20-0040.0001	<Full>
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#### [OBJ Suc]

Identifier	Success Criterion

#### [OBJ]

Identifier	OBJ-15.04.05.a-TS.0040.0002
Objective	If OBJ-15.04.05.a-TS.0040.0001 is implemented, the ADS-B Ground Surveillance Domain <b>shall</b> have the capability to determine the Round Trip Delay (RTD) of every received 1090 MHz reply elicited by its own interrogations (registered as <i>Real RTD</i> ).
Title	RTD measurement
Status	<In Progress>

#### [OBJ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<COVERS>	<ATMS Requirement>	REQ-15.04.05.a-D20-0040.0002	<Full>

#### [OBJ Suc]

Identifier	Success Criterion

#### [OBJ]

Identifier	OBJ-15.04.05.a-TS.0040.0003
Objective	If OBJ-15.04.05.a-TS.0040.0002 is implemented, the ADS-B Ground Surveillance Domain <b>shall</b> register the last RTD of each of the received ES and its time stamp.
Title	RTD storage
Status	<In Progress>

#### [OBJ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<COVERS>	<ATMS Requirement>	REQ-15.04.05.a-D20-0040.0003	<Full>

#### [OBJ Suc]

Identifier	Success Criterion

#### [OBJ]

Identifier	OBJ-15.04.05.a-TS.0040.0004
Objective	If OBJ-15.04.05.a-TS.0040.0003 is implemented, each calculated RTD <b>shall</b> be considered applicable to RTD Validation for a configurable time period.
Title	RTD applicability
Status	<In Progress>

#### [OBJ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<COVERS>	<ATMS Requirement>	REQ-15.04.05.a-D20-0040.0004	<Full>

#### [OBJ Suc]

Identifier	Success Criterion

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#### [OBJ]

Identifier	OBJ-15.04.05.a-TS.0040.0005
Objective	If OBJ-15.04.05.a-TS.0040.0003 and OBJ-15.04.05.a-TS.0040.0004 are implemented, each time a valid position message is received for a target in "target data maintenance" mode (see ED-129 chapter 3) and the associated RTD applicability is elapsed, the ADS-B position report <b>shall</b> be marked as NOT VALIDATED.
Title	Active ADS-B validation use
Status	<In Progress>

#### [OBJ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<COVERS>	<ATMS Requirement>	REQ-15.04.05.a-D20-0040.0005	<Full>

#### [OBJ Suc]

Identifier	Success Criterion

#### [OBJ]

Identifier	OBJ-15.04.05.a-TS.0040.0006
Objective	If OBJ-15.04.05.a-TS.0040.0003 and OBJ-15.04.05.a-TS.0040.0004 are implemented, each time a valid position message is received for a target in "target data maintenance" mode (see ED-129 chapter 3), the ADS-B Ground Surveillance Domain <b>shall</b> validate the ADS-B report comparing the ADS-B position data with the computed applicable RTD, if the associated RTD applicability is not elapsed.
Title	Active ADS-B validation
Status	<In Progress>

#### [OBJ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<COVERS>	<ATMS Requirement>	REQ-15.04.05.a-D20-0040.0006	<Full>

#### [OBJ Suc]

Identifier	Success Criterion

#### [OBJ]

Identifier	OBJ-15.04.05.a-TS.0040.0007
Objective	If OBJ-15.04.05.a-TS.0040.0006 is implemented, the ADS-B Ground Surveillance Domain <b>shall</b> be able to report the validation result in the ASTERIX CAT021 ADS-B report.
Title	Active ADS-B validation reporting
Status	<In Progress>

#### [OBJ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<COVERS>	<ATMS Requirement>	REQ-15.04.05.a-D20-0040.0007	<Full>

#### [OBJ Suc]

Identifier	Success Criterion
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#### [OBJ]

Identifier	OBJ-15.04.05.a-TS.0040.0008
Objective	If OBJ-15.04.05.a-TS.0040.0007 is implemented, the SDPD <b>shall</b> be able to use the validation result.
Title	Active ADS-B validation consistency use
Status	<In Progress>

#### [OBJ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<COVERS>	<ATMS Requirement>	REQ-15.04.05.a-D20-0040.0008	<Full>

#### [OBJ Suc]

Identifier	Success Criterion

#### [OBJ]

Identifier	OBJ-15.04.05.a-TS.0040.0009
Objective	If OBJ-15.04.05.a-TS.0040.0008 is implemented, the validation result (positive/negative) <b>should</b> be reported to the end user of the surveillance data.
Title	Active ADS-B validation forwarding
Status	<In Progress>

#### [OBJ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<COVERS>	<ATMS Requirement>	REQ-15.04.05.a-D20-0040.0009	<Full>

#### [OBJ Suc]

Identifier	Success Criterion

#### [OBJ]

Identifier	OBJ-15.04.05.a-TS.0040.0010
Objective	It <b>shall</b> be possible to activate/deactivate the function of range measurement from active interrogation.
Title	Range measurement from active interrogation activation
Status	<In Progress>

#### [OBJ Trace]

Relationship	Linked Element Type	Identifier	Compliance
<COVERS>	<ATMS Requirement>	REQ-15.04.05.a-D20-0040.0010	<Full>

#### [OBJ Suc]

Identifier	Success Criterion

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### 3.3 Verification Assumptions

This verification plan is the third element of a set of three test specification documents.

The tests, described in this specification, shall be in full compliance with the new requirements contained in related input documents (ADS-B Surveillance System Specifications, ADS-B Ground Station Specifications and Interface Specifications).

### 3.4 Verification Requirements on the Concept/System Under Test

Verification requirements on the system under test will be declared for each independent test in its procedure.

### 3.5 Verification Platform Needs

This document contains a set of type approval tests that can be used to demonstrate compliance with the objectives in section 3.2. These type approval tests are intended to be performed once in order to provide evidence that the ground station design complies with these requirements, and therefore is not intended as a production test or factory acceptance test activity. These test procedures may also be used as a part of a regression test following a design change. It is up to the manufacturer to determine the scope and suitability of regression test activity.

These test procedures were written with the intention of saving manufacturers the time and expense of developing their own tests while providing equipment buyers with a minimum level of assurance that the equipment is compliant with the objectives in section 3.2. Alternative tests may be substituted, if it is more convenient to do so as long as any substituted test procedures fully cover all the mandatory requirements of the relevant part of section 3.2.

Since many test procedures require a similar test equipment setup, a standard setup is defined here and specific test procedures reference this section, specifying exceptions when necessary.

The test procedures are listed in this section. Except where otherwise noted, the sub-section number of each test procedure matches the corresponding sub-section number within Section 3.2 containing the requirements being tested.

#### Test Equipment Setup

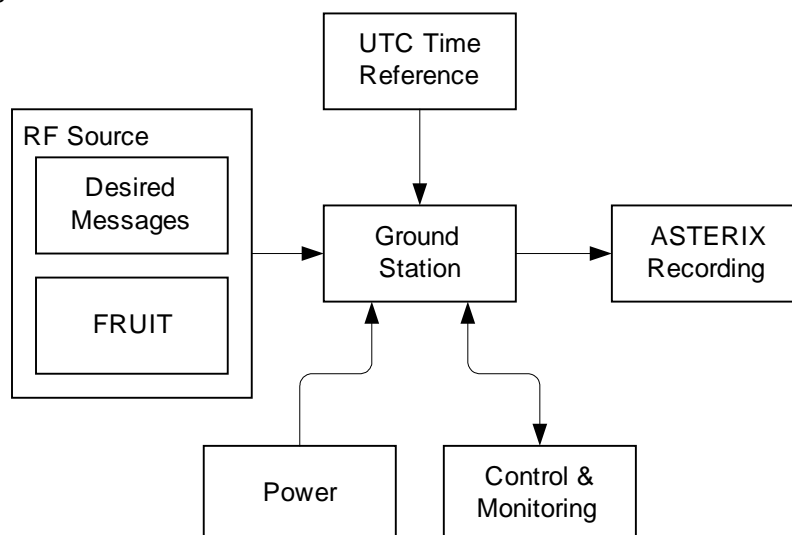
A diagram of the verification platform with standard test equipment setup is shown in Figure 1.



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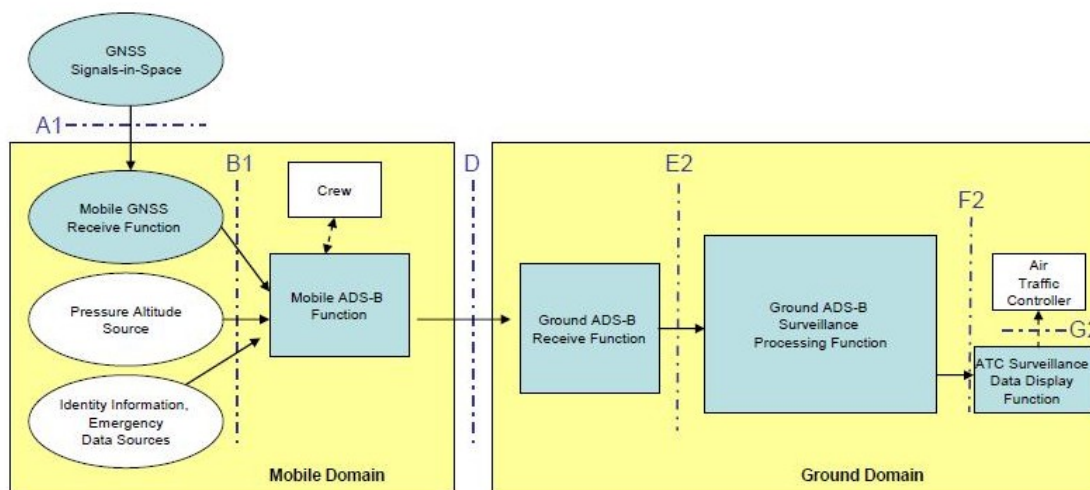
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**Figure 1: Standard Test Equipment Setup (Logical Connections)**

*Note: Figure 1 and the remainder of this section describe the test equipment in terms of functions. The functions may be implemented with one or more items of equipment as long as the required capabilities are provided.*

The following picture, Figure 2, is taken from the ED-163 document and showing the functional architecture for the ADS-B APT application.



**Figure 2: ADS-B APT Functional Architecture**

Deliverable D20 ADS-B Surveillance System Specifications [2] maps APT requirements on the ADS-B Ground Surveillance Domain as defined in Figure 2 according to the following table:

ED-163/DO-321 Functional Component	P15.4.5a Functional Component
Ground ADS-B Receive Function	ADS-B Ground Station
Ground ADS-B Surveillance Processing Function	SDPD
ATC Surveillance Data Display Function	Interfaces

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**Table 2: Mapping of ED-163 functions to Project 15.4.5a functions**

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### 3.5.1 RF Source of Desired Messages

Desired messages shall meet the requirements of sections 2.2.2.1 and 2.2.3.1 of DO-260A and DO-260B. The source shall be capable of producing messages with an adjustable power level from MTL to -10 dBm at the Ground Station input. The source shall be capable of producing messages simulating 300 targets simultaneously. Desired messages shall not overlap each other. The source shall be capable of producing messages for each simulated target at the rates shown in Table 3.

Message Type	Message Rate (per second)	Notes
Airborne Position	2	one even, one odd FTC = 9-18, 20-22
Airborne Velocity	2	FTC = 19, Subtype = 1-4
Aircraft Identification	0.2	FTC = 1-4
Target State and Status	0.8	FTC = 29, Subtype = 0
Aircraft Operational Status	0.4	FTC = 31, Subtype = 0
Aircraft Status	0.4	FTC = 28, Subtype = 1
Surface Position	2	FTC = 5-8

**Table 3: Message Rates for Desired Messages**

Dithered transmission intervals, as specified in DO-260A and DO-260B section 2.2.3.3.1, are permissible but not required. Simulated targets may be moving or stationary. Moving targets must have velocity messages.

### 3.5.2 RF Source of FRUIT

The FRUIT source shall be capable of producing Mode A/C, Mode S short and Mode S long messages randomly distributed in time with the power distribution shown in Table 4 according to [12].

Signal Level dBm	A/C Squitters	Short Squitters	Extended Squitters	Cumulative A/C	Cumulative SS	Cumulative ES	Cumulative SS+ES
-74	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-75	0.0	0.0	0.0	0.0	0.0	0.0	0.0
-76	11.4	27.6	6.2	11.4	27.6	6.2	33.8
-77	0.0	0.0	0.0	11.4	27.6	6.2	33.8
-78	5.7	24.8	9.3	17.1	52.4	15.5	67.9
-79	4.0	20.4	15.5	21.1	72.7	31.0	103.7
-80	3.5	12.0	6.2	24.5	84.7	37.2	121.9
-81	27.6	85.4	24.8	52.2	170.1	62.0	232.1
-82	19.7	91.3	24.8	71.8	261.4	86.8	348.2
-83	12.3	47.8	21.7	84.2	309.2	108.5	417.7
-84	30.7	95.6	34.1	114.9	404.8	142.6	547.4
-85	45.7	118.3	46.5	160.6	523.1	189.1	712.2
-86	60.4	189.5	55.8	221.0	712.6	244.9	957.5
-87	119.5	299.5	93.0	340.4	1012.1	337.9	1350.0
-88	85.8	218.1	62.0	426.2	1230.1	399.9	1630.0
-89	108.9	271.3	80.6	535.1	1501.5	480.5	1982.0
-90	163.7	405.9	105.4	698.8	1907.4	585.9	2493.3
-91	177.2	443.2	114.7	876.0	2350.6	700.6	3051.2
-92	169.8	502.6	124.0	1045.8	2853.2	824.6	3677.8
-93	100.4	277.9	65.1	1146.2	3131.1	889.7	4020.8
-94	113.7	259.4	55.8	1259.9	3390.5	945.5	4336.0
-95	134.2	313.6	49.6	1394.1	3704.1	995.1	4699.2
-96	48.7	164.2	27.9	1442.8	3868.3	1023.0	4891.3
-97	42.3	84.2	12.4	1485.1	3952.5	1035.4	4987.9
-98	1.2	5.7	3.1	1486.3	3958.1	1038.5	4996.6
-99	2.8	13.2	3.1	1489.1	3971.3	1041.6	5012.9
-100	0.0	0.0	0.0	1489.1	3971.3	1041.6	5012.9
-101	0.0	0.0	0.0	1489.1	3971.3	1041.6	5012.9

**Table 4: Amplitude and Message Type Distribution of the Injected FRUIT**

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The quoted amplitudes assume a zero gain reference antenna. These amplitudes must be adjusted to match the typical gain of the antenna or a FRUIT injection directly to the sensor's RF input the 1090 ES Ground Station is to be used with.

*Note: The data content of the Mode S FRUIT transmissions is not critical, since one and zero bits have equal energy content. The Mode A/C replies should have half the code bits set (e.g. 0707 or 2525) to reflect the average energy content of all messages. It may be useful to use non-ADS-B DF codes (e.g. 20) for the Mode S ES messages to prevent valid FRUIT ADS-B messages from appearing in the ASTERIX data.*

## 3.5.3 UTC Time Reference

A means of disabling or disconnecting the UTC time reference shall be provided.

## 3.5.4 Control and Monitoring Equipment

Control and monitoring equipment shall be present as to interface with the 1090 ES Ground Station. A means of polling the Ground Station for values of all parameters shall be provided. The control and monitoring equipment shall allow a user to authenticate with and control the Ground Station.

## 3.5.5 ASTERIX Recording Equipment

The ASTERIX recording equipment shall record the time of reception and all ASTERIX reports, including their time of reception, being sent from the 1090 ES Ground Station.

The control and monitoring equipment, ASTERIX recording equipment and any other network capable test equipment may be connected through suitable networking equipment.

All test equipment requiring calibration shall have documentation showing that the equipment calibration is valid.

## 3.5.6 Default Configuration, Mode and State

- a) The 1090 ES Ground Station and all of the test equipment shall be powered on before the beginning of each test.
- b) The 1090 ES Ground Station shall be configured to the default parameter values.
- c) The mode shall be Operational.
- d) The state shall be Online.
- e) The time state shall be UTC coupled.
- f) The 1090 ES Ground Station shall have no information on any targets.
- g) Network configuration parameters shall be assigned so that the 1090 ES Ground Station can communicate with the control and management equipment, the ASTERIX recording equipment and any other network connected test equipment.
- h) The maximum bit rate of the GS shall be set to the maximum value appropriate for the network.
- i) The 1090 ES Ground Station shall have a suitable configured own position (GS Latitude, GS Longitude) or self-determined (e.g. GPS self-survey) Ground Station location.
- j) The default power level for injected test messages shall be MTL + 3dB.
- k) FRUIT generation shall not be enabled by default.

## 3.5.7 Message Set Construction

Message sequences for individual targets must be constructed carefully to produce ASTERIX Category 021 output.

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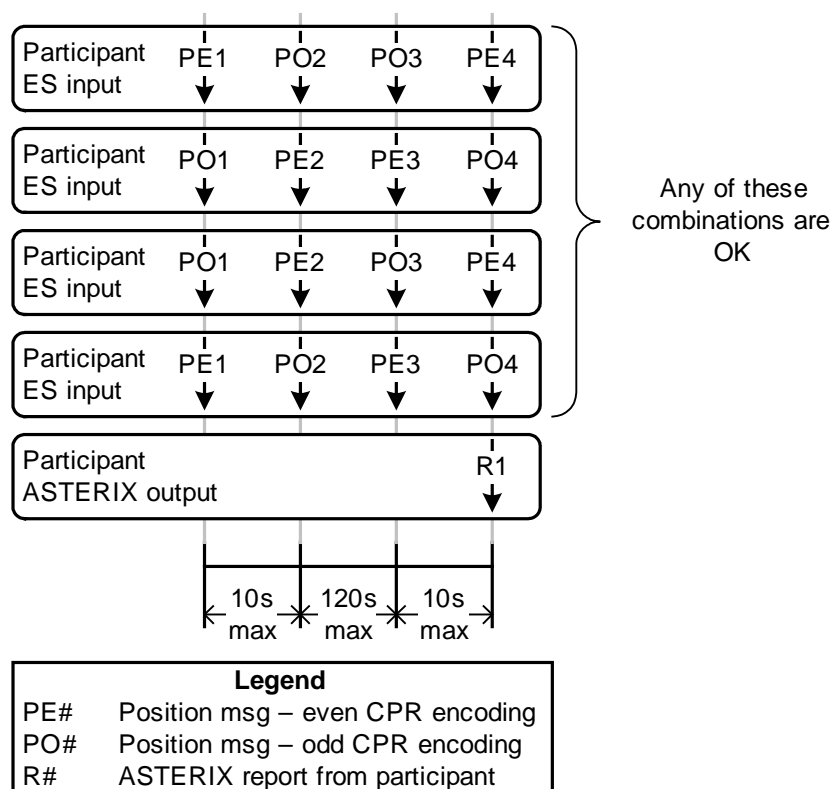


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### 3.5.8 Initial Position Messages

Sequences must begin with two even-odd (or odd-even) pairs of messages to allow the Ground Station to acquire the target.

The position messages in each of the first two pairs of messages must be less than 10 seconds apart.



**Figure 3: Initial Position Messages**

The position conveyed in the first pair of messages must be within the Max Range of the configured (GS Latitude, GS Longitude) or self-determined (e.g. GPS self-survey) Ground Station location.

If moving targets are used, the position change from one message to the next in each of the first two pairs of messages (i.e. from 1 to 2 and from 3 to 4) must be less than 3 NM in both latitude and longitude.

If the scenario is correct, the first ASTERIX report will be produced after the 2nd pair of even-odd messages.

Scenario design may be easier to verify in data-driven reporting mode.

### 3.5.9 Field Values

The most tests described in this specification use data from just a few 1090 ES message fields. If the number of values that can be conveyed by a field is small, then all the values shall be tested. A one-bit field has only two possible values, so both shall be tested. If the number of values that can be conveyed by a field is large, a subset of the values shall be checked. For example, there are thousands of possible altitude values that can be conveyed in position messages. An appropriate subset of these values would include minimum, minimum + 1 LSB, maximum, maximum – 1 LSB and a value in the middle of the altitude range.

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Fields being not relevant for a specific test should be assigned random values (respecting the field proper range). The values may be static throughout a scenario or they may change. Random values in seemingly irrelevant fields confirm that the outputs are only dependent on the expected fields. The random values must be chosen so they do not stop the output of the Ground Station. For example, if the Flight Level data item is being verified, randomised position values must not change by more than 6 NM between successive reports less than 30 seconds apart.

## 3.5.10 Altitude Values

Airborne position messages should contain barometric altitude unless geometric altitude is required for a specific test.

## 3.5.11 Configuration Changes

When a specific test procedure calls for changing a 1090 ES Ground Station configuration parameter value, assume that the user will authenticate with the Ground Station, put the Ground Station in maintenance mode, change the parameter(s), put the Ground Station back into operational mode and then log out of the Ground Station. If the Ground Station was in maintenance mode or the user was already authenticated, then the mode change and authentication steps are not necessary.

## 3.5.12 Checking of Log Files

Ground Station logs shall be checked at the conclusion of each test for unexpected warnings, errors or other anomalies. Any unexpected error or anomaly constitutes a test failure.

## 3.6 Integration and preliminary Verification activities

TBD

## 3.7 Acceptance criteria

TBD

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## 4 Verification Activities

### 4.1 Verification Exercises List

[EXE]

Identifier	EXE-15.04.05.a-TS.0030.0001
Exercise	ADS-B target report update by WAM system
Title	ADS-B target report update by WAM system
Status	<In Progress>
Responsible Project	N/A
Exercise Plan	N/A
Planned Execution Date	N/A
Planned Analysis Date	N/A
Activity Type	<Test>
Exercise Level	<Function>
Lifecycle Phase	<V2>
V&V Technique	<Real Time Simulation>

[EXE Trace]

Relationship	Linked Element Type	Identifier	Compliance
<EMBEDS>	<V&V Objective>	OBJ-15.04.05.a-TS.0030.0001	<Full>

[EXE]

Identifier	EXE-15.04.05.a-TS.0040.0001
Exercise	Range measurement from active interrogation
Title	Range measurement from active interrogation
Status	<In Progress>
Responsible Project	N/A
Exercise Plan	N/A
Planned Execution Date	N/A
Planned Analysis Date	N/A
Activity Type	<Test>
Exercise Level	<Function>
Lifecycle Phase	<V2>
V&V Technique	<Real Time Simulation>

[EXE Trace]

Relationship	Linked Element Type	Identifier	Compliance
<EMBEDS>	<V&V Objective>	OBJ-15.04.05.a-TS.0040.0001	<Full>
<EMBEDS>	<V&V Objective>	OBJ-15.04.05.a-TS.0040.0002	<Full>
<EMBEDS>	<V&V Objective>	OBJ-15.04.05.a-TS.0040.0003	<Full>
<EMBEDS>	<V&V Objective>	OBJ-15.04.05.a-TS.0040.0004	<Full>
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### 4.2 Verification Exercises Planning

N/A.

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## 5 References

- [1] SJU 15.04.05a Specification Baseline Document, D17, Ed. 00.01.00, Oct 2010
- [2] SJU 15.04.05a, ADS-B Ground Surveillance Specifications for Third Iteration D20
- [3] SJU 15.04.05a, ADS-B Ground Station Specifications for Third Iteration, D13
- [4] SJU 15.04.05a, Interface Specifications for Third Iteration, D15
- [5] SESAR Requirements and V&V Guidelines version 02.00.00
- [6] SESAR Toolbox User Manual version 02.00.00
- [7] EUROCAE/RTCA MOPS for 1090 MHz ADS-B, ED-102/DO-260, Sept. 2000
- [8] RTCA MOPS for 1090ES ADS-B and TIS-B, DO-260A, Dec. 2006 (includes Changes 1 and 2)
- [9] EUROCAE/RTCA MOPS for 1090ES ADS-B and TIS-B, ED-102A/DO-260B, Dec. 2009
- [10] EUROCAE/RTCA SPIR Document for ADS-B NRA Application, ED-126/DO-303, Dec. 2006
- [11] EUROCAE/RTCA SPIR Document for ADS-B RAD Application, ED-161/DO-318, Sept. 2009
- [12] EUROCAE ED129: Technical Specification for a 1090 MHz Extended Squitter ADS-B Ground Station, June 2010
- [13] EUROCONTROL ASTERIX Standards CAT 021, Ed 2.81, Sep 2012
- [14] EUROCONTROL ASTERIX Standards CAT 023, Ed 2.0c, Oct 2011
- [15] EUROCONTROL ASTERIX Standards CAT 062, ED 2.0e, Oct 2011
- [16] EUROCONTROL ASTERIX Standards CAT 063, Ed 1.3, July 2007
- [17] EUROCONTROL ARTAS V8, System/Segment Specifications, Doc. 46 127 300 – 305

## Appendix A

# Verification Exercise EXE-15.04.05.a-TS.0030.0001- ADS-B Target Report Update by WAM System

## A.1 Exercise Scope and Justification

### A.1.1 Exercise Level

The level of the exercise is functional.

### A.1.2 Exercise Type

The type of this exercise is “Test”.

### A.1.3 Description of the System Being Addressed

ADS-B Ground Station

### A.1.4 Context of the Verification Exercise

This document is applied to provide evidence that the ground station design complies with this requirement.

### A.1.5 Required Datasets

1090 MHz Extended Squitter Messages input and 1090 GS ASTERIX output. Mandatory recordings are ASTERIX CAT 021 target reports, ASTERIX CAT 020 output of the WAM system and ASTERIX CAT 023 status reports.

An optional recording is the Raw Data from the ADS-B system.

### A.1.6 Verification Objectives

OBJ-15.04.05.a-TS.0030.0001
In case of missing ADS-B target report updates, the ADS-B system <b>shall</b> use available WAM system target report updates (position) as target position report.

### A.1.7 Inputs

### A.1.8 Outputs

ASTERIX CAT 021 and ASTERIX CAT 023 reports; optionally ASTERIX CAT 020 reports and Raw data.

### A.1.9 Entrance Criteria

Start of the generation of ADS-B messages.

### A.1.10 Exit Criteria

The test finishes with the recording of the last ASTERIX report, when the scenario replay has stopped.

### A.1.11 Exercise Procedure

**Exercise ID/Title:** EXE-15.04.05.a-TS.0030.0001/ ADS-B target report update by WAM system

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Pass Criteria:

The test passes, if the ADS-B system complies with the expected reactions found in the table “Exercise Procedure” of this section.

Exercise Type:

Test

#### Precondition(s):

The test equipment setup shall be in line with the one described in section A.1.13.

The following transmission sequence shall be defined for all scenarios of this exercise:

**Transmission sequence:** Intervals of a length of 10 seconds are considered. The transmission of ADS-B squitters is interrupted again and again.

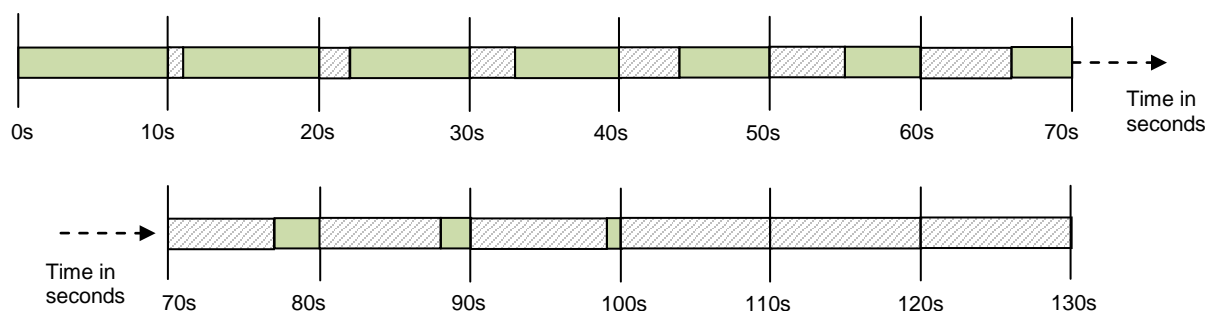
Whilst the transmission of ADS-B squitters is interrupted DF 11 or other “Non-ADS-B” messages replace the expected ADS-B messages.


Starting from the time ‘0s’, the first replacement is at ‘10s’. With every period of 10 seconds an additional second of ADS-B extended squitters (Airborne Position and Aircraft Operational Status) is replaced until no ADS-B extended squitter are sent anymore.

Once no ADS-B messages are sent anymore, the scenario shall still run for at least 30 seconds.

The principle of the transmission sequence is illustrated in Figure 4.

Figure 4: Transmission sequence



 : Transmission of only Non-ADS-B telegrams, e.g. DF 11

 : Transmission of ADS-B Extended Squitters and Non-ADS-B telegrams

Three scenarios are defined:

**Scenario A:** The scenario A consists of one target sending ADS-B data. The ADS-B telegrams are odd and even **Airborne** Position squitters, Aircraft Operational Status squitters and Non-ADS-B data, e.g. DF 11. The target sends two extended position squitters, one aircraft operational status squitter per second and two Non-ADS-B telegrams per second. The target is located by the WAM system using the sent telegrams. The WAM system provides an ASTERIX CAT 020 output stream, which is used as an additional input to the ADS-B Ground Station system to support the functionality “ADS-B target report update by WAM system”.

The transmission sequence is the one defined above.

**Scenario B:** The scenario B consists of one target sending ADS-B data. The ADS-B telegrams are odd and even **Surface** Position squitters, Aircraft Operational Status squitters and Non-ADS-B data, e.g. DF 11. The target sends two extended position squitters, one aircraft operational status squitter per second and two Non-ADS-B telegrams per second. The movement value of the Surface Position squitters is set to 170 kt or higher. The velocity is selected very high, because potential extrapolation can more easily be recognised at high speed. The target is located by the WAM system using the sent telegrams. The WAM system provides an ASTERIX CAT 020 output stream, which is used as an additional input to the ADS-B Ground Station system to support the functionality “ADS-B target report update by WAM system”.

The transmission sequence is the one defined above.

**Scenario C:** The scenario C consists of one target sending ADS-B data, which prevents the WAM system to find confirmed positions, i.e. ASTERIX CAT 20 Track Status does not report “Confirmed track”. The ADS-B telegrams are odd and even Airborne Position squitters, Aircraft Operational Status squitters and Non-ADS-B data, e.g. DF 11. The target sends two extended position squitters, one aircraft operational status squitter per second and two Non-ADS-B telegrams per second. The target is located by the WAM system using the sent telegrams. The WAM system provides an ASTERIX CAT 020 output stream, which is used as an additional input to the ADS-B Ground Station system to support the functionality “ADS-B target report update by WAM system”. The transmission sequence is the one defined above.

Note(s):

Device(s) in use:

- ADS-B Ground Station system
- RF Source for ADS-B and Non-ADS-B Mode S messages
- WAM system
- ASTERIX Recording Tool
- Power
- UTC Reference
- Control & Monitoring

Exercise Procedure:

Step	Action	Expected Reaction	Pass/ Fail	Comment
1	Put the ADS-B system in the default configuration			

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2	Set the accuracy threshold of the WAM position low enough so that the WAM position accuracy, reported in the ASTERIX CAT 20 data, lies above this threshold, i.e. the WAM position reports may replace the missing ADS-B reports.			
3	Set the maximum duration for which ADS-B target reports are allowed to be updated by WAM positions, to 25 seconds.			
4	Configure the lifetime of some data (e.g. SIL or NACp), which are carried by the Aircraft Operational Status squitter, to 24 seconds.			
5	Select data driven reporting mode in the ADS-B system.			
6	Configure the recording tools to capture ASTERIX CAT 021, ASTERIX CAT 20 and ASTERIX CAT 023 reports coming from the ADS-B system			
7	Deactivate the functionality "ADS-B target report update by WAM system" in the ADS-B system.			
8	Inject scenario A into the ADS-B system	The ASTERIX CAT 023 datagrams report that the functionality "ADS-B target report update by WAM system" is <b>de-activated</b> .		This step shows that the activation or de-activation of the functionality is reported in the status reports.
9		The ASTERIX CAT 021 report transmission is interrupted during the time segments, when no ADS-B telegrams are available.		This step shows that the functionality can be de-activated.
10	Activate the functionality "ADS-B target report update by WAM system" in the ADS-B system			
11	Inject scenario A into the ADS-B system	The ASTERIX CAT 023 datagrams report that the functionality "ADS-B target		This step shows that the activation or de-activation of

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		report update by WAM system" is <b>activated</b> .		the functionality is reported in the status reports.
12		During the related time segments, the ASTERIX CAT 021 datagrams report that replacements are performed.		This step shows that the ASTERIX CAT 021 data containing replaced data are marked as such.
13		The ASTERIX CAT 021 reports contain WAM system replacements until about 25 seconds after the last ADS-B message referring to the transmission sequence Figure 4.		This steps shows that a maximum time length can be configured, when ADS-B reports are allowed to be replaced.
14		The ASTERIX CAT 021 reports contain WAM system replacements with the first missing ADS-B report of the transmission sequence Figure 4.		This step shows that the replacement starts with the first missing ADS-B report.
15		The ASTERIX CAT 021 reports contain at least the following information during the time segments, when replacements are performed: <ul style="list-style-type: none"> <li>-Time of Applicability of Position</li> <li>-The position in WGS 84 latitude and longitude values</li> <li>-The flight level of the target.</li> </ul>		This step shows that the replaced reports contain the mandatory information.
16		The ASTERIX CAT 021 reports contain the lowest values in the quality indicators during the time segments, when replacements apply, e.g. NUCp shows the value '0'.		This step shows that the replaced reports are installed with the lowest quality indicators.
17		The Aircraft Operational Status squitter related attributes (e.g. SIL and NACp values) in the ASTERIX CAT 021 reports expire about 24 seconds after the last received Aircraft Operational Status		This step shows that the validity time of attributes being not replaced by WAM information still applies.

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		Message.		
18	Set the maximal duration that ADS-B target reports may be updated by WAM positions to 4.5 seconds.			
19	Inject scenario A into the ADS-B system	The ASTERIX CAT 021 reports contain WAM system target report replacements up to 4.5 seconds after the last ADS-B message, referring to the transmission sequence Figure 4.		This steps shows that a maximum time length can be configured, when ADS-B reports are allowed to be replaced.
20	Inject scenario B into the ADS-B system	The ASTERIX CAT 021 reports contain the following information during the time segments, when replacements are performed: <ul style="list-style-type: none"> <li>-Time of Applicability of Position</li> <li>-The position in WGS 84 latitude and longitude values</li> <li>-The Ground Bit Set (GBS) information.</li> </ul>		This step shows that the replaced reports contain the mandatory and optional information.
21		Comparing the positions of the ASTERIX CAT 021 reports to the respective positions of the WAM system (ASTERIX CAT 20), no position extrapolation or smoothing is visible, i.e. the difference of the positions is within the resolution of the ASTERIX CAT 021.		This step shows that the replaced positions are neither smoothed nor extrapolated. Note that the movement of the target is reported to be 170 kt or more.
22	Inject scenario C into the ADS-B system	The ASTERIX CAT 023 datagrams report that the functionality "ADS-B target report update by WAM system" is <b>activated</b> .		This step shows that the activation or de-activation of the functionality is reported in the status reports.
23		The ASTERIX CAT 021 report transmission is interrupted during the time segments, when no ADS-B telegrams are injected, i.e. no "ADS-B target report update by WAM system" is performed, because the		This step shows that replacement is only performed, if the WAM system reports confirmed tracks.

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		WAM data don't report a confirmed track.		
24	Configure the accuracy threshold of the WAM position low enough so that the WAM position accuracy (e.g. standard deviation), reported in the ASTERIX CAT 20 data, lies above this threshold, i.e. the WAM positions are not sufficient accurate to replace missing ADS-B reports.			
25	Inject scenario A into the ADS-B system.	The ASTERIX CAT 023 datagrams report that the functionality "ADS-B target report update by WAM system" is <b>activated</b> .		This step shows that the activation or de-activation of the functionality is reported in the status reports.
26		The ASTERIX CAT 021 report transmission is interrupted during the time segments, when no ADS-B telegrams are injected, i.e. no "ADS-B target report update by WAM system" is performed, because the WAM position's accuracy lies above the configured threshold.		This step shows that the accuracy of the WAM system must satisfy a configurable quality to be used for ADS-B report replacement.
27	Set the accuracy threshold of the WAM position back again, i.e. high enough so that the WAM position accuracy (e.g. standard deviation), reported in the ASTERIX CAT 20 data, lies below this threshold, i.e. the WAM position reports may replace the missing ADS-B reports.			
28	In the ADS-B system select periodic reporting mode.			
29	Inject scenario A into the ADS-B system.	The ASTERIX CAT 023 datagrams report that the functionality "ADS-B target report update by WAM system" is <b>activated</b> .		This step shows that the activation or de-activation of the functionality is reported in the status reports.
30		The ASTERIX CAT 023 datagrams contain the "Period for Category 021		This step confirms the configuration of the periodic

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		Reports" equal to the ASTERIX CAT 021 reporting interval configured in the ADS-B system.		mode in the ADS-B system.
31		The ASTERIX CAT 021 report transmission is interrupted during the time segments, when no ADS-B telegrams are injected, i.e. no "ADS-B target report update by WAM system" is performed, because the functionality applies only to the event-driven reporting mode.		This step shows that the functionality does not apply, if the periodic reporting mode is set in the ADS-B system.

Exercise result:

	Pass	Fail	Done By (Name, Organisation)	Configuration(s) during the exercise	Date

Table 5: Verification Exercise Result "ADS-B target report update by WAM system"

## A.1.12 Verification SUT Requirements

N/A

## A.1.13 Exercise Tool, Verification Technique and/or Platform

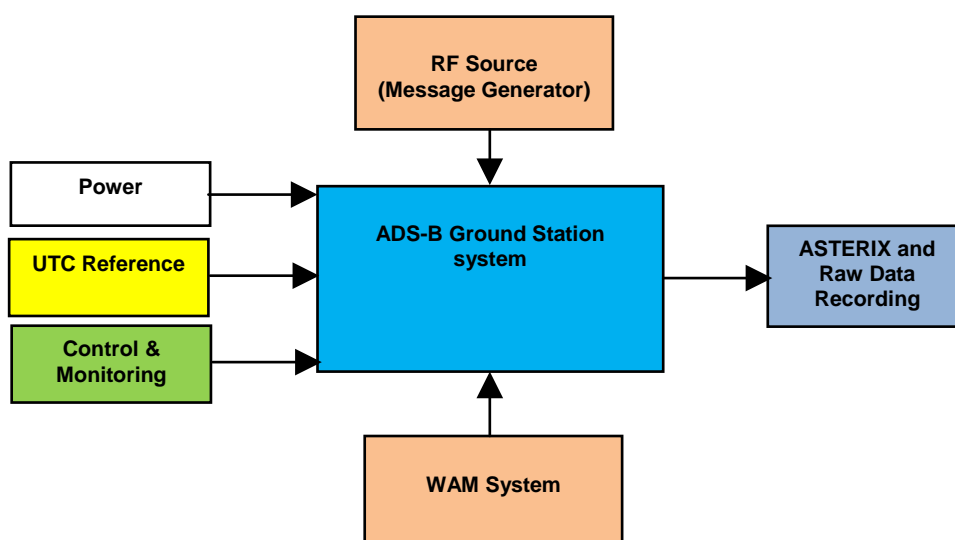


Figure 5: Test platform "ADS-B target report update by WAM system"

The Exercise will be verified on a platform, Figure 5, with the following tools/equipment:

-ADS-B Ground Station system

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- RF Source for ADS-B and Non-ADS-B Mode S messages
- WAM System
- ASTERIX Recording Tool
- Power
- UTC Reference
- Control and Monitoring

### ADS-B Ground Station System

The primary function of the ADS-B Ground Station system is to receive 1090 MHz Mode S Extended Squitter messages, to extract the data information and to create appropriate ASTERIX Category 021 target reports. The ADS-B Ground Station System sends also ASTERIX Category 023 reports containing the status of the system.

#### RF Source of Required Messages

The RF Source of Required Messages is capable to generate the required 1090 MHz Extended Squitter messages in accordance with the standards DO 260 and DO 260A.

#### WAM System

The WAM System generates ASTERIX Category 20 and Category 19 reports. The ASTERIX Category 20 carries the target information, the ASTERIX Category 19 the WAM system's status information. The WAM system uses transponder signals, which are received by antennas at different locations. The WAM system computes the target positions with the help of the times of arrivals at the different antennas.

#### UTC Time Reference

The UTC Time Reference provides the synchronization of the Ground Station to UTC time.

#### Control & Monitoring

The Control & Monitoring equipment controls and monitors the ADS-B system. It displays errors and warnings. It enables the user to read and set configuration parameters.

#### ASTERIX Recording Equipment

The ASTERIX Recording Equipment is capable to record all ASTERIX reports sent from the ADS-B Ground Station system.

## **A.1.14 Verification Platform Needs**

See section 3.5.

## **A.1.15 Platform Configuration**

N/A

## **A.1.16 Configuration(s) Identification of the Verification Platform**

N/A

## **A.1.17 Links to Other Verification Exercises**

N/A

## **A.1.18 Representatively Level / Limitations**

N/A

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## **A.2 Exercises Planning and Management**

### **A.2.1 Activities**

#### **A.2.1.1 Preparatory Activities**

Setup the tools/equipment listed in 3.5 and A.1.13 in order to meet the test preconditions.

#### **A.2.1.2 Execution Activities**

Play the scenario and record the relevant ASTERIX output.

#### **A.2.1.3 Post execution Activities**

Verify that the information found in the recorded ASTERIX reports comply with the expected output described in paragraph A.1.11.

### **A.2.2 Human Resources**

N/A

### **A.2.3 Responsibilities in the Exercise**

N/A

### **A.2.4 Training**

N/A

### **A.2.5 Time Planning**

N/A

### **A.2.6 Risks**

N/A

### **A.2.7 Errors and Observation Handling**

N/A

## **A.3 Analysis Specification**

### **A.3.1 Data Collection Methods**

The data collection during the test is qualitative. After the test execution, the analysis of ASTERIX data is done verifying that the values reported in the ADS-B system's output are as expected due to the data input.

### **A.3.2 Analysis Method**

N/A

### **A.3.3 Data Logging Requirements**

The data logging for this scenario provides at least ASTERIX CAT 021 (ADS-B), ASTERIX CAT 20 (WAM data) and ASTERIX CAT 023 (Status) data. An additional logging can be the Raw Data output of the ADS-B system.

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## Appendix B

# Verification Exercise EXE-15.04.05.a-TS.0040.0001 Range Measurement from Active Interrogation

## B.1 Exercise Scope and Justification

### B.1.1 Exercise Level

The level of the exercise is functional.

### B.1.2 Exercise Type

The type of this exercise is "Test".

### B.1.3 Description of the System Being Addressed

ADS-B Ground Station

### B.1.4 Context of the Verification Exercise

This document is applied to provide evidence that the ground station design complies with this requirement.

### B.1.5 Required Datasets

Manufacturer's Raw data input, ASTERIX CAT 021 and CAT 023 data output.

### B.1.6 Verification objectives

OBJ-15.04.05.a-TS.0040.0001

The ADS-B Ground Surveillance Domain **should** be equipped with a 1030 MHz interrogator, capable of interrogating ADS-B targets according to all relevant ICAO Annex 10 requirements.

OBJ-15.04.05.a-TS.0040.0002

If OBJ-15.04.05.a-TS.0040.0001 is implemented, the ADS-B Ground Surveillance Domain **shall** have the capability to determine the Round Trip Delay (RTD) of every received 1090 MHz reply elicited by its own interrogations (registered as *Real RTD*).

OBJ-15.04.05.a-TS.0040.0003

If OBJ-15.04.05.a-TS.0040.0002 is implemented, the ADS-B Ground Surveillance Domain **shall** register the last RTD of each of the received ES and its time stamp.

OBJ-15.04.05.a-TS.0040.0004

If OBJ-15.04.05.a-TS.0040.0003 is implemented, each calculated RTD **shall** be considered applicable to RTD Validation for a configurable time period.

OBJ-15.04.05.a-TS.0040.0005

If OBJ-15.04.05.a-TS.0040.0003 and OBJ-15.04.05.a-TS.0040.0004 are implemented, each time a valid position message is received for a target in "target data maintenance" mode (see ED-129 chapter 3) and the associated RTD applicability is elapsed, the ADS-B position report **shall** be marked as NOT VALIDATED.

OBJ-15.04.05.a-TS.0040.0006

If OBJ-15.04.05.a-TS.0040.0003 and OBJ-15.04.05.a-TS.0040.0004 are implemented, each time a valid position message is received for a target in "target data maintenance" mode (see ED-129 chapter 3), the ADS-B Ground Surveillance Domain **shall** validate the ADS-B report comparing the

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ADS-B position data with the computed applicable RTD, if the associated RTD applicability is not elapsed.
---

OBJ-15.04.05.a-TS.0040.0007
-----------------------------

If OBJ-15.04.05.a-TS.0040.0006 is implemented, the ADS-B Ground Surveillance Domain <b>shall</b> be able to report the validation result in the ASTERIX CAT021 ADS-B report.
--

OBJ-15.04.05.a-TS.0040.0008
-----------------------------

If OBJ-15.04.05.a-TS.0040.0007 is implemented, the SDPD <b>shall</b> be able to use the validation result.
--

OBJ-15.04.05.a-TS.0040.0009
-----------------------------

If OBJ-15.04.05.a-TS.0040.0008 is implemented, the validation result (positive/negative) <b>should</b> be reported to the end user of the surveillance data.
--

OBJ-15.04.05.a-TS.0040.0010
-----------------------------

It <b>shall</b> be possible to activate/deactivate the function of range measurement from active interrogation.
---

## B.1.7 Inputs

The foreseen needed inputs for this exercise are ADS-B raw data and transmitter raw data injected by ADS-B Raw Data simulator.

## B.1.8 Outputs

ASTERIX CAT 021 and ASTERIX CAT 023 reports

## B.1.9 Entrance Criteria

Start of the generation of ADS-B raw data.

## B.1.10 Exit Criteria

The test finishes with the recording of the last ASTERIX report, when the scenario replay has stopped.

## B.1.11 Exercise Procedure

**Exercise ID/Title:** EXE-15.04.05.a-TS.0040.0001/ Range Measurement from Active Interrogation

**Pass Criteria:** The test is passed if it is verified that the 1090 ES Ground Station is able to validate ADS-B tracks through the Range Measurement from Active Interrogation.

**Exercise Type:** Test

**Precondition(s):** The test equipment setup will be in line with the one described in Section B.1.13 (see below).

Define in the ADS-B Raw Data Simulator the three targets ADSB-A, ADSB-B and ADSB-C at different positions with the following attributes:

- ADSB-A is standing; the range measurement of the Target is constant and correspondent to the range of the ADS-B position (transmitted by the target) from the interrogator
- ADSB-B is standing; the initial range measurement of the Target is

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correspondent to the range of the ADS-B position (transmitted by the target) from the interrogator, and then the reported position in of the ADS-B position squitters changes in time.

- ADSB-C is standing; there is no range information of the target.

Note(s):

Device(s) in use:

- Ground Station ADS-B
- ADS-B Raw Data Simulator
- ASTERIX Recording Tool
- Power
- UTC time Reference

Exercise Procedure:

Step	Action	Expected Reaction	Pass/Fail	Comment
1	Activate the feature "Range Measurement from Active Interrogation Validation" in the ground station to be tested.			
2	Prepare the test reporting capture tools to capture related GS system ASTERIX CAT-021 and GS system 'Raw Data Output' reports.			
3	Configure the recording tool to capture ASTERIX reports coming from the ADS-B GS.			
4	Prepare the Raw Data Simulator to play the scenario.			
5	Play the test scenario described in the preconditions of this test.			
6	Allow the recording to run for sufficient time to record all the messages.			
7	Stop the recording.	The ASTERIX CAT 021 and CAT 023 outputs are recorded.		
8	Check the ASTERIX CAT 023 output of the ground station.	The ASTERIX CAT 023 output reports the <b>activation</b> of the "Range Measurement from Active Interrogation Validation"		
9	By comparison of the recorded data against the known mobiles information, verify that minimum Items to	The ASTERIX CAT 021 output reports the following "TOA Validation Result" for:  <b>ADSB-A:</b>		

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	be processed are present and in line with the values generated in input	<p>•<b>“Validated and valid”</b>: Because position of ADS-B target (ADSB-A) and related range information are consistent.</p> <p>“ADSB-B:</p> <p>•<b>“Validated and valid”</b>: Because the initial position of ADS-B target (ADSB-A) and related range information are consistent.</p> <p>•<b>“Validated and not valid”</b>: After a while, when the changing position of ADSB-B differs from the constant range measurement.</p> <p>“ADSB-C:</p> <p>•<b>“Not validated”</b>: because there is no range measurement correspondent to target ADSB-C.</p>		
10	<b>De-activate</b> the feature “Range Measurement from Active Interrogation Validation” in the ground station to be tested.			
11	Replay the test scenario described in the preconditions of this test			
12	Check the ASTERIX CAT 023 output of the ground station.	The ASTERIX CAT 023 output reports the <b>de-activation</b> of the “Range Measurement from Active Interrogation Validation”		
13	Check the ASTERIX CAT 021 output of the ground station	The ASTERIX CAT 021 output reports “ <b>Not validated</b> ” in the “Range Measurement from Active Interrogation Validation” of all ADS-B targets, because the feature “TOA Validation” is de-activated in the Ground Station.		

Exercise result:

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	Pass	Fail	Done By (Name, Organisation)	Configuration(s) during the exercise	Date

Table 6: Verification Exercise Result “Range Measurement from Active Interrogation”

## B.1.12 Verification SUT Requirements

N/A

## B.1.13 Exercise Tool, Verification Technique and/or Platform

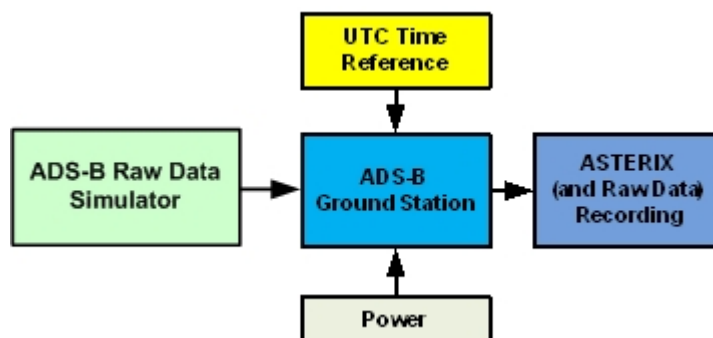


Figure 6: Test platform “Range Measurement from Active Interrogation Validation”

The Exercise will be verified on the platform shown in Figure 6, with the following tools/equipment:

- Ground Station ADS-B
- ADS-B Raw Data Simulator
- ASTERIX Recording Tool
- Power
- UTC time Reference

### Ground Station ADS-B

The primary function of the 1090 Ground Station is to receive 1090 MHz Mode S Extended Squitter messages, to extract the data information and to create appropriate ASTERIX Category 021 and 023 reports.

### Message Generator

The Messages Generator will be capable to generate the data coming from the Remote System (ADS – B Ground Station or 1090 Receiver) like:

**Target data stream** with inside the information extracted by the ADS – B message (ASTERIX CAT 021 in case of Ground Station or Raw Data in case the remote System is a 1090 MHz Receiver).

**Operational Data Stream** with inside the Remote System’s Operational Status Information (ASTERIX CAT 023 in case of Ground Station or Raw Data in case the remote System is a 1090 MHz Receiver).

### UTC Time Reference

The UTC Time Reference provides the synchronization of the Ground Station to UTC time.

### ASTERIX Recording Equipment

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The ASTERIX Recording Equipment is capable to record all ASTERIX reports sent from the 1090 ES Ground Station.

### B.1.14 Verification Platform Needs

See section 3.5.

### B.1.15 Platform Configuration

N/A

### B.1.16 Configuration(s) Identification of the Verification Platform

N/A

### B.1.17 Links to Other Verification Exercises

N/A

### B.1.18 Representatively Level / Limitations

N/A

## B.2 Exercises Planning and Management

### B.2.1 Activities

#### B.2.1.1 Preparatory Activities

Setup the tools/equipment listed in 3.5 and B.1.13 in order to meet the test preconditions.

#### B.2.1.2 Execution Activities

Play the scenario and record the relevant ASTERIX output.

#### B.2.1.3 Post Execution Activities

Verify that the information reported in the recorded ASTERIX reports is as expected due to the values of the Ground Station's input.

### B.2.2 Human Resources

N/A

### B.2.3 Responsibilities in the Exercise

N/A

### B.2.4 Training

N/A

### B.2.5 Time planning

N/A

### B.2.6 Risks

N/A

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## **B.2.7 Errors and Observation Handling**

N/A

## **B.3 Analysis Specification**

### **B.3.1 Data Collection Methods**

The data collection during the test is qualitative. After the test execution, the analysis of ASTERIX data is done verifying that the values reported in the Ground Station's output are as expected due to the values of the Ground Station's input.

### **B.3.2 Analysis Method**

N/A

### **B.3.3 Data Logging Requirements**

The data logging for this scenario provides at least ASTERIX CAT 021 and ASTERIX CAT 023 data.

## Appendix C

### Preliminary Coverage Matrix<sup>1</sup>

Requirement ID	Requirement Title	Verification Objective ID	Verification Objective Title	Exercise ID	Exercise Title
REQ-15.04.05.a-D20-0030.0001	ADS-B Target Report Data Update by WAM System	OBJ-15.04.05.a-TS.0030.0001	ADS-B Target Report Data Update by WAM System	EXE-15.04.05.a-TS.0030.0001	ADS-B Target Report Data Update by WAM System
REQ-15.04.05.a-D20-0040.0001	1030 MHz interrogation capability	OBJ-15.04.05.a-TS.0040.0001	1030 MHz interrogation capability	EXE-15.04.05.a-TS.0040.0001	Range Measurement from Active Interrogation
REQ-15.04.05.a-D20-0040.0002	RTD measurement	OBJ-15.04.05.a-TS.0040.0002	RTD measurement		
REQ-15.04.05.a-D20-0040.0003	RTD storage	OBJ-15.04.05.a-TS.0040.0003	RTD storage		
REQ-15.04.05.a-D20-0040.0004	RTD applicability	OBJ-15.04.05.a-TS.0040.0004	RTD applicability		
REQ-15.04.05.a-D20-0040.0005	Active ADS-B validation use	OBJ-15.04.05.a-TS.0040.0005	Active ADS-B validation use		
REQ-15.04.05.a-D20-0040.0006	Active ADS-B validation	OBJ-15.04.05.a-TS.0040.0006	Active ADS-B validation		
REQ-15.04.05.a-D20-0040.0007	Active ADS-B validation reporting	OBJ-15.04.05.a-TS.0040.0007	Active ADS-B validation reporting		
REQ-15.04.05.a-D20-0040.0008	Active ADS-B validation consistency use	OBJ-15.04.05.a-TS.0040.0008	Active ADS-B validation consistency use		
REQ-15.04.05.a-D20-0040.0009	Active ADS-B validation forwarding	OBJ-15.04.05.a-TS.0040.0009	Active ADS-B validation forwarding		
REQ-15.04.05.a-D20-0040.0010	Range measurement from active interrogation activation	OBJ-15.04.05.a-TS.0040.0010	Range measurement from active interrogation activation		

Table 7: Coverage Matrix

<sup>1</sup> Coverage Matrix between D20 and D13 is provided in D13, Annex A

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