

RTCA, Inc.
1150 18th Street, NW, Suite 910
Washington, DC 20036, USA

**Minimum Operational Performance Standards
(MOPS) for 1090 MHz Extended Squitter
Automatic Dependent Surveillance – Broadcast
(ADS-B) and Traffic Information Services –
Broadcast (TIS-B)**

(Corrigendum 1, Appendix W, integrated and highlighted)

RTCA DO-260B
December 2, 2009
Supersedes RTCA DO-260A,
including Change 1 and Change 2
Corrigendum 1 (Included)
December 13, 2011

Prepared by: SC-186
© 2011 RTCA, Inc.

Copies of this document may be obtained from

RTCA, Inc

Telephone: 202-833-5339

Facsimile: 202-33-434

Internet: www.rtca.org

Please visit the RTCA Online Store for document pricing and ordering information.

FOREWORD

This document was prepared by Special Committee 186 (SC-186) and approved by the RTCA Program Management Committee (PMC) on December 13, 2011.

RTCA, Incorporated is a not-for-profit corporation formed to advance the art and science of aviation and aviation electronic systems for the benefit of the public. The organization functions as a Federal Advisory Committee and develops consensus based recommendations on contemporary aviation issues. RTCA's objectives include but are not limited to:

- coalescing aviation system user and provider technical requirements in a manner that helps government and industry meet their mutual objectives and responsibilities;
- analyzing and recommending solutions to the system technical issues that aviation faces as it continues to pursue increased safety, system capacity and efficiency;
- developing consensus on the application of pertinent technology to fulfill user and provider requirements, including development of minimum operational performance standards for electronic systems and equipment that support aviation; and
- assisting in developing the appropriate technical material upon which positions for the International Civil Aviation Organization and the International Telecommunications Union and other appropriate international organizations can be based.

The organization's recommendations are often used as the basis for government and private sector decisions as well as the foundation for many Federal Aviation Administration technical Standard Orders.

Since RTCA is not an official agency of the United States Government, its recommendations may not be regarded as statements of official government policy unless so enunciated by the U.S. government organization or agency having statutory jurisdiction over any matters to which the recommendations relate.

This Page Intentionally Left Blank

TABLE OF CONTENTS

1.0	PURPOSE AND SCOPE	1
1.1	INTRODUCTION	1
1.2	SYSTEM OVERVIEW	4
1.2.1	DEFINITIONS.....	4
1.2.2	1090 MHz ADS-B SYSTEM	6
1.2.3	ADS-B AVIONICS INTEGRITY.....	6
1.2.4	1090 MHz ADS-B SUBSYSTEM IMPLEMENTATIONS	7
1.2.4.1	Source 1090 MHz ADS-B Transmitting Subsystem	7
1.2.4.1.1	Transponder-Based Subsystems	8
1.2.4.1.2	Non-Transponder-Based Subsystems.....	8
1.2.4.2	1090 MHz ADS-B & TIS-B Receiving Subsystem	8
1.2.4.2.1	Type 1 Report Assembly Function	9
1.2.4.2.2	Type 2 Report Assembly	9
1.2.4.3	Major Operating Characteristics.....	9
1.2.5	TYPICAL SYSTEM OPERATION	10
1.2.6	ADS-B MESSAGE CONTENT.....	11
1.2.7	ADS-B REPORT CONTENT	11
1.2.7.1	State Vector Report	11
1.2.7.2	Mode Status Report	11
1.2.7.3	Target State Report.....	11
1.2.7.4	Air Referenced Velocity Report	12
1.3	OPERATIONAL APPLICATIONS	12
1.3.1	GENERAL SUPPORT FOR SURVEILLANCE	12
1.3.2	COCKPIT DISPLAY OF TRAFFIC INFORMATION (CDTI)	12
1.3.2.1	Aid to Visual Acquisition	12
1.3.2.2	Enhanced Traffic Situational Awareness.....	13
1.3.3	IMPROVEMENTS TO AIRCRAFT-BASED COLLISION AVOIDANCE.....	13
1.3.4	CONFLICT MANAGEMENT AND AIRSPACE DE-CONFLICTION	13
1.3.5	ATS CONFORMANCE MONITORING	13
1.3.5.1	Simultaneous Approaches	13
1.3.5.2	Incursion Monitoring	14
1.3.6	OTHER APPLICATIONS	14
1.4	ADS-B FUNCTIONS	15
1.4.1	ADS-B MESSAGE GENERATION FUNCTION.....	15
1.4.1.1	Avionics Input Bus	15
1.4.1.2	Input Interface	15
1.4.1.3	Message Assembly/Encoder.....	15
1.4.2	ADS-B MESSAGE EXCHANGE FUNCTION.....	15
1.4.2.1	Modulation/Transmission Subfunction	15
1.4.2.2	Transmit/Receive/Antenna Subfunction.....	16
1.4.2.3	Receiver/Demodulator Subfunction	16
1.4.3	ADS-B REPORT ASSEMBLY FUNCTION	16
1.4.3.1	Decoder/Report Assembly.....	16
1.4.3.2	Output Interface.....	17
1.4.3.3	Avionics Output Bus	17
1.5	OPERATIONAL GOALS	17
1.6	ASSUMPTIONS AND RATIONALE	17
1.7	TEST PROCEDURES	17
1.7.1	ENVIRONMENTAL TESTS	18

1.7.2	QUALIFICATION TESTS	18
1.7.3	INSTALLED TESTS.....	18
1.8	MASPS COMPLIANCE	18
1.9	DEFINITION OF KEY TERMS	18
2.0	<u>EQUIPMENT PERFORMANCE REQUIREMENTS AND TEST PROCEDURES</u>	<u>21</u>
2.1	GENERAL REQUIREMENTS	21
2.1.1	AIRWORTHINESS.....	21
2.1.2	INTENDED FUNCTION	21
2.1.3	FEDERAL COMMUNICATIONS COMMISSION RULES	21
2.1.4	FIRE PROTECTION.....	21
2.1.5	OPERATION OF CONTROLS.....	21
2.1.5.1	Optional Extended Squitter Inhibit.....	21
2.1.6	ACCESSIBILITY OF CONTROLS	22
2.1.7	EQUIPMENT INTERFACES.....	22
2.1.8	EFFECTS OF TEST.....	22
2.1.9	DESIGN ASSURANCE.....	22
2.1.10	INTEGRATION AND INTEROPERABILITY WITH A MODE S TRANSPONDER	22
2.1.11	EQUIPAGE CLASS DEFINITIONS	23
2.1.12	EQUIPAGE CLASS CATEGORIES	23
2.1.12.1	Transmitting Subsystem	25
2.1.12.2	Receiving Subsystem.....	28
2.2	MINIMUM PERFORMANCE STANDARDS - STANDARD CONDITIONS AND SIGNALS.....	31
2.2.1	DEFINITION OF STANDARD CONDITIONS.....	31
2.2.2	ADS-B TRANSMITTER CHARACTERISTICS	31
2.2.2.1	Mode S Transponder-Based Transmitters	31
2.2.2.1.1	RF Peak Output Power (minimum)	31
2.2.2.1.1.1	Class A0 ADS-B Transponder-Based Transmitter Power.....	31
2.2.2.1.1.2	Class A1S and A1 ADS-B Transponder-Based Transmitter Power.....	31
2.2.2.1.1.3	Class A2 ADS-B Transponder-Based Transmitter Power.....	32
2.2.2.1.1.4	Class A3 ADS-B Transponder-Based Transmitter Power.....	32
2.2.2.1.1.5	Class B ADS-B Transponder-Based Transmitter Power.....	32
2.2.2.1.2	RF Peak Output Power (maximum)	32
2.2.2.2	Stand Alone Transmitters	32
2.2.2.2.1	Transmission Frequency	33
2.2.2.2.2	Transmission Spectrum	33
2.2.2.2.3	Modulation	33
2.2.2.2.4	Pulse Shapes	33
2.2.2.2.5	Message Structure	34
2.2.2.2.6	Pulse Intervals	34
2.2.2.2.7	Preamble	34
2.2.2.2.8	Data Pulses	34
2.2.2.2.9	Pulse Amplitude	34
2.2.2.2.10	RF Peak Output Power	34
2.2.2.2.10.1	Class A0 and B0 Equipment RF Peak Output Power.....	35
2.2.2.2.10.2	Class B2 and B3 Equipment RF Peak Output Power	35
2.2.2.2.10.3	RF Peak Output Power (maximum)	35
2.2.2.2.11	Unwanted Output Power	36
2.2.2.2.12	Broadcast Rate Capability	36
2.2.3	BROADCAST MESSAGE CHARACTERISTICS.....	36
2.2.3.1	ADS-B Message Characteristics.....	36
2.2.3.1.1	ADS-B Message Preamble	37
2.2.3.1.2	ADS-B Message Data Pulses	37

2.2.3.1.3	ADS-B Message Pulse Shape.....	38
2.2.3.1.4	ADS-B Message Pulse Spacing.....	38
2.2.3.2	ADS-B and TIS-B Message Baseline Format and Structures	38
2.2.3.2.1	ADS-B Message Baseline Field Descriptions	40
2.2.3.2.1.1	“DF” Downlink Format Field.....	40
2.2.3.2.1.2	“CA” Capability Field (used in DF=17).....	41
2.2.3.2.1.3	“CF” Field (used in DF=18).....	44
2.2.3.2.1.4	“AF” Field (used in DF=19).....	45
2.2.3.2.1.5	“AA” Address Field, Announced	45
2.2.3.2.1.6	“ME” Message, Extended Squitter	47
2.2.3.2.1.7	“PI” Parity / Identity	47
2.2.3.2.2	Determining ADS-B and TIS-B Message Types.....	47
2.2.3.2.3	ADS-B Airborne Position Messages	50
2.2.3.2.3.1	“TYPE” Code Subfield in ADS-B Airborne Position Messages.....	51
2.2.3.2.3.1.1	Airborne Position Message TYPE Code if Radius of Containment is Available	55
2.2.3.2.3.1.2	Airborne Position Message TYPE Code if Radius of Containment is Not Available	55
2.2.3.2.3.1.3	Special Processing for TYPE Code Equal to ZERO	56
2.2.3.2.3.1.3.1	Significance of TYPE Code Equal to ZERO.....	56
2.2.3.2.3.1.3.2	Broadcast of TYPE Code Equal to ZERO.....	56
2.2.3.2.3.1.4	TYPE Code based on Horizontal Position and Altitude Data	57
2.2.3.2.3.1.5	TYPE Code based on Fault Detection and Exclusion (FDE) Conditions While Airborne	57
2.2.3.2.3.2	“Surveillance Status” Subfield in ADS-B Airborne Position Messages	58
2.2.3.2.3.3	“NIC Supplement-B” Subfield in ADS-B Airborne Position Messages	59
2.2.3.2.3.4	“Altitude” Subfield in ADS-B Airborne Position Messages.....	59
2.2.3.2.3.4.1	“Barometric Altitude” in ADS-B Airborne Position Messages	59
2.2.3.2.3.4.2	“GNSS Height Above the Ellipsoid (HAE)” in ADS-B Airborne Position Messages.....	60
2.2.3.2.3.4.3	“Altitude Encoding” in ADS-B Airborne Position Messages	60
2.2.3.2.3.5	“TIME” (T) Subfield in ADS-B Airborne Position Messages	61
2.2.3.2.3.6	“CPR Format” (F) Subfield in ADS-B Airborne Position Messages	61
2.2.3.2.3.7	“CPR Encoded Latitude” Subfield in ADS-B Airborne Position Messages	62
2.2.3.2.3.7.1	Airborne Latitude Data Encoding.....	62
2.2.3.2.3.7.2	GPS/GNSS Time Mark Coupled Case (“TIME” (T)=“1”)	62
2.2.3.2.3.7.3	Non-GPS/GNSS Time Mark Coupled Case (“TIME” (T) = “0”)	64
2.2.3.2.3.7.4	Airborne Latitude Position Data Retention	66
2.2.3.2.3.8	“CPR Encoded Longitude” Subfield in ADS-B Airborne Position Messages	66
2.2.3.2.3.8.1	Airborne Longitude Data Encoding	66
2.2.3.2.3.8.2	GPS/GNSS Time Mark Coupled Case (“TIME” (T)=“1”)	66
2.2.3.2.3.8.3	Non-GPS/GNSS Time Mark Coupled Case (“TIME” (T)=“0”)	68
2.2.3.2.3.8.4	Airborne Longitude Position Data Retention	70
2.2.3.2.4	ADS-B Surface Position Messages	71
2.2.3.2.4.1	“TYPE” Code Subfield in ADS-B Surface Position Messages.....	71
2.2.3.2.4.1.1	Surface Position Message TYPE Code if Radius of Containment is Available	71
2.2.3.2.4.1.2	Surface Position Message TYPE Code if Radius of Containment is Not Available	72
2.2.3.2.4.1.3	Special Processing for TYPE Code Equal to ZERO	72
2.2.3.2.4.1.3.1	Significance of TYPE Code Equal to ZERO.....	72
2.2.3.2.4.1.3.2	Broadcast of TYPE Code Equal to ZERO.....	72
2.2.3.2.4.1.4	TYPE Code based on Horizontal Protection Level	72
2.2.3.2.4.1.5	TYPE Code based on Fault Detection and Exclusion (FDE) Conditions While on the Surface.....	73
2.2.3.2.4.2	“Movement” Subfield in ADS-B Surface Position Messages	74
2.2.3.2.4.3	“Status Bit for Heading/Ground Track” Subfield in ADS-B Surface Position Messages	74
2.2.3.2.4.4	“Heading/Ground Track” Subfield in ADS-B Surface Position Messages	75
2.2.3.2.4.5	“TIME” (T) Subfield in ADS-B Surface Position Messages	76
2.2.3.2.4.6	“CPR Format” (F) Subfield in ADS-B Surface Position Messages	76
2.2.3.2.4.7	“CPR Encoded Latitude” Subfield in ADS-B Surface Position Messages.....	77
2.2.3.2.4.7.1	Surface Latitude Data Encoding.....	77

2.2.3.2.4.7.2	GPS/GNSS Time Mark Coupled Case (“TIME” (T)=“1”)	77
2.2.3.2.4.7.3	Non-GPS/GNSS Time Mark Coupled Case (“TIME” (T) = “0”)	78
2.2.3.2.4.7.4	Surface Latitude Position Data Retention	81
2.2.3.2.4.8	“CPR Encoded Longitude” Subfield in ADS-B Surface Position Messages	81
2.2.3.2.4.8.1	Surface Longitude Data Encoding	81
2.2.3.2.4.8.2	GPS/GNSS Time Mark Coupled Case (“TIME” (T)=“1”)	81
2.2.3.2.4.8.3	Non-GPS/GNSS Time Mark Coupled Case (“TIME” (T)=“0”)	82
2.2.3.2.4.8.4	Surface Longitude Position Data Retention	85
2.2.3.2.5	ADS-B Aircraft Identification and Category Messages	85
2.2.3.2.5.1	“TYPE” Code Subfield in ADS-B Aircraft Identification and Category Message	85
2.2.3.2.5.2	“ADS-B Emitter Category” Subfield in ADS-B Aircraft Identification and Category Message	86
2.2.3.2.5.3	“ID Character” Subfield in ADS-B Aircraft Identification and Category Message	86
2.2.3.2.6	ADS-B Airborne Velocity Messages	87
2.2.3.2.6.1	ADS-B Airborne Velocity Message - Subtype=1	89
2.2.3.2.6.1.1	“TYPE” Code Subfield in Airborne Velocity Message - Subtype=1	89
2.2.3.2.6.1.2	“Subtype” Code Subfield in Airborne Velocity Message - Subtype=1	89
2.2.3.2.6.1.3	“Intent Change Flag” Subfield in Airborne Velocity Messages - Subtype=1	90
2.2.3.2.6.1.4	“Reserved Bit-A” Subfield in Airborne Velocity Messages – Subtype=1	91
2.2.3.2.6.1.5	“NAC _V ” Subfield in Airborne Velocity Messages - Subtype=1	91
2.2.3.2.6.1.6	“East/West Direction Bit” Subfield in Airborne Velocity Messages - Subtype=1	92
2.2.3.2.6.1.7	“East/West Velocity” Subfield in Airborne Velocity Messages - Subtype=1	92
2.2.3.2.6.1.8	“North/South Direction Bit” Subfield in Airborne Velocity Messages - Subtype=1	93
2.2.3.2.6.1.9	“North/South Velocity” Subfield in Airborne Velocity Messages - Subtype=1	93
2.2.3.2.6.1.10	“Source Bit for Vertical Rate” Subfield in Airborne Velocity Messages - Subtype=1	93
2.2.3.2.6.1.11	“Sign Bit for Vertical Rate” Subfield in Airborne Velocity Messages - Subtype=1	94
2.2.3.2.6.1.12	“Vertical Rate” Subfield in Airborne Velocity Messages - Subtype=1	94
2.2.3.2.6.1.13	“Reserved Bits-B” Subfield in Airborne Velocity Messages – Subtype=1	94
2.2.3.2.6.1.14	“Difference From Barometric Altitude Sign Bit” Subfield in Airborne Velocity Messages - Subtype=1	95
2.2.3.2.6.1.15	“Difference From Barometric Altitude” Subfield in Airborne Velocity Messages - Subtype=1	95
2.2.3.2.6.2	ADS-B Airborne Velocity Message - Subtype=2	96
2.2.3.2.6.2.1	“TYPE” Code Subfield in Airborne Velocity Messages - Subtype=2	96
2.2.3.2.6.2.2	“Subtype” Code Subfield in Airborne Velocity Messages - Subtype=2	97
2.2.3.2.6.2.3	“Intent Change Flag” Subfield in Airborne Velocity Messages - Subtype=2	97
2.2.3.2.6.2.4	“Reserved Bit-A” Subfield in Airborne Velocity Messages – Subtype=2	97
2.2.3.2.6.2.5	“NAC _V ” Subfield in Airborne Velocity Messages - Subtype=2	97
2.2.3.2.6.2.6	“East/West Direction Bit” Subfield in Airborne Velocity Messages - Subtype=2	97
2.2.3.2.6.2.7	“East/West Velocity” Subfield in Airborne Velocity Messages - Subtype=2	97
2.2.3.2.6.2.8	“North/South Direction Bit” Subfield in Airborne Velocity Messages - Subtype=2	98
2.2.3.2.6.2.9	“North/South Velocity” Subfield in Airborne Velocity Messages - Subtype=2	98
2.2.3.2.6.2.10	“Source Bit for Vertical Rate” Subfield in Airborne Velocity Messages - Subtype=2	99
2.2.3.2.6.2.11	“Sign Bit for Vertical Rate” Subfield in Airborne Velocity Messages - Subtype=2	99
2.2.3.2.6.2.12	“Vertical Rate” Subfield in Airborne Velocity Messages - Subtype=2	99
2.2.3.2.6.2.13	“Reserved Bits-B” Subfield in Airborne Velocity – Subtype=2 Messages	99
2.2.3.2.6.2.14	“Difference From Barometric Altitude Sign Bit” Subfield in Airborne Velocity Messages - Subtype=2	99
2.2.3.2.6.2.15	“Difference From Barometric Altitude” Subfield in Airborne Velocity Messages - Subtype=2	99
2.2.3.2.6.3	ADS-B Airborne Velocity Message - Subtype=3	99
2.2.3.2.6.3.1	“TYPE” Code Subfield in Airborne Velocity Messages - Subtype=3	100
2.2.3.2.6.3.2	“Subtype” Code Subfield in Airborne Velocity Messages - Subtype=3	100
2.2.3.2.6.3.3	“Intent Change Flag” Subfield in Airborne Velocity Messages - Subtype=3	100
2.2.3.2.6.3.4	“Reserved Bit-A” Subfield in Airborne Velocity Messages – Subtype=3	100
2.2.3.2.6.3.5	“NAC _V ” Subfield in Airborne Velocity Messages - Subtype=3	100
2.2.3.2.6.3.6	“Heading Status Bit” Subfield in Airborne Velocity Messages - Subtype=3	101
2.2.3.2.6.3.7	“Heading” Subfield in Airborne Velocity Messages - Subtype=3	101

2.2.3.2.6.3.8	“Airspeed Type” Subfield in Airborne Velocity Messages - Subtype=3	102
2.2.3.2.6.3.9	“Airspeed” Subfield in Airborne Velocity Messages - Subtype=3	102
2.2.3.2.6.3.10	“Source Bit for Vertical Rate” Subfield in Airborne Velocity Messages - Subtype=3	102
2.2.3.2.6.3.11	“Sign Bit for Vertical Rate” Subfield in Airborne Velocity Messages - Subtype=3	102
2.2.3.2.6.3.12	“Vertical Rate” Subfield in Airborne Velocity Messages - Subtype=3	103
2.2.3.2.6.3.13	“Reserved Bits-B” Subfield in Airborne Velocity Messages – Subtype=3	103
2.2.3.2.6.3.14	“Difference From Barometric Altitude Sign Bit” Subfield in Airborne Velocity Messages - Subtype=3	103
2.2.3.2.6.3.15	“Difference From Barometric Altitude” Subfield in Airborne Velocity Messages - Subtype=3	103
2.2.3.2.6.4	ADS-B Airborne Velocity Message - Subtype=4	103
2.2.3.2.6.4.1	“TYPE” Code Subfield in Airborne Velocity Messages - Subtype=4	104
2.2.3.2.6.4.2	“Subtype” Code Subfield in Airborne Velocity Messages - Subtype=4	104
2.2.3.2.6.4.3	“Intent Change Flag” Subfield in Airborne Velocity Messages - Subtype=4	104
2.2.3.2.6.4.4	“Reserved Bit-A” Subfield in Airborne Velocity Messages – Subtype=4	104
2.2.3.2.6.4.5	“NAC _V ” Subfield in Airborne Velocity Messages - Subtype=4	104
2.2.3.2.6.4.6	“Heading Status Bit” Subfield in Airborne Velocity Messages - Subtype=4	104
2.2.3.2.6.4.7	“Heading” Subfield in Airborne Velocity Messages - Subtype=4	104
2.2.3.2.6.4.8	“Airspeed Type” Subfield in Airborne Velocity Messages - Subtype=4	105
2.2.3.2.6.4.9	“Airspeed” Subfield in Airborne Velocity Messages - Subtype=4	105
2.2.3.2.6.4.10	“Source Bit for Vertical Rate” Subfield in Airborne Velocity Messages - Subtype=4	105
2.2.3.2.6.4.11	“Sign Bit for Vertical Rate” Subfield in Airborne Velocity Messages - Subtype=4	105
2.2.3.2.6.4.12	“Vertical Rate” Subfield in Airborne Velocity Messages - Subtype=4	106
2.2.3.2.6.4.13	“Reserved Bits-B” Subfield in Airborne Velocity Messages – Subtype=4	106
2.2.3.2.6.4.14	“Difference From Barometric Altitude Sign Bit” Subfield in Airborne Velocity Messages - Subtype=4	106
2.2.3.2.6.4.15	“Difference From Barometric Altitude” Subfield in Airborne Velocity Messages - Subtype=4	106
2.2.3.2.6.5	ADS-B Airborne Velocity Messages - Subtypes “5, 6, 7”	106
2.2.3.2.7	ADS-B Periodic Status and Event-Driven Messages	106
2.2.3.2.7.1	“Target State and Status” Messages	106
2.2.3.2.7.1.1	“TYPE” Code Subfield in Target State and Status Messages	107
2.2.3.2.7.1.2	“Subtype” Code Subfield in Target State and Status Messages	108
2.2.3.2.7.1.3	Target State and Status Message (Subtype=1)	108
2.2.3.2.7.1.3.1	“SIL Supplement” Subfield in Target State and Status Messages	109
2.2.3.2.7.1.3.2	“Selected Altitude Type” Subfield in Target State and Status Messages	110
2.2.3.2.7.1.3.3	“MCP/FCU Selected Altitude or FMS Selected Altitude” Subfield in Target State and Status Messages	111
2.2.3.2.7.1.3.4	“Barometric Pressure Setting (Minus 800 millibars)” Subfield in Target State and Status Messages	112
2.2.3.2.7.1.3.5	“Selected Heading Status” Subfield in Target State and Status Messages	112
2.2.3.2.7.1.3.6	“Selected Heading” Subfield in Target State and Status Messages	113
2.2.3.2.7.1.3.7	“Selected Heading” Subfield in Target State and Status Messages	114
2.2.3.2.7.1.3.8	“NAC _P ” Subfield in Target State and Status Messages	115
2.2.3.2.7.1.3.9	“NIC _{BARO} ” Subfield in Target State and Status Messages	115
2.2.3.2.7.1.3.10	“Source Integrity Level (SIL)” Subfield in Target State and Status Messages	115
2.2.3.2.7.1.3.11	“Status of MCP/FCU Mode Bits” Subfield in Target State and Status Messages	116
2.2.3.2.7.1.3.12	“Autopilot Engaged” Subfield in Target State and Status Messages	117
2.2.3.2.7.1.3.13	“VNAV Mode Engaged” Subfield in Target State and Status Messages	117
2.2.3.2.7.1.3.14	“Altitude Hold Mode” Subfield in Target State and Status Messages	117
2.2.3.2.7.1.3.15	“Reserved for ADS-R Flag” Subfield in Target State and Status Messages	118
2.2.3.2.7.1.3.16	“Approach Mode” Subfield in Target State and Status Messages	118
2.2.3.2.7.1.3.17	“TCAS Operational” Subfield in Target State and Status Messages	118
2.2.3.2.7.1.3.18	“LNAV Mode Engaged” Subfield in Target State and Status Messages	119
2.2.3.2.7.1.3.19	“Reserved” Subfield in Target State and Status Messages	119
2.2.3.2.7.1.4	Reserved for TYPE=29 and Subtype > 1 Message Formats	119
2.2.3.2.7.2	“Aircraft Operational Status” Messages	119
2.2.3.2.7.2.1	“TYPE” Code Subfield in Aircraft Operational Status Messages	121

2.2.3.2.7.2.2	“Subtype” Code Subfield in Aircraft Operational Status Messages.....	121
2.2.3.2.7.2.3	“CAPABILITY CLASS (CC)” Subfield in Aircraft Operational Status Messages	121
2.2.3.2.7.2.3.1	“Reserved” CC Code Subfields in Aircraft Operational Status Messages	123
2.2.3.2.7.2.3.2	“TCAS Operational” CC Code Subfield in Aircraft Operational Status Messages.....	123
2.2.3.2.7.2.3.3	“1090ES IN” CC Code Subfield in Aircraft Operational Status Messages.....	123
2.2.3.2.7.2.3.4	“ARV Report Capability” CC Code Subfield in Aircraft Operational Status Messages.....	124
2.2.3.2.7.2.3.5	“TS Report Capability” CC Code Subfield in Aircraft Operational Status Messages.....	124
2.2.3.2.7.2.3.6	“TC Report Capability” CC Code Subfield in Aircraft Operational Status Messages	124
2.2.3.2.7.2.3.7	“B2 Low” CC Code Subfield in Surface Aircraft Operational Status Messages	125
2.2.3.2.7.2.3.8	“NAC _v ” CC Code Subfield in Surface Aircraft Operational Status Messages.....	125
2.2.3.2.7.2.3.9	“UAT IN” CC Code Subfield in Aircraft Operational Status Messages	125
2.2.3.2.7.2.3.10	“NIC Supplement-C” CC Code Subfield in Aircraft Operational Status Messages.....	125
2.2.3.2.7.2.4	“OPERATIONAL MODE (OM)” Subfield in Aircraft Operational Status Messages.....	126
2.2.3.2.7.2.4.1	OM Subfield Format Code in Aircraft Operational Status Messages.....	127
2.2.3.2.7.2.4.2	“TCAS/ACAS Resolution Advisory Active” OM Code Subfield in Aircraft Operational Status Message	127
2.2.3.2.7.2.4.3	“IDENT Switch Active” OM Code Subfield in Aircraft Operational Status Message	127
2.2.3.2.7.2.4.4	Reserved for “Receiving ATC Services” OM Code Subfield in Aircraft Operational Status Message	128
2.2.3.2.7.2.4.5	“Single Antenna Flag” OM Code Subfield in Aircraft Operational Status Messages.....	128
2.2.3.2.7.2.4.6	“System Design Assurance” OM Code Subfield in Aircraft Operational Status Messages	128
2.2.3.2.7.2.4.7	“GPS Antenna Offset” OM Code Subfield in Aircraft Operational Status Messages.....	129
2.2.3.2.7.2.4.8	“Reserved” OM Code Subfield in Aircraft Operational Status Messages.....	131
2.2.3.2.7.2.5	ADS-B “Version Number” Subfield in Aircraft Operational Status Message	131
2.2.3.2.7.2.6	“NIC Supplement-A” Subfield in Aircraft Operational Status Messages	132
2.2.3.2.7.2.7	“Navigation Accuracy Category for Position (NAC _p)” Subfield in Aircraft Operational Status Messages	133
2.2.3.2.7.2.8	“Geometric Vertical Accuracy (GVA)” Subfield in Aircraft Operational Status Messages	134
2.2.3.2.7.2.9	“Source Integrity Level (SIL)” Subfield in Aircraft Operational Status Messages	135
2.2.3.2.7.2.10	“Barometric Altitude Integrity Code (NIC _{BARO})” Subfield in Aircraft Operational Status Messages ..	136
2.2.3.2.7.2.11	“Aircraft/Vehicle Length and Width Code” Subfield in Aircraft Operational Status Messages	137
2.2.3.2.7.2.12	“Track Angle/Heading” Subfield in Aircraft Operational Status Messages.....	138
2.2.3.2.7.2.13	“Horizontal Reference Direction (HREF)” Subfield in Aircraft Operational Status Messages	139
2.2.3.2.7.2.14	“SIL Supplement” Subfield in Aircraft Operational Status Messages	139
2.2.3.2.7.2.15	“Reserved” Subfield in Aircraft Operational Status Message	139
2.2.3.2.7.3	TYPE Code “23” ADS-B Messages for “TEST”	139
2.2.3.2.7.4	Surface System Status Messages with TYPE Code=24	140
2.2.3.2.7.4.1	“TYPE” Code Subfield in Surface System Status Messages.....	140
2.2.3.2.7.4.2	“Subtype” Code Subfield in Surface System Status Messages	140
2.2.3.2.7.4.3	“Surface System Status” Subfield in Surface System Status Messages	141
2.2.3.2.7.5	RESERVED TYPE Code “25” ADS-B Messages	141
2.2.3.2.7.6	RESERVED TYPE Code “26” ADS-B Messages	141
2.2.3.2.7.7	RESERVED TYPE Code “27” ADS-B Messages	141
2.2.3.2.7.8	Extended Squitter Aircraft Status Messages with TYPE Code=28.....	141
2.2.3.2.7.8.1	Emergency / Priority Status and Mode A Code (Subtype=1).....	141
2.2.3.2.7.8.1.1	“Emergency/Priority Status” Subfield in Aircraft Status Messages	142
2.2.3.2.7.8.1.2	“Mode A (4096) Code” Subfield in Aircraft Status Messages.....	143
2.2.3.2.7.8.2	1090ES TCAS Resolution Advisory (RA) Broadcast Message (Subtype=2)	143
2.2.3.2.7.9	RESERVED TYPE Code “30” ADS-B Messages	144
2.2.3.3	ADS-B Message Transmission Rates	144
2.2.3.3.1	Transmission Rates for Transponder - Based Transmitters.....	144
2.2.3.3.1.1	Transmission Rates Compliant with RTCA DO-181E (EUROCAE ED-73E)	144
2.2.3.3.1.2	Transmission Rates Not Specified in RTCA DO-181E (EUROCAE ED-73E)	144
2.2.3.3.1.3	Maximum Transmission Rates for Transponder - Based Transmitters	146
2.2.3.3.1.4	ADS-B Periodic Status and Event-Driven Message Broadcast Rates	146

2.2.3.3.1.4.1	ADS-B Target State and Status Message Broadcast Rates.....	146
2.2.3.3.1.4.2	ADS-B Aircraft Operational Status Message Broadcast Rates	147
2.2.3.3.1.4.3	“Extended Squitter Aircraft Status” ADS-B Event-Driven Message Broadcast Rates	148
2.2.3.3.1.4.3.1	“Emergency/Priority Status Message” Broadcast Rates.....	148
2.2.3.3.1.4.3.1.1	“Emergency/Priority Status Message” Broadcast Rates When Transmission of Mode A Code is Disabled	149
2.2.3.3.1.4.3.1.2	“Emergency/Priority Status Message” Broadcast Rates When Transmission of Mode A Code is Enabled	149
2.2.3.3.1.4.3.2	“TCAS RA Broadcast Message” Broadcast Rate	150
2.2.3.3.1.4.4	“TYPE Code=23 (TEST)” ADS-B Event-Driven Message Broadcast Rate	150
2.2.3.3.1.4.5	“TYPE Codes 24 – 27” and “TYPE Code=30” ADS-B Event-Driven Message Broadcast Rate	150
2.2.3.3.1.4.6	ADS-B Message Transmission Scheduling.....	150
2.2.3.3.1.4.6.1	Event-Driven Message Scheduling Function	150
2.2.3.3.2	Transmission Rates for Stand Alone Transmitters	152
2.2.3.3.2.1	Power-On Initialization and Start Up	152
2.2.3.3.2.1.1	Power-On Initialization	152
2.2.3.3.2.1.2	Start Up.....	153
2.2.3.3.2.2	ADS-B Airborne Position Message Broadcast Rate	153
2.2.3.3.2.3	ADS-B Surface Position Message Broadcast Rate.....	153
2.2.3.3.2.4	ADS-B Aircraft Identification and Category Message Broadcast Rate.....	154
2.2.3.3.2.5	ADS-B Velocity Information Message Broadcast Rate	154
2.2.3.3.2.6	ADS-B Periodic Status Message Broadcast Rates	155
2.2.3.3.2.6.1	ADS-B Target State and Status Message Broadcast Rates.....	155
2.2.3.3.2.6.2	ADS-B Aircraft Operational Status Message Broadcast Rates	155
2.2.3.3.2.7	“Extended Squitter Aircraft Status” ADS-B Event-Driven Message Broadcast Rate.....	155
2.2.3.3.2.8	Other ADS-B Event-Driven Message Broadcast Rates.....	155
2.2.3.3.2.8.1	“TYPE Code=23 (TEST)” ADS-B Event-Driven Message Broadcast Rate	155
2.2.3.3.2.8.2	“TYPE Codes 24 - 27” ADS-B Event-Driven Message Broadcast Rate	156
2.2.3.3.2.9	ADS-B Message Transmission Scheduling.....	156
2.2.3.3.2.9.1	Scheduling of Non Event-Driven Messages.....	156
2.2.3.3.2.9.2	Event-Driven Message Scheduling	156
2.2.3.3.2.10	Maximum ADS-B Message Transmission Rates	157
2.2.3.3.2.11	ADS-B Data Subfield Timeout.....	157
2.2.3.3.2.12	ADS-B Message Termination	158
2.2.3.4	ADS-B Transmitted Message Error Protection	160
2.2.4	ADS-B RECEIVER CHARACTERISTICS	160
2.2.4.1	Minimum Triggering Level (MTL) Definition.....	160
2.2.4.2	Receivers Shared with a TCAS Unit	161
2.2.4.2.1	Dual Minimum Triggering Levels.....	161
2.2.4.2.1.1	TCAS Compatibility	161
2.2.4.2.1.2	ADS-B Compatibility	161
2.2.4.2.2	Re-Triggerable Reply Processor.....	162
2.2.4.3	Receivers Not Shared With TCAS	162
2.2.4.3.1	In-Band Acceptance and Re-Triggerable Capability	162
2.2.4.3.1.1	In-Band Acceptance	162
2.2.4.3.1.2	Re-Triggerable Capability	163
2.2.4.3.2	Out-of-Band Rejection	163
2.2.4.3.3	Dynamic Minimum Trigger Level (DMTL).....	163
2.2.4.3.4	1090 MHz ADS-B Message Reception Techniques	163
2.2.4.3.4.1	ADS-B Message Reception.....	163
2.2.4.3.4.2	Narrow Pulse Discrimination	164
2.2.4.3.4.3	TACAN and DME Discrimination.....	164
2.2.4.3.4.4	Pulse Characteristics of Received ADS-B Messages	164
2.2.4.3.4.5	Message Formats	164
2.2.4.3.4.6	Description of 1090 MHz ADS-B Message Received Signals.....	164

2.2.4.3.4.7	ADS-B Signal Reception.....	165
2.2.4.3.4.7.1	Criteria for ADS-B Message Transmission Pulse Detection.....	165
2.2.4.3.4.7.2	Criteria for Preamble Acceptance.....	165
2.2.4.3.4.7.3	Criteria for Data Block Acceptance in ADS-B Message Signals.....	165
2.2.4.3.5	ADS-B Receiver Duty Factor.....	166
2.2.4.4	Enhanced Squitter Reception Techniques.....	166
2.2.4.4.1	Need for Enhanced Techniques.....	166
2.2.4.4.2	Enhanced Squitter Reception Technique Overview.....	166
2.2.4.4.3	Error Correction.....	167
2.2.4.4.3.1	Error Correction Requirements.....	167
2.2.4.4.3.2	Error Correction Restrictions.....	167
2.2.4.5	ADS-B Received Message Error Protection.....	167
2.2.5	ADS-B TRANSMISSION DEVICE MESSAGE PROCESSOR CHARACTERISTICS.....	168
2.2.5.1	ADS-B Transmission Device Data Processing and Message Formatting.....	168
2.2.5.1.1	Participant Address.....	168
2.2.5.1.1.1	ICAO 24-Bit Discrete Address.....	168
2.2.5.1.1.2	Anonymous Address.....	168
2.2.5.1.1.3	Address Qualifier for Non-Transponder Devices.....	168
2.2.5.1.2	ADS-B Emitter Category Data.....	169
2.2.5.1.3	Air/Ground Status Data.....	169
2.2.5.1.4	Surveillance Status Data.....	169
2.2.5.1.5	Altitude Data.....	169
2.2.5.1.6	Time Data and Time Mark Pulse.....	171
2.2.5.1.6.1	Case, where TIME (“T”) = 0.....	171
2.2.5.1.6.2	Case, where TIME (“T”) = 1.....	171
2.2.5.1.7	Own Position Latitude Data.....	174
2.2.5.1.8	Own Position Longitude Data.....	174
2.2.5.1.9	Ground Speed Data.....	175
2.2.5.1.10	Heading/Ground Track Data.....	175
2.2.5.1.11	Aircraft Identification (or Registration) Data.....	176
2.2.5.1.12	East/West Velocity Data.....	177
2.2.5.1.13	North/South Velocity Data.....	177
2.2.5.1.14	Vertical Rate Data.....	178
2.2.5.1.15	Heading (True or Magnetic) Data.....	178
2.2.5.1.16	True Airspeed Data.....	179
2.2.5.1.17	Indicated Airspeed Data.....	179
2.2.5.1.18	Intent Change Data.....	179
2.2.5.1.19	NAC _V Data.....	180
2.2.5.1.20	Subtype (Aircraft Operational Status) Data.....	180
2.2.5.1.21	Capability Class (Reserved) Data.....	180
2.2.5.1.22	Capability Class (UAT IN) Data.....	180
2.2.5.1.23	Capability Class (1090ES IN) Data.....	181
2.2.5.1.24	Capability Class (ARV Report Capability) Data.....	181
2.2.5.1.25	Capability Class (TS Report Capability) Data.....	181
2.2.5.1.26	Capability Class (TC Report Capability) Data.....	181
2.2.5.1.27	Operational Mode (OM Format) Data.....	181
2.2.5.1.28	Operational Mode (Position Offset Applied by Sensor) (OM Format) Data.....	181
2.2.5.1.29	Operational Mode (TCAS/ACAS Resolution Advisory Active) Data.....	181
2.2.5.1.30	Operational Mode (IDENT Switch Active) Data.....	182
2.2.5.1.31	Operational Mode (Reserved for Receiving ATC Services) Data.....	182
2.2.5.1.32	Radio Altitude Data.....	182
2.2.5.1.33	ADS-B Version Number Data.....	182
2.2.5.1.34	Navigation Accuracy Category for Position (NAC _P) Data.....	182
2.2.5.1.35	Navigation Integrity Category for Barometric Altitude (NIC _{BARO}) Data.....	182
2.2.5.1.36	Navigation Integrity Category Supplement Data.....	183

2.2.5.1.37	A/V Length/Width Code Data	183
2.2.5.1.38	Track Angle/Heading Data	183
2.2.5.1.39	Horizontal Reference Direction (HRD) Data	183
2.2.5.1.40	Source Integrity Level (SIL) Data	183
2.2.5.1.41	SIL Supplement Data	183
2.2.5.1.42	MCP/FCU Selected Altitude or FMS Selected Altitude Data	184
2.2.5.1.43	Barometric Pressure Setting (Minus 800 millibars) Data	184
2.2.5.1.44	Selected Heading Data	184
2.2.5.1.45	MCP / FCU Mode Bits Data	185
2.2.5.1.46	Emergency/Priority Status Data	185
2.2.5.1.47	Mode A (4096) Code	185
2.2.5.1.48	TCAS Operational Data	186
2.2.5.1.49	Single Antenna Flag Data	186
2.2.5.1.50	System Design Assurance (SDA) Data	186
2.2.5.1.51	GNSS Vertical Figure of Merit (VFOM) Data	186
2.2.5.1.52	GPS Antenna Offset Data	186
2.2.5.1.53	UTC HRs:Min:Sec Data	186
2.2.5.1.54	UTC Fine Seconds Data	187
2.2.5.2	ADS-B Transmission Device Message Latency	187
2.2.5.2.1	Airborne Position Message Latency	187
2.2.5.2.2	Surface Position Message Latency	188
2.2.5.2.3	Aircraft Identification Message Latency	188
2.2.5.2.4	Airborne Velocity Message - Subtype=1 Latency	189
2.2.5.2.5	Airborne Velocity Message - Subtype=2 Latency	189
2.2.5.2.6	Airborne Velocity Message - Subtype=3 Latency	190
2.2.5.2.7	Airborne Velocity Message - Subtype=4 Latency	190
2.2.5.2.8	Airborne Velocity Message - Subtype “5” Latency	190
2.2.5.2.9	Airborne Velocity Message - Subtype “6” Latency	190
2.2.5.2.10	Airborne Velocity Message - Subtype “7” Latency	191
2.2.5.2.11	Target State and Status Message Latency	191
2.2.5.2.12	Aircraft Operational Status Message Latency	191
2.2.5.2.13	TYPE 23 TEST Message Latency	192
2.2.5.2.14	TYPE 24 Message Latency	192
2.2.5.2.15	TYPE 25 Message Latency	192
2.2.5.2.16	TYPE 26 Message Latency	192
2.2.5.2.17	TYPE 27 Message Latency	192
2.2.5.2.18	Aircraft Status Message – Subtype=1 Latency	193
2.2.5.2.19	Aircraft Status Message – Subtype=2 Latency	193
2.2.5.3	ADS-B Transmission Device Source Selection	194
2.2.6	ADS-B RECEIVING DEVICE MESSAGE PROCESSOR CHARACTERISTICS	194
2.2.6.1	ADS-B Message Reception Function Requirements	195
2.2.6.1.1	ADS-B Message Reception Function Output Message Structure Requirements	196
2.2.6.1.2	ADS-B and TIS-B Message Reception Function Output Message Delivery Requirements	196
2.2.7	ADS-B MESSAGE PROCESSOR CHARACTERISTICS	197
2.2.7.1	ADS-B Receiving Device Message Reception	197
2.2.7.1.1	Receipt of TYPE Code Equal to ZERO	197
2.2.8	ADS-B REPORT CHARACTERISTICS	197
2.2.8.1	ADS-B State Vector Report Characteristics	197
2.2.8.1.1	State Vector Report Type and Structure Identification and Validity Flags	202
2.2.8.1.1.1	State Vector Report Type and Structure Identification	202
2.2.8.1.1.2	State Vector Report Validity Flags	204
2.2.8.1.2	Participant Address	205
2.2.8.1.3	Address Qualifier	206
2.2.8.1.4	Report Time of Applicability	206
2.2.8.1.4.1	Time of Applicability for Estimated Position/Velocity	207

2.2.8.1.4.2	Position Time of Applicability	207
2.2.8.1.4.2.1	Position Time of Applicability when “TIME” (T)=0	207
2.2.8.1.4.2.2	Position Time of Applicability when “TIME” (T)=1 and UTC Time of Message Receipt is Available.....	207
2.2.8.1.4.2.3	Position Time of Applicability when “TIME” (T)=1 and UTC Time of Message Receipt is NOT Available	208
2.2.8.1.4.3	Velocity Time of Applicability.....	208
2.2.8.1.5	Latitude (WGS-84).....	208
2.2.8.1.6	Longitude (WGS-84).....	209
2.2.8.1.7	Altitude, Geometric (WGS-84)	209
2.2.8.1.8	North/South Velocity.....	210
2.2.8.1.9	East/West Velocity	210
2.2.8.1.10	Ground Speed While on the Surface	210
2.2.8.1.11	Heading While on the Surface.....	211
2.2.8.1.12	Altitude, Barometric (Pressure Altitude).....	211
2.2.8.1.13	Vertical Rate, Geometric/Barometric	212
2.2.8.1.14	Vertical Rate, Geometric (WGS-84)	212
2.2.8.1.15	Barometric Altitude Rate.....	212
2.2.8.1.16	Navigation Integrity Category (NIC)	213
2.2.8.1.17	Estimated Latitude (WGS-84).....	214
2.2.8.1.18	Estimated Longitude (WGS-84).....	215
2.2.8.1.19	Estimated North/South Velocity.....	216
2.2.8.1.20	Estimated East/West Velocity	217
2.2.8.1.21	Surveillance Status / Discretes	219
2.2.8.1.22	Report Mode.....	219
2.2.8.2	ADS-B Mode Status Report Characteristics.....	219
2.2.8.2.1	Mode Status Report Type and Structure Identification and Validity Flags.....	223
2.2.8.2.1.1	Mode Status Report Type and Structure Identification	223
2.2.8.2.1.2	Mode Status Report Validity Flags	224
2.2.8.2.2	Participant Address.....	225
2.2.8.2.3	Address Qualifier.....	226
2.2.8.2.4	Report Time of Applicability	226
2.2.8.2.5	ADS-B Version Number	226
2.2.8.2.6	Call Sign	226
2.2.8.2.7	Emitter Category.....	227
2.2.8.2.8	Aircraft/Vehicle (A/V) Length and Width Code.....	227
2.2.8.2.9	Emergency / Priority Status	228
2.2.8.2.10	Capability Class Codes	228
2.2.8.2.11	Operational Mode.....	229
2.2.8.2.12	SV Quality – NAC _P	230
2.2.8.2.13	SV Quality – NAC _V	230
2.2.8.2.14	SV Quality – SIL, SIL Supplement, SDA	230
2.2.8.2.14.1	SV Quality – Source Integrity Level (SIL)	230
2.2.8.2.14.2	SV Quality – SIL Supplement.....	231
2.2.8.2.14.3	SV Quality – System Design Assurance (SDA).....	231
2.2.8.2.15	SV Quality – GVA	231
2.2.8.2.16	SV Quality – NIC _{BARO}	231
2.2.8.2.17	Track/Heading and Horizontal Reference Direction (HRD)	231
2.2.8.2.18	Vertical Rate Type.....	232
2.2.8.2.19	(Reserved for) Flight Mode Specific Data.....	232
2.2.8.3	ADS-B On-Condition Report Characteristics	232
2.2.8.3.1	ADS-B Target State Report.....	232
2.2.8.3.1.1	Report Type and Structure Identification	236
2.2.8.3.1.2	Target State and Status Validity Flags.....	237
2.2.8.3.1.3	Participant Address.....	238

2.2.8.3.1.4	Address Qualifier.....	238
2.2.8.3.1.5	Report Time of Applicability	238
2.2.8.3.1.6	Selected Altitude: Selected Altitude Type.....	238
2.2.8.3.1.7	Selected Altitude: MCP/FCU Selected Altitude or FMS Selected Altitude	238
2.2.8.3.1.8	Barometric Pressure Setting (Minus 800 millibars)	238
2.2.8.3.1.9	Selected Heading	238
2.2.8.3.1.10	Mode Indicators: Autopilot Engaged	238
2.2.8.3.1.11	Mode Indicators: VNAV Mode Engaged.....	239
2.2.8.3.1.12	Mode Indicators: Altitude Hold Mode	239
2.2.8.3.1.13	Mode Indicators: Approach Mode.....	239
2.2.8.3.1.14	Mode Indicators: LNAV Mode Engaged	239
2.2.8.3.1.15	Reserved	239
2.2.8.3.2	Air Referenced Velocity (ARV) Report	239
2.2.8.3.2.1	Report Type and Structure Identification and Validity Flags.....	241
2.2.8.3.2.1.1	Report Type and Structure Identification	241
2.2.8.3.2.1.2	ARV Report Validity Flags	242
2.2.8.3.2.2	Participant Address.....	242
2.2.8.3.2.3	Address Qualifier.....	242
2.2.8.3.2.4	Report Time of Applicability	243
2.2.8.3.2.5	Airspeed.....	243
2.2.8.3.2.6	Airspeed Type	243
2.2.8.3.2.7	Heading While Airborne	244
2.2.8.4	Processing of Reserved Message TYPE Codes.....	244
2.2.8.5	Receiving Installation Time Processing	244
2.2.8.5.1	Precision Installations.....	244
2.2.8.5.2	Non-Precision Installations	245
2.2.9	ADS-B REPORT TYPE REQUIREMENTS.....	245
2.2.9.1	ADS-B Receiver Reporting Requirements for Class A Equipage.....	245
2.2.9.1.1	ADS-B State Vector Reports for Class A Equipage.....	249
2.2.9.1.2	ADS-B Mode Status Reports for Class A Equipage	249
2.2.9.1.3	ADS-B Target State Reports for Class A Equipage	250
2.2.9.1.4	ADS-B Air Referenced Velocity Reports for Class A Equipage	250
2.2.9.2	ADS-B Receiver Report Content Requirements for Class B Equipage	250
2.2.10	ADS-B RECEIVER REPORT ASSEMBLY AND DELIVERY	250
2.2.10.1	Fundamental Principals of Report Assembly and Delivery.....	250
2.2.10.1.1	General Data Flow.....	250
2.2.10.1.2	ADS-B Report Organization	255
2.2.10.1.3	ADS-B Message Temporary Retention	255
2.2.10.1.4	Participant ADS-B Track Files.....	255
2.2.10.2	Report Assembly Initialization State	256
2.2.10.3	Report Assembly Acquisition State.....	256
2.2.10.3.1	Report Assembly Acquisition State --- Airborne Participant	256
2.2.10.3.1.1	Latency, Report Assembly Acquisition State --- Airborne Participant	257
2.2.10.3.2	Report Assembly Acquisition State --- Surface Participant	257
2.2.10.3.2.1	Latency, Report Assembly Acquisition State --- Surface Participant.....	258
2.2.10.3.3	Acquisition State Data Retention.....	258
2.2.10.4	Report Assembly Track State	259
2.2.10.4.1	Report Assembly Track State --- Airborne Participant	259
2.2.10.4.1.1	Report Assembly Track State Initialization --- Airborne Participant	259
2.2.10.4.1.2	Report Assembly Track State Maintenance --- Airborne Participant	260
2.2.10.4.1.3	Report Assembly Track State Termination --- Airborne Participant.....	262
2.2.10.4.2	Report Assembly Track State --- Surface Participant.....	262
2.2.10.4.2.1	Report Assembly Track State Initialization --- Surface Participant	262
2.2.10.4.2.2	Report Assembly Track State Maintenance --- Surface Participant	263
2.2.10.4.2.3	Report Assembly Track State Termination --- Surface Participant	264

2.2.10.5	Minimum Number of Participant Track Files.....	264
2.2.10.6	Reasonableness Tests for CPR Decoding of Received Position Messages	265
2.2.10.6.1	Reasonableness Test Overview	265
2.2.10.6.2	Reasonableness Test Applied to Positions Determined from Globally Unambiguous CPR Decoding.....	265
2.2.10.6.3	Reasonableness Test Applied to Positions Determined from Locally Unambiguous CPR Decoding.....	266
2.2.10.7	Duplicate Address Processing	267
2.2.10.7.1	Candidate Duplicate Address Report	267
2.2.10.7.2	Duplicate Address Condition.....	268
2.2.10.7.3	Duplicate Address Report Capacity.....	269
2.2.11	SELF TEST AND MONITORS.....	269
2.2.11.1	Self Test.....	269
2.2.11.2	Broadcast Monitoring	269
2.2.11.2.1	Transponder-Based Equipment	269
2.2.11.2.2	Non-Transponder-Based Equipment	270
2.2.11.3	Address Verification.....	270
2.2.11.3.1	Transponder-Based Equipment	270
2.2.11.3.2	Non-Transponder-Based Equipment	270
2.2.11.4	Receiver Self Test Capability	270
2.2.11.5	Device Failure Annunciation.....	270
2.2.11.5.1	ADS-B Transmission Device Failure Annunciation	270
2.2.11.5.2	ADS-B Receiving Device Failure Annunciation.....	270
2.2.11.6	ADS-B Function Fail Annunciation	271
2.2.12	RESPONSE TO MUTUAL SUPPRESSION PULSES	271
2.2.12.1	ADS-B Transmitting Subsystem Response to Mutual Suppression Pulses.....	271
2.2.12.2	ADS-B Receiving Device Response to Mutual Suppression Pulses	271
2.2.13	ANTENNA SYSTEM	272
2.2.13.1	Transmit Pattern Gain.....	272
2.2.13.2	Receiver Pattern Gain.....	272
2.2.13.3	Frequency Requirements for Transmit and Receive Antenna(s).....	272
2.2.13.4	Impedance and VSWR	272
2.2.13.5	Polarization.....	272
2.2.13.6	Diversity Operation	272
2.2.13.6.1	Transmitting Diversity.....	272
2.2.13.6.1.1	Transmitting Diversity Channel Isolation	273
2.2.13.6.2	Receiving Diversity	273
2.2.14	INTERFACES.....	276
2.2.14.1	ADS-B Transmitting Subsystem Interfaces.....	276
2.2.14.1.1	ADS-B Transmitting Subsystem Input Interfaces	276
2.2.14.1.1.1	Discrete Input Interfaces.....	276
2.2.14.1.1.2	Digital Communication Input Interfaces	276
2.2.14.1.1.3	Processing Efficiency	276
2.2.14.1.2	ADS-B Transmitting Subsystem Output Interfaces.....	276
2.2.14.1.2.1	Discrete Output Interfaces.....	276
2.2.14.1.2.2	Digital Communication Output Interfaces.....	276
2.2.14.2	ADS-B Receiving Device Interfaces.....	277
2.2.14.2.1	ADS-B Receiving Device Input Interfaces.....	277
2.2.14.2.1.1	Discrete Input Interfaces.....	277
2.2.14.2.1.2	Digital Communication Input Interfaces	277
2.2.14.2.1.3	Processing Efficiency	277
2.2.14.2.2	ADS-B Receiving Device Output Interfaces	277
2.2.14.2.2.1	Discrete Output Interfaces.....	277
2.2.14.2.2.2	Digital Communication Output Interfaces.....	277
2.2.15	POWER INTERRUPTION	277
2.2.16	COMPATIBILITY WITH OTHER SYSTEMS	278
2.2.16.1	EMI Compatibility.....	278

2.2.16.2	Compatibility with GPS Receivers.....	278
2.2.16.3	Compatibility with Other Navigation Receivers and ATC Transponders	278
2.2.17	TRAFFIC INFORMATION SERVICES – BROADCAST (TIS-B)	278
2.2.17.1	Introduction	278
2.2.17.2	TIS-B Format Structure	279
2.2.17.2.1	“DF” Downlink Format.....	280
2.2.17.2.2	“CF” Control Field	280
2.2.17.2.3	“AA” Address Announced Field.....	280
2.2.17.2.4	“ME” Message Extended Squitter Field.....	280
2.2.17.2.5	“PI” Parity/Identity Field.....	280
2.2.17.3	TIS-B Messages.....	280
2.2.17.3.1	TIS-B Fine Airborne Position Message.....	280
2.2.17.3.1.1	Relationship to ADS-B Format	281
2.2.17.3.1.2	ICAO/Mode A Flag (IMF)	281
2.2.17.3.2	TIS-B Fine Surface Position Message.....	281
2.2.17.3.2.1	Relationship to ADS-B Format	282
2.2.17.3.2.2	ICAO/Mode A Flag (IMF)	282
2.2.17.3.3	TIS-B Identification and Category Message	282
2.2.17.3.3.1	Relationship to ADS-B Format	282
2.2.17.3.4	TIS-B Velocity Message	283
2.2.17.3.4.1	Relationship to ADS-B Format	285
2.2.17.3.4.2	ICAO/Mode A Flag (IMF)	285
2.2.17.3.4.3	Navigation Integrity Code (NIC) Supplement-A	285
2.2.17.3.4.4	Navigation Accuracy Category for Position (NAC _P).....	285
2.2.17.3.4.5	Navigation Accuracy Category for Velocity (NAC _V).....	285
2.2.17.3.4.6	Source Integrity Level (SIL)	285
2.2.17.3.4.7	True/Magnetic Heading Type.....	285
2.2.17.3.5	TIS-B Coarse Position Message	286
2.2.17.3.5.1	Relationship to ADS-B Format	286
2.2.17.3.5.2	ICAO/Mode A Flag (IMF)	286
2.2.17.3.5.3	Service Volume ID (SVID)	286
2.2.17.3.5.4	Pressure Altitude	286
2.2.17.3.5.5	Ground Track Status.....	287
2.2.17.3.5.6	Ground Track Angle.....	287
2.2.17.3.5.7	Ground Speed.....	287
2.2.17.3.5.8	Encoded Latitude and Longitude.....	287
2.2.17.4	TIS-B Message Processing and Report Generation.....	288
2.2.17.4.1	TIS-B Message-to-Track Correlation.....	288
2.2.17.4.1.1	TIS-B Messages Having a ICAO 24-Bit Address	288
2.2.17.4.1.2	TIS-B Messages Having Mode A Code and Track Number	288
2.2.17.4.2	TIS-B Position Message Decoding.....	288
2.2.17.4.3	TIS-B Track Update	289
2.2.17.4.4	TIS-B Track Initiation	289
2.2.17.4.5	TIS-B Track Drop.....	290
2.2.17.4.6	TIS-B Report Generation	290
2.2.18	ADS-B REBROADCAST SERVICE – FORMATS AND CODING	291
2.2.18.1	Introduction	291
2.2.18.2	ADS-B Rebroadcast Format Definition.....	291
2.2.18.3	Control Field Allocation.....	291
2.2.18.4	ADS-R Message Processing.....	292
2.2.18.4.1	ADS-R Airborne Position Messages	292
2.2.18.4.2	ADS-R Surface Position Messages	293
2.2.18.4.3	ADS-R Aircraft Identification and Category Messages	294
2.2.18.4.4	ADS-R Airborne Velocity Messages	294
2.2.18.4.5	ADS-R Aircraft Emergency/Priority Status Messages	296

2.2.18.4.6	ADS-R Target State and Status Messages.....	296
2.2.18.4.7	ADS-R Aircraft Operational Status Messages	297
2.2.18.5	ADS-R Report Processing.....	299
2.3	EQUIPMENT PERFORMANCE - ENVIRONMENTAL CONDITIONS.....	299
2.3.1	ENVIRONMENTAL TEST CONDITIONS.....	300
2.3.2	DETAILED ENVIRONMENTAL TEST PROCEDURES	303
2.3.2.1	Transponder-Based Transmitters (§2.2.2.1).....	303
2.3.2.2	Stand Alone (Non-Transponder-Based) Transmitters (§2.2.2.2)	303
2.3.2.2.1	Frequency (§2.2.2.2.1)	304
2.3.2.2.2	Pulse Shapes (§2.2.2.2.4)	304
2.3.2.2.3	Pulse Interval (§2.2.2.2.6)	305
2.3.2.2.4	Preamble (§2.2.2.2.7)	305
2.3.2.2.5	Data Pulses (§2.2.2.2.8).....	306
2.3.2.2.6	RF Peak Output Power (§2.2.2.2.10)	306
2.3.2.2.6.1	Class A0 Equipment RF Peak Output Power (§2.2.2.2.10.1).....	306
2.3.2.2.6.2	Class B Equipment RF Peak Output Power (§2.2.2.2.10.2).....	306
2.3.2.2.7	Transmission Rates for Transponder - Based Transmitters (§2.2.3.3.1)	307
2.3.2.2.7.1	Transmission Rates Compliant with RTCA DO-181E (§2.2.3.3.1.1)	307
2.3.2.2.7.2	Transmission Rates Not Specified in RTCA DO-181E (§2.2.3.3.1.2) (EUROCAE ED-73E)	307
2.3.2.2.7.3	Maximum Transmission Rates for Transponder-Based Transmitters (§2.2.3.3.1.3).....	307
2.3.2.2.8	Transmission Rates for Stand Alone Transmitters (§2.2.3.3.1.4).....	307
2.3.2.2.8.1	Power-On Initialization (§2.2.3.3.2.1.1).....	308
2.3.2.2.8.2	ADS-B Airborne Position Message Broadcast Rate (§2.2.3.3.2.2).....	309
2.3.2.2.8.3	ADS-B Surface Position Message Broadcast Rate (§2.2.3.3.2.3)	309
2.3.2.2.8.4	ADS-B Aircraft Identification and Category Message Broadcast Rate (§2.2.3.3.2.4).....	310
2.3.2.2.8.5	ADS-B Velocity Information Message Broadcast Rate (§2.2.3.3.2.5).....	310
2.3.2.2.8.6	Target State and Status Message Broadcast Rates (§2.2.3.3.2.6.1).....	311
2.3.2.2.8.7	ADS-B Aircraft Operational Status Message Broadcast Rates (§2.2.3.3.2.6.2).....	311
2.3.2.2.8.8	“Extended Squitter Aircraft Status” Message Broadcast Rates (§2.2.3.3.2.7)	312
2.3.2.2.8.8.1	Emergency/Priority Status Message Broadcast Rates (§2.2.3.3.2.7).....	312
2.3.2.2.8.8.2	1090ES TCAS RA Message Broadcast Rates (§2.2.3.3.2.7)	312
2.3.2.2.8.9	“TYPE 23 (TEST)” ADS-B Message Broadcast Rate (§2.2.3.3.2.8).....	312
2.3.2.2.8.10	Maximum ADS-B Message Transmission Rates (§2.2.3.3.2.10).....	313
2.3.2.3	Receivers Shared with a TCAS Unit (§2.2.4.2)	313
2.3.2.3.1	TCAS Compatibility (§2.2.4.2.1.1)	313
2.3.2.3.2	Re-Triggerable Reply Processor (§2.2.4.2.2).....	314
2.3.2.3.3	Verification of Enhanced Squitter Reception Techniques (§2.2.4.4).....	316
2.3.2.3.3.1	Combined Preamble and Data Block Tests with A/C Fruit.....	316
2.3.2.3.3.2	Data Block Tests with Mode S Fruit	316
2.3.2.3.3.3	Re-Triggering Performance.....	316
2.3.2.4	Receivers Not Shared With TCAS (§2.2.4.3)	316
2.3.2.4.1	In-Band Acceptance (§2.2.4.3.1.1.a).....	316
2.3.2.4.2	Dynamic Range (§2.2.4.3.1.1.b).....	317
2.3.2.4.3	Re-Triggerable Capability (§2.2.4.3.1.2)	318
2.3.2.4.4	Out-of-Band Rejection (§2.2.4.3.2).....	320
2.3.2.4.5	Dynamic Minimum Trigger Level (DMTL) (§2.2.4.3.3).....	321
2.3.2.4.6	Criteria for ADS-B Message Transmission Pulse Detection (§2.2.4.3.4.7.1 and §2.2.4.3.4.7.2)	325
2.3.2.4.6.1	Criteria for ADS-B Message Transmission Pulse Detection for Receivers not using Enhanced Reception Techniques	325
2.3.2.4.6.2	Criteria for ADS-B Message Transmission Pulse Detection for Receivers using Enhanced Reception Techniques	327
2.3.2.4.7	Criteria for Data Block Acceptance in ADS-B Message Signals (§2.2.4.3.4.7.3)	330
2.3.2.4.8	Verification of Enhanced Squitter Reception Techniques (§2.2.4.4).....	332
2.3.2.4.8.1	Combined Preamble and Data Block Tests with A/C Fruit (§2.4.4.4.2.4)	332
2.3.2.4.8.2	Data Block Tests with Mode S Fruit (§2.4.4.4.2.5).....	334

2.3.2.4.8.3	Re-Triggering Performance (§2.4.4.4.2.6)	336
2.3.2.4.9	Track File Maintenance (§2.2.8 through §2.2.10)	338
2.3.2.5	Self Test and Monitors (§2.2.11)	342
2.3.2.5.1	Transponder-Based Equipment Address (§2.2.11.3.1)	342
2.3.2.5.2	Non-Transponder-Based Equipment (§2.2.11.3.2)	342
2.3.2.6	Response to Mutual Suppression Pulses (§2.2.12)	343
2.3.2.6.1	Transmitting Device Response to Mutual Suppression Pulses (§2.2.12.1)	343
2.3.2.6.2	Receiving Device Response to Mutual Suppression Pulses (§2.2.12.2)	344
2.3.2.7	Diversity Operation (§2.2.13.6)	344
2.3.2.7.1	Transmitting Diversity (§2.2.13.6.1)	344
2.3.2.7.2	Receiving Diversity (§2.2.13.6.2)	345
2.3.2.7.2.1	Full Receiver and Message Processing or Receiver Switching Front-End Diversity (§2.2.13.6.2)	345
2.3.2.7.2.2	Receiving Antenna Switching Diversity (§2.2.13.6.2)	347
2.3.2.8	Power Interruption (§2.2.15)	348
2.3.2.8.1	Power Interruption to ADS-B Transmitting Subsystems (§2.2.15)	348
2.3.2.8.2	Power Interruption to ADS-B Receiving Subsystems (§2.2.15)	349
2.3.2.9	Verification of Traffic Information Services – Broadcast (TIS-B) (§2.2.17)	350
2.3.2.9.1	Verification of TIS-B Report Generation (§2.2.17.4.6)	350
2.4	EQUIPMENT TEST PROCEDURES	351
2.4.1	DEFINITION OF TERMS AND CONDITIONS OF TEST	351
2.4.2	VERIFICATION OF ADS-B TRANSMITTER CHARACTERISTICS (§2.2.2)	352
2.4.2.1	Mode S Transponder-Based Transmitters (§2.2.2.1)	352
2.4.2.1.1	Verification of RF Peak Output Power (minimum) (§2.2.2.1.1)	352
2.4.2.1.1.1	Verification of Class A0 ADS-B Transponder-Based Transmitter Power (§2.2.2.1.1.1)	353
2.4.2.1.1.2	Verification of Class A1S and A1 ADS-B Transponder-Based Transmitter Power (§2.2.2.1.1.2)	353
2.4.2.1.1.3	Verification of Class A2 ADS-B Transponder-Based Transmitter Power (§2.2.2.1.1.3)	353
2.4.2.1.1.4	Verification of Class A3 ADS-B Transponder-Based Transmitter Power (§2.2.2.1.1.4)	353
2.4.2.1.1.5	Verification of Class B ADS-B Transponder-Based Transmitter Power (§2.2.2.1.1.5)	353
2.4.2.1.2	Verification of RF Peak Output Power (maximum) (§2.2.2.1.2)	353
2.4.2.2	Verification of Stand Alone Transmitters (§2.2.2.2)	353
2.4.2.2.1	Verification of Transmission Frequency (§2.2.2.2.1)	354
2.4.2.2.2	Verification of Transmission Spectrum (§2.2.2.2.2)	354
2.4.2.2.3	Verification of Modulation (§2.2.2.2.3)	354
2.4.2.2.4	Verification of Pulse Shapes (§2.2.2.2.4)	354
2.4.2.2.5	Verification of Message Structure (§2.2.2.2.5)	354
2.4.2.2.6	Verification of Pulse Intervals (§2.2.2.2.6)	354
2.4.2.2.7	Verification of Preamble (§2.2.2.2.7)	354
2.4.2.2.8	Verification of Data Pulses (§2.2.2.2.8)	355
2.4.2.2.9	Verification of Pulse Amplitude (§2.2.2.2.9)	355
2.4.2.2.10	Verification of RF Peak Output Power (§2.2.2.2.10)	355
2.4.2.2.10.1	Verification of Class A0 Equipment RF Peak Output Power (§2.2.2.2.10.1)	355
2.4.2.2.10.2	Verification of Class B Equipment RF Peak Output Power (§2.2.2.2.10.2)	355
2.4.2.2.10.3	Verification of RF Peak Output Power (maximum) (§2.2.2.2.10.3)	356
2.4.2.2.11	Verification of Unwanted Output Power (§2.2.2.2.11)	356
2.4.2.2.12	Verification of Broadcast Rate Capability (§2.2.2.2.12)	356
2.4.3	VERIFICATION OF BROADCAST MESSAGE CHARACTERISTICS (§2.2.3)	357
2.4.3.1	Verification of ADS-B Message Characteristics (§2.2.3.1)	357
2.4.3.1.1	Verification of ADS-B Message Preamble (§2.2.3.1.1)	357
2.4.3.1.2	Verification of ADS-B Message Data Pulses (§2.2.3.1.2)	357
2.4.3.1.3	Verification of ADS-B Message Pulse Shape (§2.2.3.1.3)	358
2.4.3.1.4	Verification of ADS-B Message Pulse Spacing (§2.2.3.1.4)	359
2.4.3.2	Verification of ADS-B and TIS-B Message Baseline Format and Structures (§2.2.3.2)	359
2.4.3.2.1	Verification of ADS-B Message Baseline Field Descriptions (§2.2.3.2.1)	359
2.4.3.2.1.1	Verification of “DF” Downlink Format Field (§2.2.3.2.1.1)	359
2.4.3.2.1.2	Verification of “CA” Capability Field (used in DF=17) (§2.2.3.2.1.2, §2.2.5.1.3)	359

2.4.3.2.1.2.1	Verification of On the Ground Determination (§2.2.3.2.1.2, §2.2.5.1.2, §2.2.5.1.3)	360
2.4.3.2.1.2.2	Verification of Air/Ground Format Selection (§2.2.3.2.1.2, §2.2.5.1.3)	362
2.4.3.2.1.3	Verification of the “CF” Field (used in DF=18) (§2.2.3.2.1.3)	364
2.4.3.2.1.4	Verification of the “AF” Field (used in DF=19) (§2.2.3.2.1.4)	364
2.4.3.2.1.5	Verification of “AA” Address Field, Announced (§2.2.3.2.1.1, §2.2.5.1.1)	365
2.4.3.2.1.6	Verification of “ME” Message, Extended Squitter (§2.2.3.2.1.6)	365
2.4.3.2.1.7	Verification of “PI” Parity / Identity (§2.2.3.2.1.7, §2.2.5.1.1)	365
2.4.3.2.2	Verification of the Determination of ADS-B and TIS-B Message Types (§2.2.3.2.2)	367
2.4.3.2.3	Verification of ADS-B Airborne Position Messages (§2.2.3.2.3)	368
2.4.3.2.3.1	Verification of “TYPE” Subfield in ADS-B Airborne Position Messages (§2.2.3.2.3.1)	368
2.4.3.2.3.1.1	Verification of Airborne Position Message TYPE Code if Radius of Containment is Available (§2.2.3.2.3.1.1)	370
2.4.3.2.3.1.2	Verification of Airborne Position Message TYPE Code if Radius of Containment is Not Available (§2.2.3.2.3.1.2)	370
2.4.3.2.3.1.3	Verification of Special Processing for TYPE Code ZERO (§2.2.3.2.3.1.3)	370
2.4.3.2.3.1.3.1	Verification of Significance of TYPE Code Equal to ZERO (§2.2.3.2.3.1.3.1)	370
2.4.3.2.3.1.3.2	Verification of Broadcast of TYPE Code Equal to ZERO (§2.2.3.2.3.1.3.2)	371
2.4.3.2.3.1.4	Verification of TYPE Code based on Horizontal Position and Altitude Data (§2.2.3.2.3.1.4)	371
2.4.3.2.3.1.5	Verification of TYPE Code During FDE Conditions While Airborne (§2.2.3.2.3.1.5)	371
2.4.3.2.3.2	Verification of “Surveillance Status” Subfield in ADS-B Airborne Position Messages (§2.2.3.2.3.2, §2.2.5.1.4)	373
2.4.3.2.3.3	Verification of “NIC Supplement-B” Subfield in ADS-B Airborne Position Messages (§2.2.3.2.3.3)	374
2.4.3.2.3.4	Verification of “Altitude” Subfield in ADS-B Airborne Position Messages (§2.2.3.2.3.4)	374
2.4.3.2.3.4.1	Verification of “Barometric Altitude” in ADS-B Airborne Position Messages (§2.2.3.2.3.4.1, §2.2.5.1.5)	374
2.4.3.2.3.4.2	Verification of “GNSS Height Above the Ellipsoid (HAE)” in ADS-B Airborne Position Messages (§2.2.3.2.3.4.2)	376
2.4.3.2.3.4.3	Verification of “Altitude Encoding” in ADS-B Airborne Position Messages (§2.2.3.2.3.4.3)	376
2.4.3.2.3.5	Verification of “TIME” (T) Subfield in ADS-B Airborne Position Messages (§2.2.3.2.3.5, §2.2.5.1.6, §2.2.5.1.6.1, §2.2.5.1.6.2)	377
2.4.3.2.3.6	Verification of “CPR Format” (F) Subfield in ADS-B Airborne Position Messages (§2.2.3.2.3.6)	377
2.4.3.2.3.7	Verification of “CPR Encoded Latitude” Subfield in ADS-B Airborne Position Messages (§2.2.3.2.3.6, §2.2.3.2.3.7, §2.2.5.1.7, §2.2.5.1.13, Appendix A.1.7)	377
2.4.3.2.3.7.1	Verification of Airborne Latitude and Longitude Data Encoding (§2.2.3.2.3.6, §2.2.3.2.3.7, §2.2.3.2.3.7.1, §2.2.3.2.3.8, §2.2.3.2.3.8.1, §2.2.5.1.7, §2.2.5.1.8, §2.2.5.1.12, §2.2.5.1.13, Appendix A.1.7)	377
2.4.3.2.3.7.2	Verification of GPS/GNSS Time mark Coupled Case (“TIME” (T)=“1”) (§2.2.3.2.3.7.2, §2.2.5.1.6.2, §2.2.5.1.53, §2.2.5.1.54)	383
2.4.3.2.3.7.3	Verification of Non-GPS/GNSS Time Mark Coupled Case (“TIME” (T) = “0”) (§2.2.3.2.3.7.3)	388
2.4.3.2.3.7.4	Verification of Airborne Latitude Position Data Retention (§2.2.3.2.3.7.4)	393
2.4.3.2.3.8	Verification of “CPR Encoded Longitude” Subfield in ADS-B Airborne Position Messages (§2.2.3.2.3.6, §2.2.3.2.3.8, §2.2.5.1.8, §2.2.5.1.12)	393
2.4.3.2.3.8.1	Verification of Airborne Longitude Data Encoding (§2.2.3.2.3.8.1, §2.2.5.1.8, §2.2.5.1.12)	393
2.4.3.2.3.8.2	Verification of GPS/GNSS Time Mark Coupled Case (“TIME” (T)=“1”) (§2.2.3.2.3.8.2)	394
2.4.3.2.3.8.3	Verification of Non-GPS/GNSS Time Mark Coupled Case (“TIME” (T)=“0”) (§2.2.3.2.3.8.3)	397
2.4.3.2.3.8.4	Verification of Airborne Longitude Position Data Retention (§2.2.3.2.3.8.4)	401
2.4.3.2.4	Verification of ADS-B Surface Position Messages (§2.2.3.2.4)	401
2.4.3.2.4.1	Verification of “TYPE” Subfield in ADS-B Surface Position Messages (§2.2.3.2.4.1)	401
2.4.3.2.4.1.1	Verification of Surface Position Message TYPE Code if Containment Radius is Available (§2.2.3.2.4.1.1)	403
2.4.3.2.4.1.2	Verification of Surface Position Message TYPE Code if Containment Radius is Not Available (§2.2.3.2.4.1.2)	403
2.4.3.2.4.1.3	Verification of Special Processing for TYPE Code ZERO (§2.2.3.2.3.1.3, §2.2.3.2.4.1.3)	403
2.4.3.2.4.1.3.1	Verification of Significance of TYPE Code Equal to ZERO (§2.2.3.2.4.1.3.1)	403
2.4.3.2.4.1.3.2	Verification of Broadcast of TYPE Code Equal to ZERO (§2.2.3.2.4.1.3.2)	404
2.4.3.2.4.1.4	Verification of TYPE Code based on Horizontal Protection Level (§2.2.3.2.4.1.4)	404

2.4.3.2.4.1.5	Verification of TYPE Code During FDE Conditions While on the Surface (§2.2.3.2.4.1.5)	404
2.4.3.2.4.2	Verification of “Movement” Subfield in ADS-B Surface Position Messages (§2.2.3.2.4.2).....	407
2.4.3.2.4.3	Verification of “Status Bit for Heading/Ground Track” Subfield in ADS-B Surface Position Messages (§2.2.3.2.4.3, §2.2.5.1.10).....	408
2.4.3.2.4.4	Verification of “Heading/Ground Track” Subfield in ADS-B Surface Position Messages (§2.2.3.2.4.4, §2.2.5.1.10)	409
2.4.3.2.4.5	Verification of “TIME” (T) Subfield in ADS-B Surface Position Messages (§2.2.3.2.4.5, §2.2.5.1.6) ..	410
2.4.3.2.4.6	Verification of “CPR Format” (F) Subfield in ADS-B Surface Position Messages (§2.2.3.2.4.6)	410
2.4.3.2.4.7	Verification of “CPR Encoded Latitude” Subfield in ADS-B Surface Position Messages (§2.2.3.2.4.6, §2.2.3.2.4.7, §2.2.5.1.7, §2.2.5.1.13, Appendix A.1.7)	410
2.4.3.2.4.7.1	Verification of Latitude Transition Points and Encoding (§2.2.3.2.4.6, §2.2.3.2.4.7, §2.2.3.2.4.7.1, §2.2.5.1.7, §2.2.5.1.13, Appendix A.1.7)	410
2.4.3.2.4.7.1.1	Verification of Latitude Transition Points (§2.2.3.2.4.6, §2.2.3.2.4.7, §2.2.3.2.4.7.1, §2.2.5.1.7, §2.2.5.1.13, Appendix A.1.7)	410
2.4.3.2.4.7.1.2	Verification of Surface Latitude and Longitude Data Encoding (§2.2.3.2.4.6, §2.2.3.2.4.7, §2.2.3.2.4.7.1, §2.2.3.2.4.8, §2.2.3.2.4.8.1, §2.2.5.1.7, §2.2.5.1.8, §2.2.5.1.12, §2.2.5.1.13, Appendix §A.1.7)	414
2.4.3.2.4.7.2	Verification of GPS/GNSS Time Mark Coupled Case (“TIME” (T)=“1”) (§2.2.3.2.4.7.2, §2.2.5.1.6.2, §2.2.5.1.53, §2.2.5.1.54).....	419
2.4.3.2.4.7.3	Verification of Non-Coupled Case (Estimation, “TIME” (T) = “0”) (§, §2.2.5.1.7, §2.2.5.1.13)	424
2.4.3.2.4.7.4	Verification of Surface Latitude Position Data Retention (§2.2.3.2.4.7.4, §2.2.5.1.7)	428
2.4.3.2.4.8	Verification of “CPR Encoded Longitude” Subfield in ADS-B Surface Position Messages (§2.2.3.2.4.6, §2.2.3.2.4.8, §2.2.5.1.6, §2.2.5.1.8, §2.2.5.1.13)	428
2.4.3.2.4.8.1	Verification of Surface Longitude Data Encoding (§2.2.3.2.4.8.1, §2.2.5.1.8, §2.2.5.1.13)	429
2.4.3.2.4.8.2	Verification of GPS/GNSS Time Mark Coupled Case (“TIME” (T)=“1”) (§2.2.3.2.4.8.2)	429
2.4.3.2.4.8.3	Verification of Non-GPS/GNSS Time Mark Coupled Case (Estimation, “TIME” (T) = “0”) (§2.2.3.2.4.8.3, §2.2.5.1.8, §2.2.5.1.13).....	432
2.4.3.2.4.8.4	Verification of Surface Longitude Position Data Retention (§2.2.3.2.4.8.4, §2.2.5.1.8)	436
2.4.3.2.5	Verification of ADS-B Aircraft Identification and Category Messages (§2.2.3.2.5)	436
2.4.3.2.5.1	Verification of “TYPE” Subfield in ADS-B Aircraft Identification and Category Message (§2.2.3.2.5.1) ..	436
2.4.3.2.5.2	Verification of “ADS-B Emitter Category” Subfield in ADS-B Aircraft Identification and Category Message (§2.2.3.2.5.2, §2.2.5.1.2).....	437
2.4.3.2.5.3	Verification of “Character” Subfield in ADS-B Aircraft Identification and Category Message (§2.2.3.2.5.3, §2.2.5.1.11).....	437
2.4.3.2.6	Verification of ADS-B Airborne Velocity Messages (§2.2.3.2.6)	438
2.4.3.2.6.1	Verification of ADS-B Airborne Velocity Message - Subtype=1 (§2.2.3.2.6.1)	438
2.4.3.2.6.1.1	Verification of “TYPE” Subfield in Airborne Velocity Messages - Subtype=1 (§2.2.3.2.6.1.1).....	439
2.4.3.2.6.1.2	Verification of “Subtype” Subfield in Airborne Velocity Messages - Subtype=1 (§2.2.3.2.6.1.1, §2.2.3.2.6.1.2, §2.2.3.2.6.2.1, §2.2.3.2.6.2.2, §2.2.3.2.6.3.1, §2.2.3.2.6.3.2, §2.2.3.2.6.4.1, §2.2.3.2.6.4.2, §2.2.3.2.7.1.1, §2.2.3.2.7.1.2, §2.2.3.2.7.2.1, §2.2.3.2.7.2.2)	439
2.4.3.2.6.1.3	Verification of “Intent Change Flag” Subfield in Airborne Velocity Messages - Subtype=1 (§2.2.3.2.6.1.3, §2.2.3.2.6.2.3, §2.2.3.2.6.3.3, §2.2.3.2.6.4.3, §2.2.5.1.18).....	441
2.4.3.2.6.1.4	Verification of “Reserved Bit-A” Subfield in Airborne Velocity Messages – Subtype=1 (§2.2.3.2.6.1.4)	442
2.4.3.2.6.1.5	Verification of “NAC _v ” Subfield in Airborne Velocity Messages - Subtype=1 (§2.2.3.2.6.1.5, §2.2.3.2.6.2.5, §2.2.3.2.6.3.5, §2.2.3.2.6.4.5, §2.2.5.1.19).....	443
2.4.3.2.6.1.6	Verification of “East/West Direction Bit” Subfield in Airborne Velocity Messages - Subtype=1 (§2.2.3.2.6.1.6, §2.2.3.2.6.2.6, §2.2.5.1.12).....	444
2.4.3.2.6.1.7	Verification of “East/West Velocity” Subfield in Airborne Velocity Messages - Subtype=1 (§2.2.3.2.6.1.7, §2.2.5.1.12).....	445
2.4.3.2.6.1.8	Verification of “North/South Direction Bit” Subfield in Airborne Velocity Messages - Subtype=1 (§2.2.3.2.6.1.8, §2.2.3.2.6.2.8, §2.2.5.1.13).....	448
2.4.3.2.6.1.9	Verification of “North/South Velocity” Subfield in Airborne Velocity Messages - Subtype=1 (§2.2.3.2.6.1.9, §2.2.5.1.13).....	449

2.4.3.2.6.1.10	Verification of “Source Bit for Vertical Rate” Subfield in Airborne Velocity Messages - Subtype=1 (§2.2.3.2.6.1.10, §2.2.3.2.6.2.10, §2.2.3.2.6.3.10, §2.2.3.2.6.4.10, §2.2.5.1.14).....	452
2.4.3.2.6.1.11	Verification of “Sign Bit for Vertical Rate” Subfield in Airborne Velocity Messages - Subtype=1 (§2.2.3.2.6.1.11, §2.2.3.2.6.2.11, §2.2.3.2.6.3.11, §2.2.3.2.6.4.11, §2.2.5.1.14).....	452
2.4.3.2.6.1.12	Verification of “Vertical Rate” Subfield in Airborne Velocity Messages - Subtype=1 (§2.2.3.2.6.1.12, §2.2.3.2.6.2.12, §2.2.3.2.6.3.12, §2.2.3.2.6.4.12, §2.2.5.1.14).....	454
2.4.3.2.6.1.13	Verification of “Reserved Bits-B” Subfield in Airborne Velocity Messages – Subtype=1 (§2.2.3.2.6.1.13).....	456
2.4.3.2.6.1.14	Verification of “Difference From Barometric Altitude Sign Bit” Subfield in Airborne Velocity Messages - Subtype=1 (§2.2.3.2.6.1.14, §2.2.3.2.6.2.14, §2.2.3.2.6.3.14, §2.2.3.2.6.4.14).....	456
2.4.3.2.6.1.15	Verification of “Difference From Barometric Altitude” Subfield in Airborne Velocity Messages - Subtype=1 (§2.2.3.2.6.1.15, §2.2.3.2.6.2.15, §2.2.3.2.6.3.15, §2.2.3.2.6.4.15)	457
2.4.3.2.6.2	Verification of ADS-B Airborne Velocity Message - Subtype=2 (§2.2.3.2.6.2).....	459
2.4.3.2.6.2.1	Verification of “TYPE” Subfield in Airborne Velocity Messages - Subtype=2 (§2.2.3.2.6.2.1).....	459
2.4.3.2.6.2.2	Verification of “Subtype” Subfield in Airborne Velocity Messages - Subtype=2 (§2.2.3.2.6.2.2)	459
2.4.3.2.6.2.3	Verification of “Intent Change Flag” Subfield in Airborne Velocity Messages - Subtype=2 (§2.2.3.2.6.2.3, §2.2.5.1.18).....	459
2.4.3.2.6.2.4	Verification of “Reserved Bit-A” Subfield in Airborne Velocity Messages – Subtype=2 (§2.2.3.2.6.2.4)	459
2.4.3.2.6.2.5	Verification of “NAC _v ” Subfield in Airborne Velocity Messages - Subtype=2 (§2.2.3.2.6.2.5, §2.2.5.1.19)	460
2.4.3.2.6.2.6	Verification of “East/West Direction Bit” Subfield in Airborne Velocity Messages - Subtype=2 (§2.2.3.2.6.2.6).....	460
2.4.3.2.6.2.7	Verification of “East/West Velocity” Subfield in Airborne Velocity Messages - Subtype=2 (§2.2.3.2.6.2.7, §2.2.5.1.12).....	460
2.4.3.2.6.2.8	Verification of “North/South Direction Bit” Subfield in Airborne Velocity Messages - Subtype=2 (§2.2.3.2.6.2.8).....	462
2.4.3.2.6.2.9	Verification of “North/South Velocity” Subfield in Airborne Velocity Messages - Subtype=2 (§2.2.3.2.6.2.9, §2.2.5.1.13).....	463
2.4.3.2.6.2.10	Verification of “Source Bit for Vertical Rate” Subfield in Airborne Velocity Messages - Subtype=2 (§2.2.3.2.6.2.10, §2.2.5.1.14).....	465
2.4.3.2.6.2.11	Verification of “Sign Bit for Vertical Rate” Subfield in Airborne Velocity Messages - Subtype=2 (§2.2.3.2.6.2.11, §2.2.5.1.14).....	466
2.4.3.2.6.2.12	Verification of “Vertical Rate” Subfield in Airborne Velocity Messages - Subtype=2 (§2.2.3.2.6.2.12, §2.2.5.1.14)	466
2.4.3.2.6.2.13	Verification of “Reserved Bits-B” Subfield in Airborne Velocity – Subtype=2 Messages (§2.2.3.2.6.2.13).....	466
2.4.3.2.6.2.14	Verification of “Difference From Barometric Altitude Sign Bit” Subfield in Airborne Velocity Messages - Subtype=2 (§2.2.3.2.6.2.14).....	466
2.4.3.2.6.2.15	Verification of “Difference From Barometric Altitude” Subfield in Airborne Velocity Messages - Subtype=2 (§2.2.3.2.6.2.15)	466
2.4.3.2.6.3	Verification of ADS-B Airborne Velocity Message - Subtype=3 (§2.2.3.2.6.3).....	466
2.4.3.2.6.3.1	Verification of “TYPE” Subfield in Airborne Velocity Messages - Subtype=3 (§2.2.3.2.6.3.1).....	466
2.4.3.2.6.3.2	Verification of “Subtype” Subfield in Airborne Velocity Messages - Subtype=3 (§2.2.3.2.6.3.1, §2.2.3.2.6.3.2)	466
2.4.3.2.6.3.3	Verification of “Intent Change Flag” Subfield in Airborne Velocity Messages - Subtype=3 (§2.2.3.2.6.3.3, §2.2.5.1.18).....	467
2.4.3.2.6.3.4	Verification of “Reserved Bit-A” Subfield in Airborne Velocity Messages – Subtype=3 (§2.2.3.2.6.3.4)	467
2.4.3.2.6.3.5	Verification of “NAC _v ” Subfield in Airborne Velocity Messages - Subtype=3 (§2.2.3.2.6.3.5, §2.2.5.1.19)	467
2.4.3.2.6.3.6	Verification of “Heading Status Bit” Subfield in Airborne Velocity Messages - Subtype=3 (§2.2.3.2.6.3.6, §2.2.3.2.6.4.6, §2.2.5.1.15).....	467
2.4.3.2.6.3.7	Verification of “Heading” Subfield in Airborne Velocity Messages - Subtype=3 (§2.2.3.2.6.3.7, §2.2.3.2.6.4.7, §2.2.5.1.15).....	468

2.4.3.2.6.3.8	Verification of “Airspeed Type” Subfield in Airborne Velocity Messages - Subtype=3 (§2.2.3.2.6.3.8, §2.2.3.2.6.4.8, §2.2.5.1.16, §2.2.5.1.17).....	470
2.4.3.2.6.3.9	Verification of “Airspeed” Subfield in Airborne Velocity Messages - Subtype=3 (§2.2.3.2.6.3.9, §2.2.5.1.16, §2.2.5.1.17).....	471
2.4.3.2.6.3.10	Verification of “Source Bit for Vertical Rate” Subfield in Airborne Velocity Messages - Subtype=3 (§2.2.3.2.6.3.10, §2.2.5.1.14).....	472
2.4.3.2.6.3.11	Verification of “Sign Bit for Vertical Rate” Subfield in Airborne Velocity Messages - Subtype=3 (§2.2.3.2.6.3.11, §2.2.5.1.14).....	472
2.4.3.2.6.3.12	Verification of “Vertical Rate” Subfield in Airborne Velocity Messages - Subtype=3 (§2.2.3.2.6.3.12, §2.2.5.1.14)	472
2.4.3.2.6.3.13	Verification of “Reserved Bits-B” Subfield in Airborne Velocity Messages – Subtype=3 (§2.2.3.2.6.3.13).....	473
2.4.3.2.6.3.14	Verification of “Difference From Barometric Altitude Sign Bit” Subfield in Airborne Velocity Messages - Subtype=3 (§2.2.3.2.6.3.14).....	473
2.4.3.2.6.3.15	Verification of “Difference From Barometric Altitude” Subfield in Airborne Velocity Messages - Subtype=3 (§2.2.3.2.6.3.15)	473
2.4.3.2.6.4	Verification of ADS-B Airborne Velocity Message - Subtype=4 (§2.2.3.2.6.4).....	473
2.4.3.2.6.4.1	Verification of “TYPE” Subfield in Airborne Velocity Messages - Subtype=4 (§2.2.3.2.6.4.1).....	473
2.4.3.2.6.4.2	Verification of “Subtype” Subfield in Airborne Velocity Messages - Subtype=4 (§2.2.3.2.6.4.1, §2.2.3.2.6.4.2)	473
2.4.3.2.6.4.3	Verification of “Intent Change Flag” Subfield in Airborne Velocity Messages - Subtype=4 (§2.2.3.2.6.4.3, §2.2.5.1.18).....	473
2.4.3.2.6.4.4	Verification of “Reserved Bit-A” Subfield in Airborne Velocity Messages – Subtype=4 (§2.2.3.2.6.4.4)	473
2.4.3.2.6.4.5	Verification of “NAC _v ” Subfield in Airborne Velocity Messages - Subtype=4 (§2.2.3.2.6.4.5, §2.2.5.1.19)	474
2.4.3.2.6.4.6	Verification of “Heading Status Bit” Subfield in Airborne Velocity Messages - Subtype=4 (§2.2.3.2.6.4.6, §2.2.5.1.15).....	474
2.4.3.2.6.4.7	Verification of “Heading” Subfield in Airborne Velocity Messages - Subtype=4 (§2.2.3.2.6.4.7, §2.2.5.1.15)	474
2.4.3.2.6.4.8	Verification of “Airspeed Type” Subfield in Airborne Velocity Messages - Subtype=4 (§2.2.3.2.6.4.8, §2.2.5.1.16, §2.2.5.1.17).....	474
2.4.3.2.6.4.9	Verification of “Airspeed” Subfield in Airborne Velocity Messages - Subtype=4 (§2.2.3.2.6.4.9, §2.2.5.1.16, §2.2.5.1.17).....	474
2.4.3.2.6.4.10	Verification of “Source Bit for Vertical Rate” Subfield in Airborne Velocity Messages - Subtype=4 (§2.2.3.2.6.4.10, §2.2.5.1.14).....	476
2.4.3.2.6.4.11	Verification of “Sign Bit for Vertical Rate” Subfield in Airborne Velocity Messages - Subtype=4 (§2.2.3.2.6.4.11, §2.2.5.1.14).....	476
2.4.3.2.6.4.12	Verification of “Vertical Rate” Subfield in Airborne Velocity Messages - Subtype=4 (§2.2.3.2.6.4.12, §2.2.5.1.14)	476
2.4.3.2.6.4.13	Verification of “Reserved Bits-B” Subfield in Airborne Velocity – Subtype=4 Messages (§2.2.3.2.6.4.13).....	476
2.4.3.2.6.4.14	Verification of “Difference From Barometric Altitude Sign Bit” Subfield in Airborne Velocity Messages - Subtype=4 (§2.2.3.2.6.4.14).....	476
2.4.3.2.6.4.15	Verification of “Difference From Barometric Altitude” Subfield in Airborne Velocity Messages - Subtype=4 (§2.2.3.2.6.4.15)	476
2.4.3.2.6.5	Verification of ADS-B Airborne Velocity Messages - Subtypes “5, 6, & 7” (§2.2.3.2.6.5).....	477
2.4.3.2.7	Verification of ADS-B Periodic Status and Event-Driven (§2.2.3.2.7)	477
2.4.3.2.7.1	Verification of “Target State and Status” Messages (§2.2.3.2.7.1).....	477
2.4.3.2.7.1.1	Verification of “TYPE” Subfield in Target State and Status Messages (§2.2.3.2.7.1.1)	477
2.4.3.2.7.1.2	Verification of the “Subtype” Subfield in Target State and Status Messages (§2.2.3.2.7.1.2)	478
2.4.3.2.7.1.3	Verification of the Target State and Status (Subtype=1) Format (§2.2.3.2.7.1.3).....	478
2.4.3.2.7.1.3.1	Verification of the “SIL Supplement” Subfield in Target State and Status Messages (§2.2.3.2.7.1.3.1, §2.2.3.2.7.2.14, §2.2.5.1.41).....	478

2.4.3.2.7.1.3.2	Verification of the “Selected Altitude Type” Subfield in Target State and Status Messages (§2.2.3.2.7.1.3.2).....	479
2.4.3.2.7.1.3.3	Verification of the “MCP/FCU Selected Altitude or FMS Selected Altitude” Subfield in Target State and Status Messages (§2.2.3.2.7.1.3.3, §2.2.5.1.42).....	479
2.4.3.2.7.1.3.4	Verification of the “Barometric Pressure Setting (Minus 800 millibars)” Subfield in Target State and Status Messages (§2.2.3.2.7.1.3.4, §2.2.5.1.43)	481
2.4.3.2.7.1.3.5	Verification of the “Selected Heading Status” Subfield in Target State and Status Messages (§2.2.3.2.7.1.3.5).....	482
2.4.3.2.7.1.3.6	Verification of the “Selected Heading Sign” Subfield in Target State and Status Messages (§2.2.3.2.7.1.3.6).....	482
2.4.3.2.7.1.3.7	Verification of the “Selected Heading” Subfield in Target State and Status Messages (§2.2.3.2.7.1.3.7, §2.2.5.1.44)	483
2.4.3.2.7.1.3.8	Verification of the “NAC _P ” Subfield in Target State and Status Messages (§2.2.3.2.7.1.3.8, §2.2.5.1.34)	484
2.4.3.2.7.1.3.9	Verification of the “NIC _{BARO} ” Subfield in Target State and Status Messages (§2.2.3.2.7.1.3.9, §2.2.5.1.35)	485
2.4.3.2.7.1.3.10	Verification of the “SIL” Subfield in Target State and Status Messages (§2.2.3.2.7.1.3.10, §2.2.3.2.7.2.9, §2.2.5.1.40)	486
2.4.3.2.7.1.3.11	Verification of the “Status of MCP/FCU Mode Bits” Subfield in Target State and Status Messages (§2.2.3.2.7.1.3.11, §2.2.5.1.45).....	486
2.4.3.2.7.1.3.12	Verification of the “Autopilot Engaged” Subfield in Target State and Status Messages (§2.2.3.2.7.1.3.12, §2.2.5.1.45).....	487
2.4.3.2.7.1.3.13	Verification of the “VNAV Mode Engaged” Subfield in Target State and Status Messages (§2.2.3.2.7.1.3.13, §2.2.5.1.45).....	488
2.4.3.2.7.1.3.14	Verification of the “Altitude Hold Mode” Subfield in Target State and Status Messages (§2.2.3.2.7.1.3.14, §2.2.5.1.45).....	488
2.4.3.2.7.1.3.15	Verification of the “Reserved for ADS-R Flag” Subfield in Target State and Status Messages (§2.2.3.2.7.1.3.15).....	489
2.4.3.2.7.1.3.16	Verification of the “Approach Mode” Subfield in Target State and Status Messages (§2.2.3.2.7.1.3.16, §2.2.5.1.45).....	490
2.4.3.2.7.1.3.17	Verification of the “TCAS Operational” Subfield in Target State and Status Messages (§2.2.3.2.7.1.3.17, §2.2.5.1.48).....	490
2.4.3.2.7.1.3.18	Verification of the “LNAV Mode Engaged” Subfield in Target State and Status Messages (§2.2.3.2.7.1.3.18, §2.2.5.1.45).....	491
2.4.3.2.7.1.3.19	Verification of “Reserved” Bits in Target State and Status Messages (§2.2.3.2.7.1.3.19).....	491
2.4.3.2.7.1.4	Verification of the Reserved for TYPE=29 and Subtype>1 Message Formats (§2.2.3.2.7.1.4)	492
2.4.3.2.7.2	Verification of “Aircraft Operational Status” Messages (§2.2.3.2.7.2).....	492
2.4.3.2.7.2.1	Verification of “TYPE” Code Subfield in Aircraft Operational Status Messages (§2.2.3.2.7.2.1).....	492
2.4.3.2.7.2.2	Verification of “Subtype” Code Subfield in Aircraft Operational Status Messages (§2.2.3.2.7.2.2, §2.2.5.1.20)	492
2.4.3.2.7.2.3	Verification of “CAPABILITY CLASS (CC)” Subfield in Aircraft Operational Status Messages (§2.2.3.2.7.2.3).....	493
2.4.3.2.7.2.3.1	Verification of the “Reserved” CC Code Subfield in Aircraft Operational Status Message (§2.2.3.2.7.2.3.1, §2.2.5.1.21).....	493
2.4.3.2.7.2.3.2	Verification of the “TCAS Operational” CC Code Subfield in Aircraft Operational Status Messages (§2.2.3.2.7.2.3.2).....	493
2.4.3.2.7.2.3.3	Verification of “1090ES IN” CC Code Subfield in Aircraft Operational Status Messages (§2.2.3.2.7.2.3.3, §2.2.5.1.23).....	494
2.4.3.2.7.2.3.4	Verification of the “ARV Report Capability” CC Code Subfield in Aircraft Operational Status Messages (§2.2.3.2.7.2.3.4, §2.2.5.1.24)	494
2.4.3.2.7.2.3.5	Verification of the “TS Report Capability” CC Code Subfield in Aircraft Operational Status Messages (§2.2.3.2.7.2.3.5).....	495
2.4.3.2.7.2.3.6	Verification of the “TC Report Capability” CC Code Subfield in Aircraft Operational Status Messages (§2.2.3.2.7.2.3.6)	495

2.4.3.2.7.2.3.7	Verification of the “B2 Low” CC Code Subfield in Aircraft Operational Status Messages (§2.2.3.2.7.2.3.7).....	496
2.4.3.2.7.2.3.8	Verification of “NAC _v ” CC Code Subfield in Surface Aircraft Operational Status Messages (§2.2.3.2.7.2.3.8, §2.2.5.1.19).....	496
2.4.3.2.7.2.3.9	Verification of “UAT IN” CC Code Subfield in Aircraft Operational Status Messages (§2.2.3.2.7.2.3.9, §2.2.5.1.22).....	497
2.4.3.2.7.2.3.10	Verification of “NIC Supplement-C” CC Code Subfield in Aircraft Operational Status Messages (§2.2.3.2.7.2.3.10).....	497
2.4.3.2.7.2.4	Verification of “OPERATIONAL MODE (OM)” Subfield in Aircraft Operational Status Messages (§2.2.3.2.7.2.4).....	497
2.4.3.2.7.2.4.1	Verification of the “OM” Subfield Format Code in Aircraft Operational Status Messages (§2.2.3.2.7.2.4.1, §2.2.5.1.27).....	497
2.4.3.2.7.2.4.2	Verification of the “TCAS/ACAS Resolution Advisory Active” OM Code Subfield in Aircraft Operational Status Message (§2.2.3.2.7.2.4.2, §2.2.5.1.29).....	498
2.4.3.2.7.2.4.3	Verification of the “IDENT Switch Active” OM Code Subfield in Aircraft Operational Status Message (§2.2.3.2.7.2.4.3, §2.2.5.1.30).....	498
2.4.3.2.7.2.4.4	Verification of the bit Reserved for “Receiving ATC Services” OM Code Subfield in Aircraft Operational Status Message (§2.2.3.2.7.2.4.4).....	499
2.4.3.2.7.2.4.5	Verification of “Single Antenna Flag” OM Code Subfield in Aircraft Operational Status Message (§2.2.3.2.7.2.4.5, §2.2.5.1.49).....	499
2.4.3.2.7.2.4.6	Verification of “System Design Assurance” OM Code Subfield in Aircraft Operational Status Messages (§2.2.3.2.7.2.4.6, §2.2.5.1.50).....	500
2.4.3.2.7.2.4.7	Verification of the “GPS Antenna Offset” OM Code Subfield in Aircraft Operational Status Messages (§2.2.3.2.7.2.4.7, §2.2.5.1.28, §2.2.5.1.52).....	501
2.4.3.2.7.2.4.8	Verification of the “Reserved” OM Code Subfield in Aircraft Operational Status Messages (§2.2.3.2.7.2.4.8).....	501
2.4.3.2.7.2.5	Verification of “ADS-B Version Number” Subfield in Aircraft Operational Status Message (§2.2.3.2.7.2.5).....	502
2.4.3.2.7.2.6	Verification of the “NIC Supplement-A” Subfield in Aircraft Operational Status Messages (§2.2.3.2.7.2.6).....	502
2.4.3.2.7.2.7	Verification of the “Navigation Accuracy Category for Position (NAC _p)” Subfield in Aircraft Operational Status Messages (§2.2.3.2.7.2.7, §2.2.5.1.34).....	503
2.4.3.2.7.2.8	Verification of the “Geometric Vertical Accuracy (GVA)” Subfield in Aircraft Operational Status Messages (§2.2.3.2.7.2.8, §2.2.5.1.51).....	504
2.4.3.2.7.2.9	Verification of the “Source Integrity Level (SIL)” Subfield in Aircraft Operational Status Messages (§2.2.3.2.7.2.9, §2.2.5.1.40).....	505
2.4.3.2.7.2.10	Verification of the “Barometric Altitude Integrity Code (NIC _{BARO})” Subfield in Aircraft Operational Status Messages (§2.2.3.2.7.2.10, §2.2.5.1.35).....	505
2.4.3.2.7.2.11	Verification of the “Aircraft/Vehicle Length and Width Code” Subfield in Aircraft Operational Status Messages (§2.2.3.2.7.2.11, §2.2.5.1.37).....	506
2.4.3.2.7.2.12	Verification of the “Track Angle/Heading” Subfield in Aircraft Operational Status Messages (§2.2.3.2.7.2.12, §2.2.5.1.38).....	507
2.4.3.2.7.2.13	Verification of the “Horizontal Reference Direction (HRD)” Subfield in Aircraft Operational Status Messages (§2.2.3.2.7.2.13, §2.2.5.1.39).....	508
2.4.3.2.7.2.14	Verification of “SIL Supplement” Subfield in Aircraft Operational Status Messages (§2.2.3.2.7.2.14, §2.2.5.1.41).....	509
2.4.3.2.7.2.15	Verification of “Reserved” Subfields in Aircraft Operational Status Message (§2.2.3.2.7.2.15).....	510
2.4.3.2.7.3	Verification of TYPE Code “23” ADS-B Messages for “TEST” (§2.2.3.2.7.3).....	510
2.4.3.2.7.4	Verification of Surface System Status Messages with TYPE Code=24 (§2.2.3.2.7.4).....	510
2.4.3.2.7.4.1	Verification of “TYPE” Code Subfield in Surface System Status Messages (§2.2.3.2.7.4.1).....	510
2.4.3.2.7.4.2	Verification of “Subtype” Code Subfield in Surface System Status Messages (§2.2.3.2.7.4.2).....	510
2.4.3.2.7.4.3	Verification of “Surface System Status” Subfield in Surface System Status Messages (§2.2.3.2.7.4.3).....	510
2.4.3.2.7.5	Verification of RESERVED TYPE Code “25” ADS-B Messages (§2.2.3.2.7.5).....	511
2.4.3.2.7.6	Verification of RESERVED TYPE Code “26” ADS-B Messages (§2.2.3.2.7.6).....	511

2.4.3.2.7.7	Verification of RESERVED TYPE Code “27” ADS-B Messages (§2.2.3.2.7.7).....	511
2.4.3.2.7.8	Verification of Extended Squitter Aircraft Status Messages with TYPE Code=28 (§2.2.3.2.7.8).....	511
2.4.3.2.7.8.1	Verification of Emergency/Priority Status and Mode A Code (Subtype=1) (§2.2.3.2.7.8.1)	511
2.4.3.2.7.8.1.1	Verification of “Emergency/Priority Status” Subfield in Aircraft Status Messages (§2.2.3.2.7.8.1.1)....	511
2.4.3.2.7.8.1.2	Verification of “Mode A (4096) Code” Subfield in Aircraft Status Messages (§2.2.3.2.7.8.1.2).....	512
2.4.3.2.7.8.2	Verification of the 1090ES TCAS RA Message (Subtype = 2) (§2.2.3.2.7.8.2).....	512
2.4.3.2.7.9	Verification of RESERVED TYPE Code “30” ADS-B Messages (§2.2.3.2.7.9).....	513
2.4.3.3	Verification of ADS-B Message Transmission Rates (§2.2.3.3).....	513
2.4.3.3.1	Verification of Transmission Rates for Transponder - Based Transmitters (§2.2.3.3.1).....	514
2.4.3.3.1.1	Verification of Transmission Rates Compliant with RTCA DO-181E (§2.2.3.3.1.1) (EUROCAE ED-73E)	514
2.4.3.3.1.2	Verification of Transmission Rates Not Specified in RTCA DO-181E (§2.2.3.3.1.2) (EUROCAE ED-73E)	514
2.4.3.3.1.3	Verification of Maximum Transmission Rates for Transponder-Based Transmitters (§2.2.3.3.1.3)	514
2.4.3.3.1.4	Verification of the ADS-B Periodic Status and Event-Driven Message Broadcast Rates (§2.2.3.3.1.4).....	514
2.4.3.3.1.4.1	Verification of the ADS-B Target State and Status Message Broadcast Rates (§2.2.3.3.1.4.1).....	515
2.4.3.3.1.4.2	Verification of the ADS-B Aircraft Operational Status Message Broadcast Rates (§2.2.3.3.1.4.2)	516
2.4.3.3.1.4.3	Verification of the “Extended Squitter Aircraft Status” ADS-B Event-Driven Message Broadcast Rate (§2.2.3.3.1.4.3).....	518
2.4.3.3.1.4.3.1	Verification of “Emergency/Priority Status Message” Broadcast Rates	518
2.4.3.3.1.4.3.1.1	Verification of “Emergency/Priority Status Message” Broadcast Rates When Transmission of Mode A Code is Disabled (§2.2.3.3.1.4.3.1.1).....	522
2.4.3.3.1.4.3.1.2	Verification of “Emergency/Priority Status Message” Broadcast Rates When Transmission of Mode A Code is Enabled (§2.2.3.3.1.4.3.1.2).....	522
2.4.3.3.1.4.3.2	Verification of “TCAS RA Broadcast Message” Broadcast Rate (§2.2.3.3.1.4.3.2).....	522
2.4.3.3.1.4.4	Verification of the “TYPE Code=23 (TEST)” ADS-B Event-Driven Message Broadcast Rate (§2.2.3.3.1.4.4).....	522
2.4.3.3.1.4.5	Verification of the “TYPE Codes 24 – 27” and “TYPE Code=30” ADS-B Event-Driven Message Broadcast Rate (§2.2.3.3.1.4.5)	523
2.4.3.3.1.4.6	Verification of the ADS-B Message Transmission Scheduling (§2.2.3.3.1.4.6).....	523
2.4.3.3.1.4.6.1	Verification of the Event-Driven Message Scheduling Function (§2.2.3.3.1.4.6.1)	523
2.4.3.3.2	Verification of Transmission Rates for Stand Alone Transmitters (§2.2.3.3.2)	525
2.4.3.3.2.1	Verification of Power-On Initialization and Start Up (§2.2.3.3.2.1).....	527
2.4.3.3.2.1.1	Verification of Power-On Initialization (§2.2.3.3.2.1.1)	527
2.4.3.3.2.1.2	Verification of Start Up (§2.2.3.3.2.1.2)	527
2.4.3.3.2.2	Verification of ADS-B Airborne Position Message Broadcast Rate (§2.2.3.3.2.2)	528
2.4.3.3.2.3	Verification of ADS-B Surface Position Message Broadcast Rate (§2.2.3.3.2.3)	529
2.4.3.3.2.4	Verification of ADS-B Aircraft Identification and Category Message Broadcast Rate (§2.2.3.3.2.4)	530
2.4.3.3.2.5	Verification of ADS-B Velocity Information Message Broadcast Rate (§2.2.3.3.2.5)	531
2.4.3.3.2.6	Verification of ADS-B Periodic Status Message Broadcast Rates (§2.2.3.3.2.6)	532
2.4.3.3.2.6.1	Verification of ADS-B Target State and Status Message Broadcast Rates (§2.2.3.3.2.6.1)	532
2.4.3.3.2.6.2	Verification of ADS-B Aircraft Operational Status Message Broadcast Rates (§2.2.3.3.2.6.2)	534
2.4.3.3.2.7	Verification of “Extended Squitter Aircraft Status” ADS-B Event-Driven Message Broadcast Rate (§2.2.3.3.2.7).....	537
2.4.3.3.2.8	Verification of Other ADS-B Event-Driven Messages (§2.2.3.3.2.8).....	539
2.4.3.3.2.8.1	Verification of “TYPE Code=23 (TEST)” ADS-B Event-Driven Message Broadcast Rate (§2.2.3.3.2.8)	539
2.4.3.3.2.8.2	Verification of “TYPE Code 24 - 27” ADS-B Event-Driven Message Broadcast Rate (§2.2.3.3.2.8.2)....	539
2.4.3.3.2.9	Verification of ADS-B Message Transmission Scheduling (§2.2.3.3.2.9).....	540
2.4.3.3.2.9.1	Verification of Scheduling of Non Event-Driven Messages (§2.2.3.3.2.9.1)	541
2.4.3.3.2.9.2	Verification of Event-Driven Message Scheduling (§2.2.3.3.2.9.2)	542
2.4.3.3.2.10	Verification of Maximum ADS-B Message Transmission Rates (§2.2.3.3.2.10)	542
2.4.3.3.2.11	Verification of ADS-B Message Timeout (§2.2.3.3.2.11)	542

2.4.3.3.2.12	Verification of ADS-B Message Termination (§2.2.3.3.2.12)	542
2.4.3.4	Verification of ADS-B Transmitted Message Error Protection (§2.2.3.4)	542
2.4.4	VERIFICATION OF ADS-B RECEIVER CHARACTERISTICS (§2.2.4)	542
2.4.4.1	Verification of Minimum Triggering Level (MTL) Definition (§2.2.4.1)	543
2.4.4.2	Verification of Receivers Shared with a TCAS Unit (§2.2.4.2)	543
2.4.4.2.1	Verification of Dual Minimum Triggering Levels (§2.2.4.2.1)	543
2.4.4.2.1.1	Verification of TCAS Compatibility (§2.2.4.2.1.1)	543
2.4.4.2.1.2	Verification of ADS-B Compatibility (§2.2.4.2.1.2)	544
2.4.4.2.2	Verification of Re-Triggerable Reply Processor (§2.2.4.2.2)	544
2.4.4.3	Verification of Receivers Not Shared With TCAS (§2.2.4.3)	546
2.4.4.3.1	Verification of In-Band Acceptance and Re-Triggerable Capability (§2.2.4.3.1)	546
2.4.4.3.1.1	Verification of In-Band Acceptance and Dynamic Range (§2.2.4.3.1.1)	546
2.4.4.3.1.1.1	Verification of In-Band Acceptance (§2.2.4.3.1.1.a)	546
2.4.4.3.1.1.2	Verification of Dynamic Range (§2.2.4.3.1.1.b, §2.2.4.3.1.1.c)	547
2.4.4.3.1.2	Verification of Re-Triggerable Capability (§2.2.4.3.1.2)	549
2.4.4.3.2	Verification of Out-of-Band Rejection (§2.2.4.3.2)	550
2.4.4.3.3	Verification of Dynamic Minimum Trigger Level (DMTL) (§2.2.4.3.3)	552
2.4.4.3.4	Verification of 1090 MHz ADS-B Message Reception Techniques (§2.2.4.3.4)	555
2.4.4.3.4.1	Verification of ADS-B Message Reception (§2.2.4.3.4.1)	555
2.4.4.3.4.2	Verification of Narrow Pulse Discrimination (§2.2.4.3.4.2)	555
2.4.4.3.4.3	Verification of TACAN and DME Discrimination (§2.2.4.3.4.3)	557
2.4.4.3.4.4	Verification of Pulse Characteristics of Received ADS-B Messages (§2.2.4.3.4.4)	557
2.4.4.3.4.5	Message Formats (§2.2.4.3.4.5)	557
2.4.4.3.4.6	Description of 1090 MHz ADS-B Message Received Signals (§2.2.4.3.4.6)	557
2.4.4.3.4.7	Verification of ADS-B Signal Reception (§2.2.4.3.4.7)	557
2.4.4.3.4.7.1	Verification of Criteria for ADS-B Message Transmission Pulse Detection (§2.2.4.3.4.7.1 and §2.2.4.3.4.7.2)	558
2.4.4.3.4.7.2	Verification of Criteria for Preamble Acceptance (§2.2.4.3.4.7.2)	560
2.4.4.3.4.7.3	Verification of Criteria for Data Block Acceptance in ADS-B Message Signals (§2.2.4.3.4.7.3)	561
2.4.4.3.5	Verification of ADS-B Receiver Duty Factor (§2.2.4.3.5)	563
2.4.4.4	Verification of Enhanced Squitter Reception Techniques (§2.2.4.4)	564
2.4.4.4.1	Verification of the Need for Enhanced Squitter Reception Techniques (§2.2.4.4.1)	564
2.4.4.4.2	Verification for the Enhanced Squitter Reception Technique Overview (§2.2.4.4.2)	564
2.4.4.4.2.1	Test Equipment Requirements	565
2.4.4.4.2.1.1	Mode A/C Fruit Signal Source Requirements	565
2.4.4.4.2.1.2	Mode S Fruit Signal Source Requirements	566
2.4.4.4.2.1.3	Extended Squitter Signal Source Requirements	566
2.4.4.4.2.2	Four-Pulse Preamble Detection Tests	567
2.4.4.4.2.3	Preamble Validation Tests	579
2.4.4.4.2.4	Combined Preamble and Data Block Tests with Mode A/C FRUIT	581
2.4.4.4.2.5	Data Block Tests with Mode S Fruit	584
2.4.4.4.2.6	Re-Triggering Performance	586
2.4.4.4.3	Verification of Error Correction (§2.2.4.4.3)	590
2.4.4.4.3.1	Verification of Error Correction Requirements (§2.2.4.4.3.1)	590
2.4.4.4.3.2	Verification of Error Correction Restrictions (§2.2.4.4.3.2)	590
2.4.4.5	Verification of ADS-B Received Message Error Protection (§2.2.4.5)	591
2.4.5	VERIFICATION OF ADS-B TRANSMISSION DEVICE MESSAGE PROCESSOR CHARACTERISTICS (§2.2.5)	592
2.4.5.1	Verification of ADS-B Transmission Device Data Processing and Message Formatting (§2.2.5.1)	592
2.4.5.1.1	Verification of the Participant Address (§2.2.5.1.1)	592
2.4.5.1.1.1	Verification of the ICAO 24-Bit Address (§2.2.5.1.1.1)	592
2.4.5.1.1.2	Verification of the Anonymous Address (§2.2.5.1.1.2)	592
2.4.5.1.1.3	Verification of the Address Qualifier for Non-Transponder Devices (§2.2.5.1.1.3)	592
2.4.5.1.2	Verification of ADS-B Emitter Category Data (§2.2.5.1.2)	592
2.4.5.1.3	Verification of Air/Ground Status Data (§2.2.5.1.3)	592
2.4.5.1.4	Verification of Surveillance Status Data (§2.2.5.1.4)	593

2.4.5.1.5	Verification of Altitude Data (§2.2.5.1.5)	593
2.4.5.1.6	Verification of Time Data and Time Mark Pulse (§2.2.5.1.6).....	593
2.4.5.1.6.1	Verification of Case, where TIME (“T”) = 0 (§2.2.5.1.6.1).....	593
2.4.5.1.6.2	Verification of Case, where TIME (“T”) = 1 (§2.2.5.1.6.2).....	593
2.4.5.1.7	Verification of Own Position Latitude Data (§2.2.5.1.7)	593
2.4.5.1.8	Verification of Own Position Longitude Data (§2.2.5.1.8)	593
2.4.5.1.9	Verification of Ground Speed Data (§2.2.5.1.9)	594
2.4.5.1.10	Verification of Heading/Ground Track Data (§2.2.5.1.10)	594
2.4.5.1.11	Verification of Aircraft Identification (or Registration) Data (§2.2.5.1.11).....	594
2.4.5.1.12	Verification of East/West Velocity Data (§2.2.5.1.12)	594
2.4.5.1.13	Verification of North/South Velocity Data (§2.2.5.1.13).....	594
2.4.5.1.14	Verification of Vertical Rate Data (§2.2.5.1.14)	594
2.4.5.1.15	Verification of Heading Data (§2.2.5.1.15).....	594
2.4.5.1.16	Verification of True Airspeed Data (§2.2.5.1.16)	595
2.4.5.1.17	Verification of Indicated Airspeed Data (§2.2.5.1.17)	595
2.4.5.1.18	Verification of Intent Change Data (§2.2.5.1.18).....	595
2.4.5.1.19	Verification of NAC _V Data (§2.2.5.1.19).....	595
2.4.5.1.20	Verification of Subtype (Aircraft Status) Data (§2.2.5.1.20)	595
2.4.5.1.21	Verification of Capability Class (Reserved) Data (§2.2.5.1.21).....	595
2.4.5.1.22	Verification of Capability Class (UAT IN) Data (§2.2.5.1.22)	595
2.4.5.1.23	Verification of Capability Class (1090ES IN) Data (§2.2.5.1.23).....	595
2.4.5.1.24	Verification of Capability Class (ARV Report Capability) Data (§2.2.5.1.24).....	596
2.4.5.1.25	Verification of Capability Class (TS Report Capability) Data (§2.2.5.1.25)	596
2.4.5.1.26	Verification of Capability Class (TC Report Capability) Data (§2.2.5.1.26).....	596
2.4.5.1.27	Verification of Operational Mode (OM Format) Data (§2.2.5.1.27).....	596
2.4.5.1.28	Verification of Operational Mode (Position Offset Applied by Sensor) Data (§2.2.5.1.28).....	596
2.4.5.1.29	Verification of Operational Mode (TCAS/ACAS Resolution Advisory Active) Data (§2.2.5.1.29).....	596
2.4.5.1.30	Verification of Operational Mode (IDENT Switch Active) Data (§2.2.5.1.30)	596
2.4.5.1.31	Verification of Operational Mode (Reserved for Receiving ATC Services) Data (§2.2.5.1.31)	596
2.4.5.1.32	Verification of the Radio Altitude Data (§2.2.5.1.32)	597
2.4.5.1.33	Verification of the ADS-B Version Number Data (§2.2.5.1.33).....	597
2.4.5.1.34	Verification of Navigation Accuracy Category for Position (NAC _P) Data (§2.2.5.1.34)	597
2.4.5.1.35	Verification of Navigation Integrity Category for Barometric Altitude (NIC _{BARO}) Data (§2.2.5.1.35).....	597
2.4.5.1.36	Verification of Navigation Integrity Category Supplement Data (§2.2.5.1.36)	597
2.4.5.1.37	Verification of A/V Length/Width Code Data (§2.2.5.1.37).....	597
2.4.5.1.38	Verification of Track Angle/Heading Data (§2.2.5.1.38).....	597
2.4.5.1.39	Verification of Horizontal Reference Direction (HRD) Data (§2.2.5.1.39)	597
2.4.5.1.40	Verification of Source Integrity Level (SIL) Data (§2.2.5.1.40).....	598
2.4.5.1.41	Verification of SIL Supplement Data (§2.2.5.1.41)	598
2.4.5.1.42	Verification of MCP/FCU Selected Altitude or FMS Selected Altitude Data (§2.2.5.1.42).....	598
2.4.5.1.43	Verification of Barometric Pressure Setting (Minus 800 millibars) Data (§2.2.5.1.43).....	598
2.4.5.1.44	Verification of Selected Heading Data (§2.2.5.1.44)	598
2.4.5.1.45	Verification of MCP/FCU Mode Bits Data (§2.2.5.1.45)	598
2.4.5.1.46	Verification of Emergency/Priority Status Data (§2.2.5.1.46)	598
2.4.5.1.47	Verification of Mode A (4096) Code Data (§2.2.5.1.47)	598
2.4.5.1.48	Verification of TCAS Operational Data (§2.2.5.1.48, §2.4.3.2.7.2.3.2)	599
2.4.5.1.49	Verification of Single Antenna Flag Data (§2.2.5.1.49, §2.2.3.2.7.2.4.5).....	599
2.4.5.1.50	Verification of System Design Assurance (SDA) Data (§2.2.5.1.50, §2.2.3.2.7.2.4.6)	599
2.4.5.1.51	Verification of GNSS Vertical Figure of Merit (VFOM) Data (§2.2.5.1.51, §2.2.3.2.7.2.8).....	599
2.4.5.1.52	Verification of GPS Antenna Offset Data (§2.2.5.1.52, §2.2.3.2.7.2.4.7)	599
2.4.5.1.53	Verificaion of UTC HRs:Min:Sec Data (§2.2.5.1.53).....	599
2.4.5.1.54	Verificaion Of UTC Fine Seconds Data (§2.2.5.1.54)	599
2.4.5.2	ADS-B Transmission Device Message Latency (§2.2.5.2)	599
2.4.5.2.1	Verification of Airborne Position Message Latency (§2.2.5.2.1).....	600
2.4.5.2.2	Verification of Surface Position Message Latency (§2.2.5.2.2).....	602

2.4.5.2.3	Verification of Aircraft Identification and Category Message Latency (§2.2.5.2.3).....	604
2.4.5.2.4	Verification of Airborne Velocity Message – Subtype=1 Latency (§2.2.5.2.4, §2.2.3.2.6.1).....	606
2.4.5.2.5	Verification of Airborne Velocity Message – Subtype=2 Latency (§2.2.3.2.6.2, §2.2.5.2.5).....	610
2.4.5.2.6	Verification of Airborne Velocity Message – Subtype=3 Latency (§2.2.3.2.6.3, §2.2.5.2.6).....	610
2.4.5.2.7	Verification of Airborne Velocity Message – Subtype=4 Latency (§2.2.3.2.6.4, §2.2.5.2.7).....	613
2.4.5.2.8	Verification of Airborne Velocity Message – Subtype “5” Latency (§2.2.5.2.8)	613
2.4.5.2.9	Verification of Airborne Velocity Message – Subtype “6” Latency (§2.2.5.2.9)	613
2.4.5.2.10	Verification of Airborne Velocity Message – Subtype “7” Latency (§2.2.5.2.10)	614
2.4.5.2.11	Verification of Target State and Status Message Latency (§2.2.3.2.7.1, §2.2.5.2.11)	614
2.4.5.2.12	Verification of Aircraft Operational Status Message Latency (§2.2.3.2.7.2, §2.2.5.2.12)	618
2.4.5.2.13	Verification of TYPE 23 Test Message Latency (§2.2.5.2.13)	625
2.4.5.2.14	Verification of TYPE 24 Message Latency (§2.2.5.2.14)	625
2.4.5.2.15	Verification of TYPE 25 Message Latency (§2.2.5.2.15)	626
2.4.5.2.16	Verification of TYPE 26 Message Latency (§2.2.5.2.16)	626
2.4.5.2.17	Verification of TYPE 27 Message Latency (§2.2.5.2.17)	626
2.4.5.2.18	Verification of Aircraft Status Messages – Subtype=1 (§2.2.5.2.18).....	626
2.4.5.2.19	Verification of TCAS RA Broadcast Messages – Subtype=2 (§2.2.5.2.19)	627
2.4.5.3	Verification of ADS-B Transmission Device Source Selection (§2.2.5.3)	628
2.4.6	VERIFICATION OF ADS-B RECEIVING DEVICE MESSAGE PROCESSOR CHARACTERISTICS (§2.2.6)	629
2.4.6.1	Verification of ADS-B Message Reception Function Requirements (§2.2.6.1).....	629
2.4.6.1.1	Verification of ADS-B Message Reception Function Output Message Structure Requirements (§2.2.6.1.1) ..	629
2.4.6.1.2	Verification of ADS-B and TIS-B Message Reception Function Output Message Delivery Requirements (§2.2.6.1.2).....	630
2.4.7	VERIFICATION OF THE ADS-B MESSAGE PROCESSOR CHARACTERISTICS (§2.2.7)	631
2.4.7.1	Verification of the ADS-B Receiving Device Message Reception (§2.2.7.1).....	631
2.4.7.1.1	Verification of the Receipt of TYPE Code Equal to ZERO (§2.2.7.1.1)	632
2.4.8	VERIFICATION OF THE ADS-B REPORT CHARACTERISTICS (§2.2.8).....	632
2.4.8.1	Verification of the ADS-B State Vector Report Characteristics (§2.2.8.1).....	632
2.4.8.1.1	Verification of the State Vector Report Type and Structure Identification and Validity Flags (§2.2.8.1.1).....	633
2.4.8.1.1.1	Verification of the State Vector Report Type and Structure Identification (§2.2.8.1.1.1)	633
2.4.8.1.1.2	Verification of State Vector Report Validity Flags Reporting (§2.2.8.1.1.2).....	634
2.4.8.1.2	Verification of the Participant Address (§2.2.8.1.2).....	634
2.4.8.1.3	Verification of the Address Qualifier (§2.2.8.1.3)	635
2.4.8.1.4	Verification of the Report Time of Applicability (§2.2.8.1.4)	636
2.4.8.1.4.1	Verification of the Time of Applicability for Estimated Position/Velocity (§2.2.8.1.4.1)	636
2.4.8.1.4.2	Verification of the Position Time of Applicability (§2.2.8.1.4.2)	638
2.4.8.1.4.2.1	Verification of Position Time of Applicability when “TIME” (T)=0 (§2.2.8.1.4.2.1)	639
2.4.8.1.4.2.2	Verification of Position Time of Applicability When “TIME” (T)=1 and UTC Time of Message Receipt is Available (§2.2.8.1.4.2.2).....	640
2.4.8.1.4.2.3	Verification of Position Time of Applicability when “TIME” (T) = “1” and UTC Time of Message Receipt is NOT available (§2.2.8.1.4.2.3)	642
2.4.8.1.4.3	Verification of the Velocity Time of Applicability (§2.2.8.1.4.3).....	642
2.4.8.1.5	Verification of Latitude (WGS-84) Reporting (§2.2.8.1.5).....	644
2.4.8.1.6	Verification of Longitude (WGS-84) Reporting (§2.2.8.1.6).....	646
2.4.8.1.7	Verification of Altitude, Geometric (WGS-84) Reporting (§2.2.8.1.7)	647
2.4.8.1.8	Verification of North/South Velocity Reporting (§2.2.8.1.8)	651
2.4.8.1.9	Verification of East/West Velocity Reporting (§2.2.8.1.9)	653
2.4.8.1.10	Verification of Ground Speed Reporting While on the Surface (§2.2.8.1.10)	655
2.4.8.1.11	Verification of Heading While on the Surface Reporting (§2.2.8.1.11).....	656
2.4.8.1.12	Verification of Altitude, Barometric (Pressure Altitude) Reporting (§2.2.8.1.12).....	657
2.4.8.1.13	Verification of Vertical Rate, Geometric/Barometric (§2.2.8.1.13)	659
2.4.8.1.14	Verification of Vertical Rate, Geometric (WGS-84) Reporting (§2.2.8.1.14)	660
2.4.8.1.15	Verification of Barometric Altitude Rate Reporting (§2.2.8.1.15).....	661
2.4.8.1.16	Verification of the Navigation Integrity Code (NIC) (§2.2.8.1.16).....	663

2.4.8.1.17	Verification of Estimated Latitude (WGS-84) Reporting (§2.2.8.1.17)	665
2.4.8.1.18	Verification of Estimated Longitude (WGS-84) Reporting (§2.2.8.1.18)	669
2.4.8.1.19	Verification of Estimated North/South Velocity Reporting (§2.2.8.1.19)	670
2.4.8.1.20	Verification of Estimated East/West Velocity Reporting (§2.2.8.1.20)	672
2.4.8.1.21	Verification of Surveillance Status / Discretes Reporting (§2.2.8.1.21)	675
2.4.8.1.22	Verification of Report Mode Reporting (§2.2.8.1.22)	677
2.4.8.2	Verification of the ADS-B Mode Status Report (§2.2.8.2)	677
2.4.8.2.1	Verification of the Mode Status Report Type and Structure Identification and Validity Flags (§2.2.8.2.1)	677
2.4.8.2.1.1	Verification of Mode Status Report Type and Structure Identification (§2.2.8.2.1.1)	678
2.4.8.2.1.2	Verification of the Mode Status Report Validity Flags (§2.2.8.2.1.2)	678
2.4.8.2.2	Verification of the Participant Address (§2.2.8.2.2)	678
2.4.8.2.3	Verification of the Address Qualifier (§2.2.8.2.3)	679
2.4.8.2.4	Verification of the Mode Status Report – Report Time of Applicability (§2.2.8.2.4)	679
2.4.8.2.5	Verification of the Mode Status Report – ADS-B Version Number (§2.2.8.2.5)	680
2.4.8.2.6	Verification of the Mode Status Report - Call Sign (§2.2.8.2.6)	681
2.4.8.2.7	Verification of the Mode Status Report - Emitter Category (§2.2.8.2.7)	682
2.4.8.2.8	Verification of the A/V Length and Width Code (§2.2.8.2.8)	684
2.4.8.2.9	Verification of the Mode Status Report - Emergency / Priority Status (§2.2.8.2.9)	685
2.4.8.2.10	Verification of the Mode Status Report - Capability Class Codes (§2.2.8.2.10)	686
2.4.8.2.11	Verification of the Mode Status Report - Operational Mode Data (§2.2.8.2.11)	687
2.4.8.2.12	Verification of the Mode Status Report - SV Quality – NAC _P (§2.2.8.2.12)	688
2.4.8.2.13	Verification of the Mode Status Report - SV Quality – NAC _V (§2.2.8.2.13)	690
2.4.8.2.14	Verification of the Mode Status Report - SV Quality – SIL (§2.2.8.2.14)	691
2.4.8.2.15	Verification of the Mode Status Report - SV Quality – GVA (§2.2.8.2.15)	692
2.4.8.2.16	Verification of the Mode Status Report - SV Quality NIC _{BARO} (§2.2.8.2.16)	693
2.4.8.2.17	Verification of the Track/Heading and Horizontal Reference Direction (HRD) (§2.2.8.2.17)	694
2.4.8.2.18	Verification of the Mode Status Report - Vertical Rate Type (§2.2.8.2.18)	698
2.4.8.2.19	Verification of the (Reserved for) Flight Mode Specific Data (§2.2.8.2.19)	699
2.4.8.3	Verification of the ADS-B On-Condition Report Characteristics (§2.2.8.3)	699
2.4.8.3.1	Verification of the Target State Report (§2.2.8.3.1)	699
2.4.8.3.1.1	Verification of the Target State Report Type and Structure Identification (§2.2.8.3.1.1)	699
2.4.8.3.1.2	Verification of Target State and Status Validity Flags (§2.2.8.3.1.2)	700
2.4.8.3.1.3	Verification of the Participant Address (§2.2.8.3.1.3)	701
2.4.8.3.1.4	Verification of the Address Qualifier (§2.2.8.3.1.4)	701
2.4.8.3.1.5	Verification of the Target State Report - Time of Applicability (§2.2.8.3.1.5)	701
2.4.8.3.1.6	Verification of Selected Altitude: Selected Altitude Type (§2.2.8.3.1.6)	702
2.4.8.3.1.7	Verification of the Selected Altitude: MCP/FCU Selected Altitude or FMS Selected Altitude (§2.2.8.3.1.7)	703
2.4.8.3.1.8	Verification of the Barometric Pressure Setting (Minus 800 millibars) (§2.2.8.3.1.8)	703
2.4.8.3.1.9	Verification of the Selected Heading (§2.2.8.3.1.9)	704
2.4.8.3.1.10	Verification of the Mode Indicators: Autopilot Engaged (§2.2.8.3.1.10)	704
2.4.8.3.1.11	Verification of the Mode Indicators: VNAV Mode Engaged (§2.2.8.3.1.11)	705
2.4.8.3.1.12	Verification of the Mode Indicators: Altitude Hold Mode (§2.2.8.3.1.12)	705
2.4.8.3.1.13	Verification of the Mode Indicators: Approach Mode (§2.2.8.3.1.13)	706
2.4.8.3.1.14	Verification of Mode Indicators: LNAV Mode Engaged (§2.2.8.3.1.14)	706
2.4.8.3.1.15	Verification of the Reserved Byte (§2.2.8.3.1.15)	707
2.4.8.3.2	Verification of the Air Referenced Velocity (ARV) Report (§2.2.8.3.2)	707
2.4.8.3.2.1	Verification of the ARV Report Type and Structure Identification and Validity Flags (§2.2.8.3.2.1)	707
2.4.8.3.2.1.1	Verification of the ARV Report Type and Structure Identification (§2.2.8.3.2.1.1)	707
2.4.8.3.2.1.2	Verification of the ARV Report Validity Flags (§2.2.8.3.2.1.2)	708
2.4.8.3.2.2	Verification of the Participant Address (§2.2.8.3.2.2)	709
2.4.8.3.2.3	Verification of the Address Qualifier (§2.2.8.3.2.3)	709
2.4.8.3.2.4	Verification of the Report Time of Applicability (§2.2.8.3.2.4)	710
2.4.8.3.2.5	Verification of the Airspeed (§2.2.8.3.2.5)	711

2.4.8.3.2.5.1	Verification of True Airspeed (TAS) Reporting (§2.2.8.3.2.5).....	711
2.4.8.3.2.5.2	Verification of Indicated Airspeed (IAS) Reporting (§2.2.8.3.2.5).....	712
2.4.8.3.2.6	Verification of the Airspeed Type (§2.2.8.3.2.6)	714
2.4.8.3.2.7	Verification of the Heading While Airborne (§2.2.8.3.2.7)	716
2.4.8.4	Verification of the Processing of Reserved Message Types (§2.2.8.4).....	717
2.4.8.5	Verification of the Receiving Installation Time Processing (§2.2.8.5)	717
2.4.8.5.1	Verification of Precision Installations (§2.2.8.5.1)	718
2.4.8.5.2	Verification of the Non-Precision Installations (§2.2.8.5.2)	718
2.4.9	VERIFICATION OF THE ADS-B REPORT TYPE REQUIREMENTS (§2.2.9).....	719
2.4.9.1	Verification of the ADS-B Receiver Reporting Requirements for Class A Equipage (§2.2.9.1).....	719
2.4.9.1.1	Verification of the ADS-B State Vector Reports for Class A Equipage (§2.2.9.1.1).....	719
2.4.9.1.2	Verification of the ADS-B Mode Status Reports for Class A Equipage (§2.2.9.1.2)	720
2.4.9.1.3	Verification of the ADS-B Target State Reports for Class A Equipage (§2.2.9.1.3)	721
2.4.9.1.4	Verification of the ADS-B Air Referenced Velocity Reports for Class A Equipage (§2.2.9.1.4)	721
2.4.9.2	Verification of the ADS-B Receiver Report Content Requirements for Class B Equipage (§2.2.9.2)	721
2.4.10	VERIFICATION OF THE ADS-B RECEIVER REPORT ASSEMBLY AND DELIVERY (§2.2.10)	721
2.4.10.1	Verification of the Fundamental Principals of Report Assembly and Delivery (§2.2.10.1).....	721
2.4.10.1.1	Verification of the General Data Flow (§2.2.10.1.1).....	722
2.4.10.1.2	Verification of the ADS-B Report Organization (§2.2.10.1.2)	722
2.4.10.1.3	Verification of the ADS-B Message Temporary Retention (§2.2.10.1.3).....	722
2.4.10.1.4	Verification of the Participant ADS-B Track Files (§2.2.10.1.4).....	724
2.4.10.2	Verification of the Report Assembly Initialization State (§2.2.10.2)	724
2.4.10.3	Verification of the Report Assembly Acquisition State (§2.2.10.3).....	724
2.4.10.3.1	Verification of the Report Assembly Acquisition State --- Airborne Participant (§2.2.10.3.1)	725
2.4.10.3.1.1	Verification of the Latency, Report Assembly Acquisition State --- Airborne Participant (§2.2.10.3.1.1)	728
2.4.10.3.2	Verification of the Report Assembly Acquisition State --- Surface Participant (§2.2.10.3.2)	728
2.4.10.3.2.1	Verification of the Latency, Report Assembly Acquisition State --- Surface Participant (§2.2.10.3.2.1)....	732
2.4.10.3.3	Verification of the Acquisition State Data Retention (§2.2.10.3.3)	732
2.4.10.4	Verification of the Report Assembly Track State (§2.2.10.4)	732
2.4.10.4.1	Verification of the Report Assembly Track State - Airborne Participant (§2.2.10.4.1)	732
2.4.10.4.1.1	Verification of the Report Assembly Track State Initialization - Airborne Participant (§2.2.10.4.1.1).....	733
2.4.10.4.1.2	Verification of the Report Assembly Track State Maintenance - Airborne Participant (§2.2.10.4.1.2)	735
2.4.10.4.1.3	Verification of the Report Assembly Track State Termination - Airborne Participant (§2.2.10.4.1.3)	737
2.4.10.4.2	Verification of the Report Assembly Track State - Surface Participant (§2.2.10.4.2)	738
2.4.10.4.2.1	Verification of the Report Assembly Track State Initialization - Surface Participant (§2.2.10.4.2.1) ...	739
2.4.10.4.2.2	Verification of the Report Assembly Track State Maintenance - Surface Participant (§2.2.10.4.2.2)...	740
2.4.10.4.2.3	Verification of the Report Assembly Track State Termination - Surface Participant (§2.2.10.4.2.3)....	741
2.4.10.5	Verification of the Minimum Number of Participant Track Files (§2.2.10.5).....	742
2.4.10.6	Verification of Reasonableness Tests for CPR Decoding of Received Position Messages (§2.2.10.6)	743
2.4.10.6.1	Verification of Reasonableness Test Overview (§2.2.10.6.1)	743
2.4.10.6.2	Verification of Reasonableness Test Applied to Positions Determined from Globally Unambiguous CPR Decoding (§2.2.10.6.2)	743
2.4.10.6.3	Verification of Reasonableness Test Applied to Positions Determined from Locally Unambiguous CPR Decoding (§2.2.10.6.3)	745
2.4.10.7	Verification of Duplicate Address Processing (§2.2.10.7).....	747
2.4.10.7.1	Verification of Candidate Duplicate Address Reporting (§2.2.10.7.1)	748
2.4.10.7.2	Verification of Duplicate Address Conditions (§2.2.10.7.2).....	749
2.4.10.7.3	Verification of Duplicate Address Report Capacity (§2.2.10.7.3)	751
2.4.11	VERIFICATION OF SELF TEST AND MONITORS (§2.2.11)	752
2.4.11.1	Verification of Self Test (§2.2.11.1).....	753
2.4.11.2	Verification of Broadcast Monitoring (§2.2.11.2).....	753
2.4.11.2.1	Verification of Transponder-Based Equipment Broadcast Monitoring (§2.2.11.2.1)	753
2.4.11.2.2	Verification of Non-Transponder-Based Equipment Broadcast Monitoring (§2.2.11.2.2).....	762

2.4.11.3	Verification of Address (§2.2.11.3).....	763
2.4.11.3.1	Verification of Transponder-Based Equipment Addressing (§2.2.11.3.1).....	763
2.4.11.3.2	Verification of Non-Transponder-Based Equipment Addressing (§2.2.11.3.2).....	763
2.4.11.4	Verification of Receiver Self Test Capability (§2.2.11.4).....	764
2.4.11.5	Verification of Failure Annunciation (§2.2.11.5).....	765
2.4.11.5.1	Verification of ADS-B Transmission Device Failure Annunciation (§2.2.11.5.1).....	765
2.4.11.5.2	Verification of ADS-B Receiving Device Failure Annunciation (§2.2.11.5.2).....	765
2.4.11.5.3	Verification of Co-Located ADS-B Transmission and Receiving Device Failure Annunciation (§2.2.11.6).	765
2.4.12	VERIFICATION OF RESPONSE TO MUTUAL SUPPRESSION PULSES (§2.2.12).....	765
2.4.12.1	Verification of ADS-B Transmitting Subsystem Response to Mutual Suppression Pulses (§2.2.12.1).....	766
2.4.12.2	Verification of ADS-B Receiving Device Response to Mutual Suppression Pulses (§2.2.12.2).....	766
2.4.13	VERIFICATION OF ANTENNA SYSTEM (§2.2.13).....	767
2.4.13.1	Verification of Transmit Pattern Gain (§2.2.13.1).....	767
2.4.13.2	Verification of Receiver Pattern Gain (§2.2.13.2).....	767
2.4.13.3	Verification of Frequency Requirements for Transmit and Receive Antenna(s) (§2.2.13.3).....	768
2.4.13.4	Verification of Impedance and VSWR (§2.2.13.4).....	768
2.4.13.5	Verification of Polarization (§2.2.13.5).....	768
2.4.13.6	Verification of Diversity Operation (§2.2.13.6).....	768
2.4.13.6.1	Verification of Transmitting Diversity (§2.2.13.6.1).....	768
2.4.13.6.1.1	Verification of Transmitting Diversity Channel Isolation (§2.2.13.6.1.1).....	769
2.4.13.6.2	Verification of Receiving Diversity (§2.2.13.6.2).....	770
2.4.13.6.2.1	Verification of Full Receiver and Message Processing or Receiver Switching Front-End Diversity (§2.2.13.6.2).....	770
2.4.13.6.2.2	Verification Receiving Antenna Switching Diversity (§2.2.13.6.2).....	772
2.4.14	VERIFICATION OF INTERFACES (§2.2.14).....	773
2.4.14.1	Verification of ADS-B Transmitting Subsystem Interfaces (§2.2.14.1).....	773
2.4.14.1.1	Verification of ADS-B Transmitting Subsystem Input Interfaces (§2.2.14.1.1).....	773
2.4.14.1.1.1	Verification of Discrete Input Interfaces (§2.2.14.1.1.1).....	773
2.4.14.1.1.2	Verification of Digital Communication Input Interfaces (§2.2.14.1.1.2).....	773
2.4.14.1.1.3	Verification of Processing Efficiency (§2.2.14.1.1.3).....	773
2.4.14.1.2	Verification of ADS-B Transmitting Subsystem Output Interfaces (§2.2.14.1.2).....	774
2.4.14.1.2.1	Verification of Discrete Output Interfaces (§2.2.14.1.2.1).....	774
2.4.14.1.2.2	Verification of Digital Communication Output Interfaces (§2.2.14.1.2.2).....	774
2.4.14.2	Verification of ADS-B Receiving Device Interfaces (§2.2.14.2).....	774
2.4.14.2.1	Verification of ADS-B Receiving Device Input Interfaces (§2.2.14.2.1).....	774
2.4.14.2.1.1	Verification of Discrete Input Interfaces (§2.2.14.2.1.1).....	774
2.4.14.2.1.2	Verification of Digital Communication Input Interfaces (§2.2.14.2.1.2).....	775
2.4.14.2.1.3	Verification of Processing Efficiency (§2.2.14.2.1.3).....	775
2.4.14.2.2	Verification of ADS-B Receiving Device Output Interfaces (§2.2.14.2.2).....	775
2.4.14.2.2.1	Verification of Discrete Output Interfaces (§2.2.14.2.2.1).....	775
2.4.14.2.2.2	Verification of Digital Communication Output Interfaces (§2.2.14.2.2.2).....	776
2.4.15	VERIFICATION OF POWER INTERRUPTION (§2.2.15).....	776
2.4.15.1	Verification of Power Interruption to ADS-B Transmitting Subsystems (§2.2.15).....	776
2.4.15.2	Verification of Power Interruption to ADS-B Receiving Subsystems (§2.2.15).....	777
2.4.16	VERIFICATION OF COMPATIBILITY WITH OTHER SYSTEMS (§2.2.16).....	778
2.4.16.1	Verification of EMI Compatibility (§2.2.16.1).....	778
2.4.16.2	Verification of Compatibility with GPS Receivers (§2.2.16.2).....	778
2.4.16.3	Verification of Compatibility with Other Navigation Receivers and ATC Transponders (§2.2.16.3).....	778
2.4.17	VERIFICATION OF TRAFFIC INFORMATION SERVICES – BROADCAST (TIS-B) (§2.2.17).....	778
2.4.17.1	Verification of TIS-B Introduction (§2.2.17.1).....	778
2.4.17.2	Verification of the TIS-B Format Structure (§2.2.17.2).....	778
2.4.17.2.1	Verification of the “DF” Downlink Format (§2.2.17.2.1).....	779
2.4.17.2.2	Verification of the “CF” Control Field (§2.2.17.2.2).....	779
2.4.17.2.3	Verification of the “AA” Address Announced Field (§2.2.17.2.3).....	780

2.4.17.2.4	Verification of the “ME” Message Extended Squitter Field (§2.2.17.2.4).....	780
2.4.17.2.5	Verification of the “PI” Parity/Identify Field (§2.2.17.2.5)	781
2.4.17.3	Verification of TIS-B Messages (§2.2.17.3)	781
2.4.17.3.1	Verification of TIS-B Fine Airborne Position Message (§2.2.17.3.1)	781
2.4.17.3.1.1	Verification of the Relationship to ADS-B Format (§2.2.17.3.1.1)	781
2.4.17.3.1.2	Verification of the ICAO/Mode A Flag (IMF) (§2.2.17.3.1.2)	781
2.4.17.3.2	Verification of TIS-B Fine Surface Position Message (§2.2.17.3.2).....	782
2.4.17.3.2.1	Verification of the Relationship to ADS-B Format (§2.2.17.3.2.1)	782
2.4.17.3.2.2	Verification of the ICAO/Mode A Flag (IMF) (§2.2.17.3.2.2)	782
2.4.17.3.3	TIS-B Identification and Category Message (§2.2.17.3.3).....	783
2.4.17.3.3.1	Verification of the Relationship to ADS-B Format (§2.2.17.3.3.1)	783
2.4.17.3.4	Verification of TIS-B Velocity Message (§2.2.17.3.4)	783
2.4.17.3.4.1	Verification of the Relationship to ADS-B Format (§2.2.17.3.4.1)	783
2.4.17.3.4.2	Verification of ICAO/Mode A Flag (IMF) (§2.2.17.3.4.2).....	784
2.4.17.3.4.3	Verification of Navigation Integrity Category (NIC) Supplement-A (§2.2.17.3.4.3)	784
2.4.17.3.4.4	Verification of the Navigation Accuracy Category for Position (NAC _p) (§2.2.17.3.4.4).....	785
2.4.17.3.4.5	Verification of the Navigation Accuracy Category for Velocity (NAC _v) (§2.2.17.3.4.5).....	785
2.4.17.3.4.6	Verification of the Source Integrity Level (SIL) (§2.2.17.3.4.6)	786
2.4.17.3.4.7	Verification of the True/Magnetic Heading Type (§2.2.17.3.4.7).....	786
2.4.17.3.5	Verification of the TIS-B Coarse Position Message (§2.2.17.3.5).....	786
2.4.17.3.5.1	Verification of the Relationship to ADS-B Format (§2.2.17.3.5.1)	786
2.4.17.3.5.2	Verification of the ICAO/Mode A Flag (IMF) (§2.2.17.3.5.2)	786
2.4.17.3.5.3	Verification of the Service Volume ID (SVID) (§2.2.17.3.5.3).....	787
2.4.17.3.5.4	Verification of the Pressure Altitude (§2.2.17.3.5.4)	787
2.4.17.3.5.5	Verification of the Ground Track Status (§2.2.17.3.5.5).....	787
2.4.17.3.5.6	Verification of the Ground Track Angle (§2.2.17.3.5.6).....	788
2.4.17.3.5.7	Verification of the Ground Speed (§2.2.17.3.5.7).....	789
2.4.17.3.5.8	Verification of the 12-bit CPR Decoded Latitude and Longitude (§2.2.17.3.5.8)	789
2.4.17.4	Verification of TIS-B Message Processing and Report Generation (§2.2.17.4)	794
2.4.17.4.1	Verification of TIS-B Message-to-Track Correlation (§2.2.17.4.1).....	795
2.4.17.4.1.1	Verification of TIS-B Messages Having a ICAO 24-Bit Address (§2.2.17.4.1.1).....	795
2.4.17.4.1.2	Verification of TIS-B Messages Having Mode A Code and Track Number (§2.2.17.4.1.2).....	795
2.4.17.4.2	Verification of TIS-B Position Message Decoding (§2.2.17.4.2)	796
2.4.17.4.3	Verification of TIS-B Track Update (§2.2.17.4.3)	796
2.4.17.4.4	Verification of TIS-B Track Initiation (§2.2.17.4.4).....	797
2.4.17.4.5	Verification of TIS-B Track Drop (§2.2.17.4.5)	798
2.4.17.4.6	Verification of TIS-B Report Generation (§2.2.17.4.6)	798
2.4.18	VERIFICATION OF THE ADS-B REBROADCAST SERVICE – FORMATS AND CODING (§2.2.18).....	799
2.4.18.1	Verification of the Introduction (§2.2.18.1)	799
2.4.18.2	Verification of the ADS-B Rebroadcast Format Definitions (§2.2.18.2).....	799
2.4.18.3	Verification of the Control Field Allocations (§2.2.18.3)	799
2.4.18.4	Verification of the ADS-B Rebroadcast Surveillance Message Definitions (§2.2.18.4).....	799
2.4.18.4.1	Verification of the ADS-R Airborne Position Messages (§2.2.18.4.1)	800
2.4.18.4.2	Verification of the ADS-R Surface Position Messages (§2.2.18.4.2)	801
2.4.18.4.3	Verification of the ADS-R Aircraft Identification and Category Messages (§2.2.18.4.3)	802
2.4.18.4.4	Verification of the ADS-R Airborne Velocity Messages (§2.2.18.4.4)	802
2.4.18.4.5	Verification of the ADS-R Aircraft Emergency/Priority Status Messages (§2.2.18.4.5).....	804
2.4.18.4.6	Verification of the ADS-R Target State and Status Messages (§2.2.18.4.6).....	805
2.4.18.4.7	Verification of the ADS-R Aircraft Operational Status Messages (§2.2.18.4.7)	806
2.4.18.5	Verification of ADS-R Report Processing (§2.2.18.5).....	807

3.0 INSTALLED EQUIPMENT PERFORMANCE 809

3.1 INSTALLED EQUIPMENT CONSIDERATIONS 809

3.1.1	DATA SOURCES	810
3.1.2	ADS-B TRANSMIT POWER	810
3.1.3	ADS-B RECEIVER	810
3.1.4	REPORT GENERATOR.....	811
3.1.5	APPLICATIONS	811
3.2	EQUIPMENT INSTALLATION	811
3.2.1	AIRCRAFT ENVIRONMENT	811
3.2.2	AIRCRAFT POWER SOURCE.....	811
3.2.2.1	Power Fluctuation.....	811
3.2.3	ACCESSIBILITY	811
3.2.4	DISPLAY VISIBILITY	812
3.2.5	INDICATORS.....	812
3.2.6	ALERTS	812
3.2.7	FAILURE PROTECTION	812
3.2.8	FAILURE INDICATION	812
3.2.8.1	ADS-B Transmission or Receiver Device Failure Annunciation	812
3.2.8.2	ADS-B Function Fail Annunciation (§2.2.11.6)	812
3.2.8.2.1	ADS-B Transmit Function Fail Annunciation.....	812
3.2.8.2.2	ADS-B Receive Function Fail Annunciation	813
3.2.9	INTERFERENCE EFFECTS	813
3.3	ANTENNA INSTALLATION	813
3.3.1	GENERAL CONSIDERATIONS	813
3.3.2	TRANSMISSION LINES.....	813
3.3.3	ANTENNA LOCATION.....	814
3.3.3.1	Minimum Distance from Other Antennas	814
3.3.3.2	Mutual Suppression	814
3.3.4	ANTENNA GAIN PERFORMANCE	814
3.3.4.1	Gain Performance Verification.....	815
3.3.4.1.1	Success Criteria	815
3.3.4.2	Full Scale Anechoic Antenna Range Measurements of Gain.....	816
3.3.4.3	Scaled Model Measurements of Gain.....	816
3.3.4.4	Model Tests	816
3.3.4.5	Theoretical Calculations of Antenna Gain	817
3.3.4.5.1	Validation of Theoretical Calculations.....	817
3.3.4.5.2	Distance Area Calculations	817
3.3.4.5.3	Dynamic Response	818
3.3.4.6	Installed Equipment Antenna System.....	818
3.3.4.6.1	Verification of Transmit Pattern Gain (§2.2.13.1)	818
3.3.4.6.2	Verification of Receiver Pattern Gain (§2.2.13.2).....	826
3.3.4.6.3	Verification of Frequency Requirements for Transmit and Receive Antenna(s) (§2.2.13.3).....	827
3.3.4.6.4	Verification of Impedance and VSWR (§2.2.13.4).....	827
3.3.4.6.5	Verification of Polarization (§2.2.13.5).....	828
3.4	FLIGHT ENVIRONMENT DATA SOURCES.....	829
3.4.1	NAVIGATION ACCURACY CATEGORY (NAC _p).....	829
3.4.2	ALTITUDE.....	829
3.4.3	SURFACE/ AIR (VERTICAL) STATUS	829
3.5	AIRCRAFT / VEHICLE DATA	829
3.5.1	FIXED DATA	829
3.5.2	VARIABLE DATA	829
3.5.3	ON-CONDITION SENSORS.....	830
3.5.4	CLASS CODE (BASIC).....	830
3.5.5	CAPABILITY CLASS DATA	830
3.6	FLIGHT TEST PROCEDURES.....	830
3.6.1	DISPLAYED DATA READABILITY	830
3.6.2	INTERFERENCE EFFECTS.....	830

3.6.3	SURVEILLANCE TESTING	831
-------	----------------------------	-----

4.0 OPERATIONAL CHARACTERISTICS AND FUNCTIONAL REQUIREMENTS.....833

4.1	SYSTEM OPERATION	833
4.1.1	GENERAL OPERATION: TRANSMITTING SUBSYSTEM	833
4.1.2	GENERAL OPERATION: RECEIVING SUBSYSTEM	834
4.2	OPERATING MODES	835
4.2.1	OPERATING MODES: TRANSMIT.....	835
4.2.1.1	Surface Mode.....	836
4.2.1.2	Air Mode	836
4.2.2	AUTOMATIC OPERATION	836
4.3	SELF TEST	836
4.3.1	RECEIVE	836
4.3.2	TRANSMIT	837
4.3.2.1	Broadcast Monitor	837
4.3.2.2	Address Monitor	837
4.3.2.3	Failure Annunciation	837
4.4	CONTROLS.....	837
4.4.1	POWER ON/OFF (OPTIONAL)	837
4.4.2	MANUAL TEST (OPTIONAL).....	837
4.4.2.1	Traffic Report	838
4.4.2.2	State Vector Report	838
4.4.3	PARTICIPANT ADDRESS (OPTIONAL)	838
4.4.4	FLIGHT NUMBER (OPTIONAL)	838
4.4.5	1090 MHz ADS-B LINK CONTROL (OPTIONAL)	838
4.4.6	STANDBY.....	838
4.4.7	MODE CONTROL.....	838
4.4.8	BAROMETRIC ALTITUDE.....	839

MEMBERSHIP.....841

A EXTENDED SQUITTER AND TIS-B FORMATS AND CODING DEFINITIONSA-3

A.1	ADS-B 1090 MHz FORMATS AND CODING	A-3
A.1.1	INTRODUCTION.....	A-3
A.1.2	REGISTER ALLOCATION RELATED TO EXTENDED SQUITTER	A-4
A.1.3	GENERAL CONVENTIONS ON DATA FORMATS	A-5
A.1.3.1	Validity of Data	A-5
A.1.3.2	Representation of Numerical Data.....	A-5
A.1.4	EXTENDED SQUITTER FORMATS	A-7
A.1.4.1	Format TYPE Codes.....	A-7
A.1.4.1.1	Airborne Position Message TYPE Code	A-11
A.1.4.1.1.1	Airborne Position Message TYPE Code if Containment Radius is Available	A-11
A.1.4.1.1.2	Airborne Position Message TYPE Code if Containment Radius is Not Available	A-11
A.1.4.1.1.3	Airborne Position Message TYPE Code During Fault Detection and Exclusion Condition.....	A-12
A.1.4.1.2	Surface Position Message TYPE Code.....	A-13
A.1.4.1.2.1	Surface Position Message TYPE Code if Containment Radius is Available.....	A-13
A.1.4.1.2.2	Surface Position Message TYPE Code if Radius of Containment is Not Available	A-13
A.1.4.1.2.3	Surface Position Message TYPE Code based on Horizontal Protection Level or Estimated Horizontal Position Accuracy	A-13

A.1.4.1.2.4	Surface Position Message TYPE Code During Fault Detection and Exclusion Condition	A-14
A.1.4.2	Airborne Position Format	A-15
A.1.4.2.1	Compact Position Reporting (CPR) Format (F)	A-15
A.1.4.2.2	Time Synchronization (T).....	A-15
A.1.4.2.3	CPR Encoded Latitude/Longitude	A-15
A.1.4.2.3.1	Extrapolating Position (When T=1)	A-16
A.1.4.2.3.2	Extrapolating Position (When T=0)	A-17
A.1.4.2.3.3	Time-Out When New Position Data is Unavailable	A-17
A.1.4.2.4	Altitude	A-18
A.1.4.2.5	NIC Supplement-B	A-18
A.1.4.3	Surface Position Format	A-18
A.1.4.3.1	Movement.....	A-18
A.1.4.3.2	Heading.....	A-19
A.1.4.3.2.1	Heading/Ground Track Status	A-19
A.1.4.3.2.2	Heading/Ground Track Value	A-19
A.1.4.3.3	Compact Position Reporting (CPR) Format (F)	A-19
A.1.4.3.4	Time Synchronization (T).....	A-20
A.1.4.3.5	CPR Encoded Latitude/Longitude	A-20
A.1.4.3.5.1	Extrapolating Position (When T=1)	A-20
A.1.4.3.5.2	Extrapolating Position (When T=0)	A-20
A.1.4.3.5.3	Time-Out When New Position Data is Unavailable.....	A-20
A.1.4.4	Identification and Category Format.....	A-21
A.1.4.4.1	Aircraft Identification Coding	A-21
A.1.4.5	Airborne Velocity Format.....	A-21
A.1.4.5.1	Subtypes 1 and 2.....	A-22
A.1.4.5.2	Subtypes 3 and 4.....	A-22
A.1.4.5.3	Intent Change Flag in Airborne Velocity Messages	A-23
A.1.4.5.4	Navigation Accuracy Category for Velocity (NAC _V).....	A-23
A.1.4.5.5	Heading in Airborne Velocity Messages	A-24
A.1.4.5.5.1	Heading Status.....	A-24
A.1.4.5.5.2	Heading Value	A-24
A.1.4.5.6	Difference from Baro Altitude in Airborne Velocity Messages	A-24
A.1.4.6	Aircraft Status Register Format	A-24
A.1.4.6.1	Purpose	A-25
A.1.4.6.2	Transmission Rate Subfield (TRS)	A-25
A.1.4.6.3	Altitude Type Subfield (ATS)	A-25
A.1.4.7	Event-Driven Protocol	A-25
A.1.4.7.1	Purpose	A-26
A.1.4.7.2	TCAS Resolution Advisory (RA) Broadcast.....	A-26
A.1.4.7.2.1	Transmission Rate	A-26
A.1.4.7.2.2	Message Delivery	A-26
A.1.4.7.3	Emergency/Priority Status and Mode A Code.....	A-27
A.1.4.7.3.1	Transmission Rate	A-27
A.1.4.7.3.1.1	“Emergency/Priority Status Message” Broadcast Rates When Transmission of Mode A Code is Disabled	A-27
A.1.4.7.3.1.2	Emergency/Priority Status Message” Broadcast Rates When Transmission of Mode A Code is Enabled	A-28
A.1.4.7.3.2	Message Delivery	A-28
A.1.4.8	Periodic Status Messages.....	A-28
A.1.4.9	Target State and Status Information	A-29
A.1.4.9.1	Transmission Rate	A-29
A.1.4.9.2	Source Integrity Level (SIL) Supplement.....	A-29
A.1.4.9.3	Selected Altitude Type	A-29
A.1.4.9.4	MCP/FCU Selected Altitude or FMS Selected Altitude.....	A-30
A.1.4.9.5	Barometric Pressure Setting (Minus 800 millibars).....	A-31

A.1.4.9.6	Selected Heading Status	A-32
A.1.4.9.7	Selected Heading Sign.....	A-32
A.1.4.9.8	Selected Heading	A-33
A.1.4.9.9	Navigation Accuracy Category for Position (NAC _P).....	A-34
A.1.4.9.10	Navigation Integrity Category for Baro (NIC _{BARO}).....	A-34
A.1.4.9.11	Source Integrity Level (SIL).....	A-35
A.1.4.9.12	Status of MCP/FCU Mode Bits	A-36
A.1.4.9.13	Autopilot Engaged.....	A-36
A.1.4.9.14	VNAV Mode Engaged	A-37
A.1.4.9.15	Altitude Hold Mode.....	A-37
A.1.4.9.16	Reserved for ADS-R Flag.....	A-38
A.1.4.9.17	Approach Mode	A-38
A.1.4.9.18	TCAS/ACAS Operational	A-38
A.1.4.9.19	LNAV Mode Engaged.....	A-39
A.1.4.10	Aircraft Operational Status Message	A-39
A.1.4.10.1	Transmission Rate	A-39
A.1.4.10.2	Message Delivery	A-40
A.1.4.10.3	Capability Class (CC) Codes	A-40
A.1.4.10.4	Operational Mode (OM).....	A-42
A.1.4.10.5	Version Number	A-44
A.1.4.10.6	Navigation Integrity Category (NIC) and NIC Supplement-A.....	A-44
A.1.4.10.7	Navigation Accuracy Category for Position (NAC _P).....	A-45
A.1.4.10.8	Geometric Vertical Accuracy (GVA).....	A-46
A.1.4.10.9	Source Integrity Level (SIL).....	A-46
A.1.4.10.10	Barometric Altitude Integrity Code (NIC _{BARO}).....	A-46
A.1.4.10.11	Aircraft Length and Width Codes	A-47
A.1.4.10.12	Track Angle/Heading	A-48
A.1.4.10.13	Horizontal Reference Direction (HRD).....	A-48
A.1.4.10.14	System Design Assurance (SDA).....	A-48
A.1.4.10.15	SIL Supplement	A-49
A.1.4.10.16	TCAS/ACAS Operational	A-49
A.1.4.10.17	1090ES IN	A-49
A.1.4.10.18	UAT IN.....	A-50
A.1.4.10.19	Navigation Accuracy Category for Velocity (NAC _V).....	A-50
A.1.4.10.20	NIC Supplement-C	A-50
A.1.4.10.21	GPS Antenna Offset	A-50
A.1.5	INITIALIZATION AND TIMEOUT	A-52
A.1.5.1	Initiation of Extended Squitter Broadcast.....	A-52
A.1.5.2	Register Timeout	A-52
A.1.5.3	Termination of Extended Squitter Broadcast.....	A-54
A.1.5.4	Requirements for Non-Transponder Devices	A-55
A.1.6	GENERAL FORMATTER/MANAGER (GFM)	A-55
A.1.6.1	Navigation Source Selection.....	A-55
A.1.6.2	Loss of Input Data	A-55
A.1.6.3	Special Processing for Format TYPE Code Zero	A-56
A.1.6.3.1	Significance of Format TYPE Code Equal to Zero	A-56
A.1.6.3.2	Broadcast of Format TYPE Code Equal to Zero	A-56
A.1.6.3.3	Reception of Format TYPE Code Equal to Zero	A-56
A.1.6.4	Handling of Event-Driven Protocol.....	A-57
A.1.6.4.1	Transponder Support for the Event Driven Protocol.....	A-57
A.1.6.4.2	GFM Use of the Event-Driven Protocol.....	A-57
A.1.6.4.3	Event-Driven Message Transmission Scheduling Function	A-58
A.1.7	LATITUDE/LONGITUDE CODING USING COMPACT POSITION REPORTING (CPR)	A-59
A.1.7.1	Principle of the CPR Algorithm	A-59
A.1.7.2	CPR Algorithm Parameters and Internal Functions.....	A-60

A.1.7.3	CPR Encoding Process	A-62
A.1.7.4	Locally Unambiguous CPR Decoding.....	A-64
A.1.7.5	Locally Unambiguous CPR Decoding for Airborne, TIS-B and Intent Lat/Lon.....	A-64
A.1.7.6	Locally Unambiguous Decoding for Surface Position	A-65
A.1.7.7	Globally Unambiguous Airborne Position Decoding.....	A-66
A.1.7.8	Globally Unambiguous CPR Decoding of Surface Position	A-68
A.1.7.9	CPR Decoding of Received Position Reports.....	A-71
A.1.7.9.1	Overview	A-71
A.1.7.9.2	Emitter Centered Local Decoding	A-71
A.1.7.10	Reasonableness Test for CPR Decoding of Received Position Messages.....	A-71
A.1.7.10.1	Overview	A-71
A.1.7.10.2	Reasonableness Test Applied to Position Determined from Globally Unambiguous Decoding.....	A-72
A.1.7.10.3	Reasonableness Test Applied to Position Determined from Locally Unambiguous Decoding.....	A-72
A.1.7.10.4	Duplicate Address Processing	A-73
A.1.7.10.4.1	Candidate Duplicate Address Report.....	A-74
A.1.7.10.4.2	Duplicate Address Condition.....	A-74
A.1.7.10.4.3	Duplicate Address Report Capacity.....	A-75
A.1.8	FORMATS FOR EXTENDED SQUITTER.....	A-75
A.2	TRAFFIC INFORMATION SERVICES – BROADCAST (TIS-B) FORMATS AND CODING.....	A-87
A.2.1	INTRODUCTION.....	A-87
A.2.2	TIS-B FORMAT DEFINITION	A-87
A.2.3	CONTROL FIELD ALLOCATION.....	A-87
A.2.4	TIS-B SURVEILLANCE MESSAGE DEFINITION	A-88
A.2.4.1	TIS-B Fine Airborne Position Message.....	A-88
A.2.4.1.1	ICAO/Mode A Flag (IMF)	A-88
A.2.4.1.2	Pressure Altitude.....	A-89
A.2.4.1.3	Compact Position Reporting (CPR) Format (F)	A-89
A.2.4.1.4	Latitude/Longitude	A-89
A.2.4.2	TIS-B Surface Position Message	A-89
A.2.4.2.1	Movement.....	A-89
A.2.4.2.1.1	Ground Track (True)	A-89
A.2.4.2.1.1.1	Ground Track Status.....	A-89
A.2.4.2.1.1.2	Ground Track Angle.....	A-89
A.2.4.2.1.2	ICAO/Mode A Flag (IMF)	A-89
A.2.4.2.1.3	Compact Position Reporting (CPR) Format (F)	A-89
A.2.4.2.1.4	Latitude/Longitude	A-90
A.2.4.3	Identification and Category Message	A-90
A.2.4.3.1	Aircraft Identification Coding	A-90
A.2.4.4	Velocity Message	A-90
A.2.4.4.1	Subtype Field.....	A-90
A.2.4.4.2	ICAO/Mode A Flag (IMF)	A-90
A.2.4.5	Coarse Airborne Position Message.....	A-91
A.2.4.5.1	ICAO/Mode A Flag (IMF)	A-91
A.2.4.5.2	Service Volume ID (SVID)	A-91
A.2.4.5.3	Pressure Altitude.....	A-91
A.2.4.5.4	Ground Track Status.....	A-91
A.2.4.5.5	Ground Track Angle.....	A-91
A.2.4.5.6	Ground Speed	A-91
A.2.4.5.7	Latitude/Longitude	A-92
A.2.5	TIS-B AND ADS-R MANAGEMENT MESSAGES	A-92
A.2.6	TIS-B REPORT GENERATION.....	A-92
A.2.7	FORMATS FOR 1090 MHz TIS-B MESSAGES	A-93
A.3	ADS-B REBROADCAST SERVICE – FORMATS AND CODING	A-99
A.3.1	INTRODUCTION.....	A-99
A.3.2	ADS-B REBROADCAST FORMAT DEFINITION.....	A-99

A.3.3	CONTROL FIELD ALLOCATION.....	A-99
A.3.4	ADS-B REBROADCAST SURVEILLANCE MESSAGE DEFINITIONS	A-99
A.3.4.1	Rebroadcast of ADS-B Airborne Position Messages	A-100
A.3.4.2	ADS-R Surface Position Message	A-100
A.3.4.3	ADS-R Aircraft Identification and Category Message	A-100
A.3.4.4	ADS-R Airborne Velocity Message	A-100
A.3.4.5	ADS-R Extended Squitter Aircraft Status Message	A-101
A.3.4.6	ADS-R Target State and Status Message	A-101
A.3.4.7	ADS-R Aircraft Operational Status Message	A-101
A.3.5	ADS-R REPORT PROCESSING	A-102

B ACRONYMS AND DEFINITION OF TERMS B-3

B.1	ACRONYMS	B-3
B.2	DEFINITION OF TERMS.....	B-11
B.3	ILLUSTRATIONS OF GEODETIC COORDINATE DEFINITIONS.....	B-22
B.3.1	LATITUDE, LONGITUDE AND GEODETIC HEIGHT	B-22
B.3.2	LATITUDE AND LONGITUDE REPRESENTATIONS	B-24

C AIRCRAFT ANTENNA CHARACTERISTICS..... C-3

C.1	INTRODUCTION	C-3
C.2	MODEL AIRCRAFT ANTENNA PATTERN MEASUREMENTS	C-4
C.3	ANALYSIS OF AIRCRAFT ANTENNA GAIN MEASUREMENTS.....	C-4

D 1090 MHZ ADS-B GROUND ARCHITECTURE EXAMPLE.....D-3

D.1	INTRODUCTION AND PURPOSE.....	D-3
D.2	ATC SURVEILLANCE	D-3
D.2.1	AVIONICS EQUIPAGE	D-3
D.2.2	TRANSITION ISSUES	D-4
D.2.3	GROUND SURVEILLANCE OF AIRBORNE AIRCRAFT	D-4
D.2.3.1	Surveillance techniques	D-4
D.2.3.1.1	Current technology	D-4
D.2.3.1.2	End state surveillance using Extended Squitter	D-4
D.2.3.2	Airspace considerations	D-5
D.2.3.3	Transition strategy	D-5
D.2.3.3.1	Validation	D-5
D.2.3.3.2	Backup	D-6
D.2.3.3.3	Mixed equipage	D-6
D.2.3.4	Special considerations for precision runway monitoring	D-6
D.2.4	SURFACE SURVEILLANCE.....	D-7
D.2.4.1	Surveillance techniques	D-7
D.2.4.1.1	Current technology	D-7
D.2.4.1.2	End state surveillance using Extended Squitter	D-7
D.2.4.2	Transition strategy	D-8
D.2.4.2.1	Validation	D-8
D.2.4.2.2	Backup	D-8
D.2.4.2.3	Mixed equipage	D-8
D.2.4.2.4	ASDE-X Surface Surveillance System.....	D-8
D.2.5	TRANSITION STRATEGY SUMMARY	D-9
D.2.6	GROUND ARCHITECTURE FOR AIR-GROUND SURVEILLANCE	D-9

D.2.6.1	Introduction	D-9
D.2.6.1.1	Purpose	D-9
D.2.6.1.2	Overview	D-10
D.2.6.1.3	Interface Considerations	D-10
D.2.6.2	Mode S SSR Ground Station	D-10
D.2.6.3	Extended Squitter Ground Stations	D-11
D.2.6.3.1	Overview	D-11
D.2.6.3.2	Omni Antenna, Receive only.....	D-12
D.2.6.3.3	Omni Antenna, Receive only, Angle of Arrival Capability.....	D-13
D.2.6.3.4	Six-Sector Antenna, Receive/Transmit.....	D-14
D.2.6.3.5	Multilateration Augmentation.....	D-15
D.2.7	GROUND ARCHITECTURE FOR SURFACE SURVEILLANCE	D-16
D.2.7.1	Overview	D-16
D.2.7.2	Extended Squitter Surface Ground System	D-16
D.2.7.3	Candidate Ground Architecture.....	D-17
D.2.8	INTEGRATION WITH OTHER RADARS AND AUTOMATION SYSTEMS	D-17
D.2.8.1	Overview	D-17
D.2.8.2	The Need for Fusion	D-18
D.2.8.3	Architecture Considerations	D-18
D.2.9	ATC SURVEILLANCE SUMMARY	D-20
D.3	TRAFFIC INFORMATION SERVICE BROADCAST (TIS-B)	D-20
D.3.1	OVERVIEW.....	D-20
D.3.2	GROUND DETERMINATION OF EXTENDED SQUITTER EQUIPAGE.....	D-21
D.3.3	GROUND RADAR DATA CONSIDERATIONS.....	D-21
D.3.4	TIS-B FORMAT SELECTION	D-21
D.3.5	GROUND ARCHITECTURE	D-22
D.3.5.1	Overview	D-22
D.3.5.2	TIS-B Cell Size Considerations.....	D-23
<u>E</u>	<u>AIR-TO-AIR RANGE AS LIMITED BY POWER.....</u>	<u>E-3</u>
<u>F</u>	<u>MASPS COMPLIANCE MATRIX.....</u>	<u>F-3</u>
F.1	INTRODUCTION.....	F-3
F.2	ADS-B MASPS COMPLIANCE MATRIX	F-3
F.3	TRAFFIC INFORMATION SERVICES – BROADCAST (TIS-B) MASPS COMPLIANCE.....	F-3
<u>G</u>	<u>1090 MHZ ADS-B TRANSITION ISSUES FOR AVIONICS</u>	<u>G-3</u>
G.1	INTRODUCTION	G-3
G.2	AIR-TO-AIR ADS-B APPLICATIONS.....	G-3
G.3	AIRCRAFT INTEGRATION.....	G-3
G.4	AIR-GROUND SURVEILLANCE APPLICATIONS.....	G-4
G.5	OPERATIONAL APPROVALS	G-4
<u>H</u>	<u>REPORT ASSEMBLY GUIDANCE.....</u>	<u>H-3</u>
H.1	SCOPE AND PURPOSE	H-3
H.2	DATA FLOW INTO AND OUT OF THE REPORT ASSEMBLY FUNCTION	H-3
H.2.1	OPTIONAL REPORT CONTROL INTERFACE	H-3

H.2.2	TYPE 1 AND TYPE 2 REPORT ASSEMBLY FUNCTIONS.....	H-4
H.2.3	TIS-B REPORT ASSEMBLY FUNCTION	H-4
H.3	MESSAGES AND REPORTS	H-5
H.3.1	ADS-B MESSAGES (INPUT DATA FOR REPORT ASSEMBLY)	H-5
H.3.2	ADS-B REPORTS (DATA DELIVERED BY REPORT ASSEMBLY FUNCTION)	H-5
H.3.2.1	State Vector Reports	H-5
H.3.2.2	Mode Status Reports.....	H-7
H.3.2.3	Target State Reports	H-9
H.3.2.4	Air Reference Velocity Reports.....	H-10
H.4	ESTIMATING REPORT FIELD VALUES	H-10
H.4.1	ESTIMATING HORIZONTAL POSITION (LATITUDE AND LONGITUDE)	H-10
H.4.2	ESTIMATING HORIZONTAL VELOCITY	H-13
H.4.3	COMPUTING GEOMETRIC ALTITUDE (HEIGHT ABOVE WGS-84 ELLIPSOID).....	H-14
H.5	TRACKING ADS-B PARTICIPANTS	H-15
H.6	TRACK ACQUISITION AND COAST CONSIDERATIONS.....	H-15

I EXTENDED SQUITTER ENHANCED RECEPTION TECHNIQUES..... I-3

I.1	PURPOSE AND SCOPE.....	I-3
I.2	BACKGROUND.....	I-3
I.3	CURRENT SQUITTER RECEPTION TECHNIQUES.....	I-3
I.3.1	OVERVIEW OF CURRENT TECHNIQUES	I-4
I.3.2	CURRENT TECHNIQUES FOR BIT AND CONFIDENCE DECLARATION	I-4
I.3.3	CURRENT ERROR DETECTION AND CORRECTION TECHNIQUES	I-6
I.3.3.1	Overview	I-6
I.3.3.2	Sliding Window Technique.....	I-6
I.4	ENHANCED SQUITTER RECEPTION TECHNIQUES.....	I-7
I.4.1	ENHANCED PREAMBLE DETECTION	I-7
I.4.1.1	Log Video Samples.....	I-7
I.4.1.2	Threshold	I-7
I.4.1.3	Valid Pulse Position	I-7
I.4.1.4	Leading Edge	I-7
I.4.1.5	Initial Detection of a 4-Pulse Preamble.....	I-8
I.4.1.6	Arrival Time.....	I-8
I.4.1.7	Reference Level Generation.....	I-8
I.4.1.8	Overlapping Signals and Re-Triggering	I-8
I.4.1.9	Consistent Power Test.....	I-9
I.4.1.10	DF Validation.....	I-10
I.4.1.11	Re-Triggering.....	I-10
I.4.1.12	Preamble Detection Summary	I-11
I.4.2	ENHANCED BIT AND CONFIDENCE DECLARATION	I-12
I.4.2.1	Overview	I-12
I.4.2.2	Use of Center Amplitude.....	I-12
I.4.2.3	Use of Multiple Amplitude Samples	I-14
I.4.2.3.1	Baseline Multi-Sample Technique	I-14
I.4.2.3.2	Multi-Sample Technique With Full Table Lookup.....	I-15
I.4.2.3.3	Multi-Sample Technique With Reduced Table Lookup	I-16
I.4.3	ENHANCED ERROR DETECTION AND CORRECTION TECHNIQUES	I-17
I.4.3.1	Overview	I-17
I.4.3.2	Conservative Technique.....	I-18
I.4.3.3	Whole Message Error Detection and Correction Technique.....	I-18
I.4.3.4	Brute Force Error Correction Technique	I-22
I.5	IMPROVED RECEPTION PERFORMANCE IN A HIGH TRAFFIC ENVIRONMENT.....	I-24
I.6	SUMMARY	I-25

J DETERMINING THE NAVIGATION ACCURACY CATEGORY FOR VELOCITY (NAC_v).....J-3

J.1	PURPOSE AND SCOPE	J-3
J.2	RATIONALE FOR TABLE 2-22, “DETERMINING NAC_v BASED ON POSITION SOURCE DECLARED HORIZONTAL VELOCITY ERROR	J-3
J.3	TESTS TO DETERMINE VELOCITY ACCURACY FOR SUPPORT SETTING NAC_v = 1 OR 2.....	J-4
J.3.1	HORIZONTAL VELOCITY ACCURACY TEST CONDITIONS COMMENSURATE WITH NAC _v = 1.....	J-4
J.3.1.1	Pass/Fail Determination	J-5
J.3.1.2	Vertical Velocity Accuracy Test Conditions Commensurate with NAC _v = 1	J-6
J.3.1.3	Pass/Fail Determination	J-8
J.3.2	ADDITIONAL TESTS TO DEMONSTRATE ACCURACY COMMENSURATE WITH NAC _v = 2	J-8
J.4	EXPECTED GNSS VELOCITY ACCURACY IN STABLE FLIGHT	J-9

K VELOCITY ACCURACY AS AFFECTED BY REPORT ASSEMBLYK-3

K.1	PURPOSE.....	K-3
K.2	BACKGROUND	K-3
K.3	SCENARIOS AND RESULTS	K-3
K.4	A MINIMUM REPORT ASSEMBLY TECHNIQUE	K-6
K.5	A KALMAN FILTER REPORT ASSEMBLY TECHNIQUE.....	K-7
K.5.1	FILTER STATE AND COVARIANCE	K-7
K.5.2	INITIAL STATE AND COVARIANCE.....	K-7
K.5.3	KALMAN FILTER STEADY STATE ALGORITHM	K-8
K.5.3.1	State Extrapolation	K-8
K.5.3.2	Covariance Matrix Extrapolation	K-8
K.5.3.3	Track Residual, Filter Gain, Track Smoothing, and Covariance Update Calculations.....	K-9
K.5.3.3.1	Residual Variance, Gain, Track Smoothing, and Covariance Update for Position Measurement.....	K-9
K.5.3.3.2	Residual Variance, Gain, Track Smoothing, and Covariance Update for Velocity Measurement.....	K-10
K.6	REAL TIME PERFORMANCE EVALUATION.....	K-10
K.7	CONCLUSIONS.....	K-11

L IMPACT OF RADIO FREQUENCY INTERFERENCE ON EXTENDED SQUITTER REPORT INTEGRITY.....L-3

L.1	UNDETECTED REPORT ERROR RATE	L-3
------------	---	------------

M EXTENDED RANGE RECEPTION TECHNIQUESM-3

M.1	PURPOSE AND SCOPE	M-3
M.2	BACKGROUND	M-3
M.3	CURRENT RECEPTION RANGE.....	M-4
M.4	TECHNIQUES FOR EXTENDED RECEPTION RANGE	M-4
M.4.1	OPTIMIZED 1090 MHz ANTENNA	M-4
M.4.2	OPTIMIZED RECEIVER CHARACTERISTICS	M-5
M.4.2.1	Optimized Receiver Bandwidth	M-5
M.4.2.2	Optimized Receiver Extended Squitter Decoding	M-6
M.5	TRANSMISSION POWER	M-6

N PROPOSED RTCA DO-260B/EUROCAE ED-102A PROVISIONS FOR BACKWARD COMPATIBILITY WITH RTCA DO-260/EUROCAE ED-102 AND RTCA DO-260A MESSAGE FORMATSN-3

N.1	INTRODUCTION	N-3
N.1.1	PURPOSE OF THIS APPENDIX	N-3
N.1.2	MESSAGE VERSION NUMBER.....	N-3
N.2	1090 MHz ADS-B VERSION ZERO (0) MESSAGE PROCESSING	N-3
N.2.1	ADS-B VERSION ZERO (0) MESSAGE TYPES.....	N-3
N.2.1.1	Message TYPE Codes	N-4
N.2.2	STATE VECTOR REPORTS GENERATED USING VERSION ZERO (0) MESSAGES.....	N-5
N.2.2.1	State Vector Report to 1090 MHz ADS-B Message Mapping	N-6
N.2.2.2	Navigation Integrity Category (NIC).....	N-9
N.2.2.3	Movement.....	N-11
N.2.3	MODE STATUS REPORTS.....	N-11
N.2.3.1	ADS-B Version Number	N-14
N.2.3.2	Emitter Category.....	N-14
N.2.3.3	A/V Length and Width Code.....	N-14
N.2.3.4	Emergency/Priority Status.....	N-15
N.2.3.5	Capability Codes.....	N-15
N.2.3.6	Operational Modes	N-15
N.2.3.7	Navigation Accuracy Category for Position (NAC _P).....	N-16
N.2.3.8	Navigation Accuracy Category for Velocity (NAC _V).....	N-16
N.2.3.9	Source Integrity Level (SIL).....	N-17
N.2.3.10	Barometric Altitude Integrity Code (NIC _{BARO}).....	N-17
N.2.3.11	Track/Heading and Horizontal Reference Direction (HRD)	N-18
N.2.4	AIR REFERENCED VELOCITY REPORTS	N-19
N.2.5	TARGET STATUS REPORTS.....	N-19
N.3	1090 MHz ADS-B VERSION 1 MESSAGE PROCESSING	N-19
N.3.1	ADS-B VERSION ONE (1) MESSAGE TYPES	N-19
N.3.1.1	Message TYPE Codes	N-20
N.3.2	STATE VECTOR REPORTS GENERATED USING VERSION ONE (1) MESSAGES	N-20
N.3.2.1	State Vector Report to 1090 MHz ADS-B Message Mapping	N-20
N.3.2.2	Navigation Integrity Category (NIC).....	N-23
N.3.2.3	Movement.....	N-25
N.3.3	MODE STATUS REPORTS.....	N-25
N.3.3.1	ADS-B Version Number	N-28
N.3.3.2	Emitter Category.....	N-28
N.3.3.3	A/V Length and Width Code.....	N-28
N.3.3.4	Emergency/Priority Status.....	N-29
N.3.3.5	Capability Codes.....	N-29
N.3.3.6	Source Integrity Level (SIL).....	N-30
N.3.3.7	Track/Heading and Horizontal Reference Direction (HRD)	N-31
N.3.4	AIR REFERENCED VELOCITY REPORTS	N-31
N.3.5	TARGET STATE REPORTS.....	N-31
N.4	FORMATS FOR VERSION ZERO (0) AND VERSION ONE (1) 1090 MHz ADS-B MESSAGES.....	N-32
N.4.1	FORMATS FOR VERSION ZERO (0) 1090 MHz ADS-B MESSAGES	N-32
N.4.2	FORMATS FOR VERSION ONE (1) 1090 MHz ADS-B MESSAGES.....	N-40

O ACCOMMODATION OF TRAJECTORY CHANGE REPORTING **O-3**

O.1	INTRODUCTION	O-3
O.2	SUMMARY OF TRAJECTORY CHANGE REPORTING REQUIREMENTS	O-3
O.3	1090 MHz ADS-B MESSAGE FOR TRAJECTORY CHANGE INFORMATION	O-4
O.4	TRANSMISSION RATE REQUIREMENTS	O-7
O.5	ESTIMATED PERFORMANCE	O-8
O.5.1	TC+0 PERFORMANCE ESTIMATE	O-8
O.5.2	TC+1 PERFORMANCE ESTIMATE	O-19

O.6	OTHER FACTORS AND ISSUES.....	O-19
O.7	CONCLUSIONS.....	O-20

P 1090 MHZ SYSTEM PERFORMANCE SIMULATION RESULTS P-3

P.1	INTRODUCTION.....	P-3
P.2	PERFORMANCE EVALUATION BY APL.....	P-4
P.2.1	1090 EXTENDED SQUITTER DETAILED SIMULATION FEATURES AND METHODOLOGY	P-4
P.2.1.1	1090 ES Detailed Simulation Features.....	P-4
P.2.1.2	Calculation of the Performance Metrics.....	P-6
P.2.2	RECEIVER PERFORMANCE MODEL	P-7
P.2.2.1	Background	P-7
P.2.2.2	Modifications to the Receiver Performance Model.....	P-7
P.2.3	LOS ANGELES BASIN HIGH DENSITY (LA).....	P-9
P.2.3.1	LA Scenario Description	P-9
P.2.3.2	LA Results and Analysis	P-10
P.2.4	LOW DENSITY SCENARIO	P-17
P.2.4.1	Low Density Scenario Description.....	P-17
P.2.4.2	Low Density Results and Analysis.....	P-18
P.2.5	RESULTS AND CONCLUSIONS	P-19
P.2.5.1	Considerations.....	P-19
P.2.5.2	Summary	P-20
P.3	PERFORMANCE EVALUATION BY MIT LINCOLN LABORATORY	P-21
P.3.1	PULSE LEVEL SIMULATION	P-21
P.3.1.1	Formulation of the Pulse-Level Simulation.....	P-21
P.3.1.2	Interference Rates and Power Distribution.....	P-23
P.3.1.3	Pulse-Level Simulation Results for A3 to A3	P-24
P.3.1.4	Pulse-Level Simulation Results for A2	P-25
P.3.2	TRACK-LEVEL SIMULATION.....	P-27
P.3.2.1	Formulation of the Track-Level Simulation.....	P-27
P.3.2.2	Track-Level Simulation Results for A3-to-A3.....	P-28
P.3.2.3	Track-Level Simulation Results for A2-to-A2	P-31
P.3.2.4	Track-Level Simulation Results for A3-to-A2	P-31
P.3.3	EFFECTS OF ALTITUDE	P-33
P.3.4	HIGHER FRUIT LA ENVIRONMENT	P-35
P.3.5	LOW DENSITY ENVIRONMENT.....	P-35
P.3.5.1	Reception Probability versus Signal Power	P-35
P.3.5.2	Low Density Environment Track-Level Simulation	P-35
P.4	SUMMARY OF DO-260A PERFORMANCE ANALYSIS	P-38
P.5	ADDITIONAL PERFORMANCE ANALYSIS.....	P-40
P.5.1	EAST COAST AIR TRAFFIC SCENARIOS.....	P-40
P.5.2	FUTURE INTERFERENCE ENVIRONMENTS	P-41
P.5.3	AIR-TO-AIR PERFORMANCE RESULTS	P-44
P.5.3.1	Performance for Class A1-S.....	P-44
P.5.3.2	Performance for Class A3	P-44

Q PROPOSED FUTURE RUNWAY THRESHOLD SPEED ON-CONDITION MESSAGE Q-3

Q.1	BACKGROUND	Q-3
Q.2	INFORMATION CONTENT	Q-4
Q.3	REFERENCE.....	Q-4

R EXTENDED SQUITTER BROADCAST RATE ANALYSIS R-3

R.1	PURPOSE AND SCOPE	R-3
R.2	BACKGROUND	R-3
R.3	ANALYSIS OF EXTENDED SQUITTER BROADCAST RATES FOR SPECIFIC SCENARIOS	R-3
R.3.1	SCENARIO 1: AIRBORNE STEADY STATE CONDITIONS.....	R-3
R.3.2	SCENARIO 2: AIRBORNE WITH MODE A CODE CHANGE	R-4
R.3.3	SCENARIO 3: AIRBORNE, TSS, PERMANENT ALERT STATE (7500, 7600, 7700)	R-5
R.3.4	SCENARIO 4: AIRBORNE, NO TSS, NAC/SIL CHANGE.....	R-6
R.3.5	SCENARIO 5: AIRBORNE, NO TSS, TCAS/NAC/SIL CHANGE, MODE A CODE CHANGE	R-7
R.3.6	SCENARIO 6: ON-THE-GROUND, MOVING, MODE A CODE CHANGE, NIC _{Supp} /NAC/SIL CHANGE	R-8

S GPS TIME TAG AND UTC TIME SYNCHRONIZATION S-3

S.1	INTRODUCTION.....	S-3
S.2	METHOD FOR TIME MARK / UTC TIME SYNCHRONIZATION.....	S-6
S.2.1	START OF SYNCHRONIZATION (BLOCK #1 THROUGH 3)	S-7
S.2.2	WAIT FOR GPS DATA (BLOCK #4).....	S-7
S.2.3	COMPUTE CURRENT TIME (BLOCK #5).....	S-7
S.2.4	DETERMINE SUB-EPOCH BASE AND REMAINDER (BLOCK #6).....	S-7
S.2.5	DETERMINE CURRENT SUB-EPOCH BASE (BLOCK #7 AND 8).....	S-10
S.2.6	DETERMINE CURRENT SUB-EPOCH EVEN OR ODD ENCODING (BLOCK #9 THROUGH 11).....	S-11
S.2.7	COMPUTE TIME TO NEXT EXACT 0.2 SECOND SUB-EPOCH (BLOCK #12)	S-11
S.2.8	SET COUNT DOWN TIMER TO NEXT SUB-EPOCH (BLOCK #14).....	S-11
S.2.9	DETERMINE IF THERE IS SUFFICIENT COMPUTATION TIME (BLOCK #15)	S-11
S.2.10	SUFFICIENT COMPUTATION TIME (BLOCK #20 THROUGH #25)	S-12
S.2.10.1	Compute Position at Next 0.2 Sub-epoch (Block #20)	S-12
S.2.10.2	Save Position for Extrapolation (Block #21)	S-13
S.2.10.3	Determine Next Sub-Epoch Even/Odd Encoding (Block #22 through #24)	S-14
S.2.10.4	Clear Position Load Flag (Block #25).....	S-14
S.2.11	INSUFFICIENT COMPUTATION TIME PROCESS SET UP (BLOCK # 16 THROUGH 19)	S-14
S.2.11.1	Determine the Next Sub-Epoch Even/Odd Encoding (Block # 16 through 18).....	S-14
S.2.11.2	SET the Position Load Flag (Block #19)	S-15
S.2.12	TIMER COUNT DOWN AND POSITION FLAG STATUS (BLOCK # 26 THROUGH #27).....	S-15
S.2.12.1	Position Load Flag NOT SET (Block # 27)	S-15
S.2.12.2	Position Load Flag SET (Block # 27)	S-15
S.2.12.2.1	Compute Position to be Loaded (Block # 28)	S-15
S.2.12.2.2	Save Position for Load (Block #29).....	S-16
S.2.12.2.3	CPR Encode New Position Data (Block # 31)	S-16
S.2.12.2.4	Load BDS Buffer (Block # 32).....	S-16
S.2.13	ESTABLISHED PROCESSING LOOP (BLOCK # 30 THROUGH #33)	S-16
S.3	SUMMARY / CONCLUSION.....	S-17

T INTRODUCTION AND TUTORIAL FOR COMPACT POSITION REPORTING (CPR) T-3

T.1	PURPOSE	T-3
T.2	MOTIVATION FOR COMPACT POSITION REPORTING (CPR).....	T-3
T.3	CPR COORDINATE SYSTEM.....	T-4
T.3.1	LATITUDE ZONES	T-7
T.3.2	LONGITUDE ZONES AND BINS	T-10
T.4	CPR ENCODING	T-13
T.5	CPR DECODING	T-14

T.5.1	GLOBAL DECODING FOR AIRBORNE AND TIS-B POSITION.....	T-15
T.5.1.1	Airborne and TIS-B Latitude Global Decoding.....	T-15
T.5.1.2	Airborne and TIS-B Longitude Global Decoding.....	T-20
T.5.2	SURFACE GLOBAL DECODING.....	T-22
T.5.3	AIRBORNE AND TIS-B LOCALLY UNAMBIGUOUS DECODING	T-24
T.5.3.1	Airborne and TIS-B Latitude Local Decoding.....	T-25
T.5.3.2	Airborne and TIS-B Longitude Local Decoding	T-28
T.5.4	SURFACE LOCAL DECODING	T-28
T.6	ADDITIONAL INFORMATION	T-29
T.6.1	NL TRANSITION LATITUDES	T-29
T.7	DERIVATION OF EQUATIONS FOR NL AND NL TRANSITION LATITUDES.....	T-50
T.8	SUMMARY.....	T-55

U TOTAL AND UNCOMPENSATED LATENCY IN 1090 MHZ EXTENDED SQUITTER ADS-B.....U-3

U.1	INTRODUCTION	U-3
U.2	DESCRIPTION OF THE PROBLEM.....	U-3
U.3	TIMING NOTATION.....	U-4
U.4	LATENCY DEFINITIONS.....	U-5
U.5	TOTAL LATENCY.....	U-5
U.6	UNCOMPENSATED LATENCY	U-7

V PROVISIONING FOR POTENTIAL WAKE VORTEX AND ARRIVAL MANAGEMENT ADS-B APPLICATIONSV-3

V.1	INTRODUCTION	V-3
V.1.1	PROPOSED WAKE TURBULENCE APPLICATIONS	V-4
V.1.2	ADDITIONAL CAPABILITIES	V-7
V.1.2.1	Improved Arrival Management Scheduling and Aircraft Trajectory Synthesis	V-7
V.1.2.2	Increased Wind Field Prediction Accuracy	V-8
V.1.2.3	Better Situational Awareness of Current Weather.....	V-8
V.1.3	BROADCAST SYSTEM ARCHITECTURE	V-8
V.2	DATA REQUIREMENTS FOR WAKE AND ARRIVAL MANAGEMENT APPLICATIONS	V-9
V.3	MESSAGE FORMATS AND RATES	V-15
V.3.1	DESIGN FOR AIRCRAFT-DERIVED METEOROLOGICAL DATA DISSEMINATION VIA MODE S 1090 MHZ EXTENDED SQUITTER (1090ES)	V-15
V.3.1.1	Introduction	V-15
V.3.1.2	Proposed Meteorological Squitter Register Formats	V-16
V.3.1.3	Proposed Meteorological Squitter Update Rates	V-20
V.3.1.4	Mode S Transponder Configuration Bits.....	V-22
V.3.1.5	Summary.....	V-22
V.3.2	BROADCAST OF AIR-REFERENCE VECTOR FOR FUTURE AIRBORNE AND AIR-GROUND APPLICATIONS.....	V-23
V.3.2.1	Wind Triangle and Derivation of Wind Vector from Ground Vector and ARV Data.....	V-23
V.3.2.2	Derivation of Wind Vector from Ground Vector and Low Rate ARV Broadcasts	V-25
V.3.2.3	Proposed Update Rates for Wind Vector and ARV Broadcasts	V-26
V.3.2.4	Data Coasting for Continuity of ARV Data During Gaps in ARV Reception.....	V-27
V.4	PROVISIONING OF MET AND ARV DATA	V-29
V.5	REFERENCES	V-35
V.6	ADDENDUM ON CAS, MACH, AND TAS RELATIONSHIPS	V-35

W CORRIGENDUM- FOR RTCA DO-260BW-1

LIST OF FIGURES

Figure 1-1: The Scope of the 1090 MHz ADS-B System.....	5
Figure 1-2: Scope of the 1090 MHz TIS-B System.....	6
Figure 1-3: 1090 MHz ADS-B Subsystems.....	7
Figure 2-1: ADS-B Message Transmission Waveform	37
Figure 2-2: ADS-B and TIS-B Message Baseline Format Structure	39
Figure 2-3: ADS-B Airborne Position Message Format.....	50
Figure 2-4: Altitude Subfield Encoding For “Q=0”	60
Figure 2-5: ADS-B Surface Position Message Format	71
Figure 2-6: ADS-B Aircraft Identification and Category Message Format	85
Figure 2-7: ADS-B Airborne Velocity Message Subtype ”1&2”	88
Figure 2-8: ADS-B Airborne Velocity Message Subtype ”3&4”	88
Figure 2-9: “Target State and Status” Message Format	107
Figure 2-10: “Target State and Status Message” (Subtype=1 Format).....	109
Figure 2-11: “Aircraft Operational Status” ADS-B Message “ME” Field Format	120
Figure 2-12: “TEST” Message with Subtype=0 Format.....	140
Figure 2-13: “Surface System Status” ADS-B Message “ME” Field Format.....	140
Figure 2-14: 1090ES Aircraft Status Message (Emergency/Priority Status) (TYPE=28, Subtype=1).....	142
Figure 2-15: 1090ES Aircraft Status Message (TCAS RA Broadcast Message) (TYPE=28, Subtype=2).....	143
Figure 2-16: GPS/GNSS Time Mark Pulse.....	173
Figure 2-17: ADS-B Receiver / Report Assembly Functional Types.....	194
Figure 2-18: ADS-B Output Message Format Structure.....	196
Figure 2-19: ADS-B and TIS-B Message Reception Function Output Message Delivery	196
Figure 2-20: ADS-B Message And Report General Data Flow	251
Figure 2-21: Illustration of Report State Changes In A Typical Case	252
Figure 2-22: Report Assembly Airborne State Transition Diagram	253
Figure 2-23: Detailed Report Assembly State Transition Diagram	254
Figure 2-24: Various ADS-B Receiving Architectures.....	275
Figure 2-25: TIS-B Baseline Format Definition	279
Figure 2-26: TIS-B Fine Airborne Position Message Format.....	280
Figure 2-27: TIS-B Fine Surface Position Message Format	281
Figure 2-28: TIS-B Identification and Category Message Format.....	282
Figure 2-29: TIS-B Velocity Message, Subtypes 1 and 2.....	283
Figure 2-30: TIS-B Velocity Message, Subtypes 3 & 4	284
Figure 2-31: TIS-B Coarse Position Message Format	286
Figure 2-32: TIS-B Tracks	289
Figure 2-33: ADS-R Airborne Position Message Format	293
Figure 2-34: ADS-R Surface Position Message Format	293
Figure 2-35: ADS-R Airborne Velocity Message Subtype ”1 & 2” Format.....	295
Figure 2-36: ADS-R Airborne Velocity Message Subtype ”3 & 4” Format.....	295
Figure 2-37: ADS-R Aircraft Emergency/Priority Status Message Format.....	296
Figure 2-38: ADS-R “Target State and Status” Message Format	297
Figure 2-39: ADS-R Aircraft Operational Status Message “ME” Field Format.....	298
Figure 2-40: Airborne Capability Class (CC) Code Format in Version 2 ADS-R Messages.	298
Figure 2-41: ADS-B Receiving Subsystem Environmental Test Scenario Pattern.....	340
Figure 2-42: Bit Error and Low Confidence Flags	591
Figure 3-1: Antenna Test Configuration - 1.....	819
Figure 3-2: Antenna Test Configuration - 2.....	826
<u>Figure A-1: Extended Squitter Airborne Position.....</u>	<u>A-76</u>

<u>Figure A-2:</u> Extended Squitter Surface Position	A-77
<u>Figure A-3:</u> Extended Squitter Status	A-78
<u>Figure A-4:</u> Extended Squitter Identification and Category	A-79
<u>Figure A-5:</u> Extended Squitter Airborne Velocity (Subtypes 1 and 2: Velocity Over Ground)	A-80
<u>Figure A-6:</u> Extended Squitter Airborne Velocity (Subtypes 3 and 4: Airspeed and Heading)	A-81
<u>Figure A-7:</u> Extended Squitter Event-Driven Register	A-82
<u>Figure A-8a:</u> Extended Squitter Aircraft Status (Subtype 1: Emergency/Priority Status and Mode A Code).....	A-83
<u>Figure A-8b:</u> Extended Squitter Aircraft Status (Subtype 2: 1090ES TCAS RA Broadcast).....	A-84
<u>Figure A-9:</u> Target State and Status Information (Subtype = 1: Compatible with RTCA DO-260B/EUROCAE ED-102A, ADS-B Version Number=2)	A-85
<u>Figure A-10:</u> Aircraft Operational Status.....	A-86
<u>Figure A-11:</u> TIS-B Format Definition	A-87
<u>Figure A-12:</u> TIS-B Fine Airborne Position Message	A-93
<u>Figure A-13:</u> TIS-B Fine Surface Position Message.....	A-94
<u>Figure A-14:</u> TIS-B Identification and Category Message	A-95
<u>Figure A-15:</u> TIS-B Velocity Messages (Subtypes 1 and 2: Velocity Over Ground).....	A-96
<u>Figure A-16:</u> TIS-B Velocity Messages (Subtypes 3 and 4: Air Referenced Velocity)	A-97
<u>Figure A-17:</u> TIS-B Coarse Airborne Position Message	A-98
<u>Figure B-1:</u> Geodetic Coordinate Definitions	B-22
<u>Figure B-2:</u> Latitude Definition	B-23
<u>Figure B-3:</u> Representations of Latitude and Longitude.....	B-24
<u>Figure D-1:</u> Mode S Secondary Surveillance Radar ground station providing surveillance of all Mode A/C/S aircraft in high density environments, as well as ADS-B surveillance (via enhanced surveillance), validation and spoofing resistance.	D-10
<u>Figure D-2:</u> Basic Extended Squitter System Block Diagram	D-12
<u>Figure D-3:</u> Simple receive-only Extended Squitter ground station configuration providing ADS-B surveillance.	D-13
<u>Figure D-4:</u> Receive only Extended Squitter ground station with angle-of-arrival sensor configuration providing ADS-B surveillance, azimuth verification and spoofing resistance.....	D-14
<u>Figure D-5:</u> Extended squitter ground station providing ADS-B surveillance, position validation, spoofing resistance, coarse surveillance of all Mode A/C/S aircraft and fall-back surveillance for ADS-B aircraft.	D-15
<u>Figure D-6:</u> Extended squitter ground station providing ADS-B surveillance, position validation, spoofing resistance, accurate surveillance of all Mode A/C/S aircraft and backup surveillance for ADS-B aircraft.	D-16
<u>Figure D-7:</u> Ground architecture for surface surveillance using ADS-B, multilateration and radar.....	D-17
<u>Figure D-8:</u> Conceptual architecture for implementing surveillance fusion of multi-sensor / multi-site target reports	D-20
<u>Figure D-9:</u> TIS-B Cell Characteristics.....	D-23
<u>Figure H-1:</u> ADS-B Message and Report General Data Flow.	H-3
<u>Figure H-2:</u> Expressing a Small Change in Latitude and Longitude (ϕ , λ) As a Change in Local Cartesian Coordinates (x,y).	H-11
<u>Figure H-3:</u> Non-Rectangular Latitude/Longitude Graticule Near the Poles.....	H-13
<u>Figure I-1:</u> Mode S Extended Squitter Waveform	I-4
<u>Figure I-2:</u> Current and Enhanced Bit Demodulation Techniques.....	I-5
<u>Figure I-3:</u> Overlap of a Weak Signal by a Later and Stronger Signal	I-9
<u>Figure I-4:</u> Overview of Extended Squitter Preamble Detection	I-11
<u>Figure I-5:</u> Center Amplitude Bit and Confidence Declaration	I-13

<u>Figure I-6: Whole Message Top Level Error Correction Algorithm</u>	I-20
<u>Figure I-7: Whole Message Detailed Error Correction Algorithm</u>	I-21
<u>Figure I-8: Whole Message Error Correction Example</u>	I-22
<u>Figure I-9: Error Detection and Correction.....</u>	I-23
<u>Figure K-1: Scenario Geometry Used in the Evaluation.....</u>	I-4
<u>Figure K-2: Velocity Accuracy at Time of Each State Vector Report Update</u>	I-5
<u>Figure K-3: Velocity Accuracy Sampled at 1 Second Epochs.....</u>	I-6
<u>Figure L-1: Simulation Results Giving Acceptance Probability and Undetected Error Rate.</u>	L-4
<u>Figure N-1: Version Zero (0) Extended Squitter Airborne Position Message</u>	N-33
<u>Figure N-2: Version Zero (0) Extended Squitter Surface Position Message</u>	N-34
<u>Figure N-3: Version Zero (0) Extended Squitter Aircraft Identification and Category Message</u>	N-35
<u>Figure N-4: Version Zero (0) Extended Squitter Airborne Velocity Message (Subtypes 1 and 2: Velocity Over Ground)</u>	N-36
<u>Figure N-5: Version Zero (0) Extended Squitter Airborne Velocity Message (Subtypes 3 and 4: Airspeed and Heading).....</u>	N-37
<u>Figure N-6: Version Zero (0) Extended Squitter Aircraft Status Message (Subtype 1: Emergency/Priority Status)</u>	N-38
<u>Figure N-7: Version Zero (0) Aircraft Operational Status Message</u>	N-39
<u>Figure N-8: Version One (1) Extended Squitter Airborne Position.....</u>	N-41
<u>Figure N-9: Version One (1) Extended Squitter Surface Position Message</u>	N-42
<u>Figure N-10: Version One (1) Extended Squitter Status.....</u>	N-43
<u>Figure N-11: Version One (1) Extended Squitter Identification and Category Message.....</u>	N-44
<u>Figure N-12: Version One (1) Extended Squitter Airborne Velocity (Subtypes 1 and 2: Velocity Over Ground)</u>	N-45
<u>Figure N-13: Version One (1) Extended Squitter Airborne Velocity Message (Subtypes 3 and 4: Airspeed and Heading).....</u>	N-46
<u>Figure N-14: Version One (1) Extended Squitter Event-Driven Register</u>	N-47
<u>Figure N-15: Version One (1) Extended Squitter Aircraft Status (Subtype 1: Emergency/Priority Status)</u>	N-48
<u>Figure N-16: Version One (1) Target State and Status Message</u>	N-49
<u>Figure N-17: Version One (1) Aircraft Operational Status Message</u>	N-50
<u>Figure O-1: Case 1 – LA2020-[24k] for A3 Tx -to- A3 Rx.....</u>	O-11
<u>Figure O-2: Case 1 – LA2020-[24k] for A2 Tx -to- A3 Rx.....</u>	O-12
<u>Figure O-3: Case 1 – Low Density A3 Tx -to- A3 Rx.....</u>	O-13
<u>Figure O-4: Case 2 – LA2020-[24k] for A3 Tx -to- A3 Rx.....</u>	O-14
<u>Figure O-5: Case 2 – LA2020-[24k] for A2 Tx -to- A3 Rx.....</u>	O-15
<u>Figure O-6: Case 2 – Low Density A3 Tx -to- A3 Rx.....</u>	O-16
<u>Figure O-7: Case 3 – LA2020-[24k] for A3 Tx -to- A3 Rx.....</u>	O-17
<u>Figure O-8: Case 3 – LA2020-[24k] for A2 Tx -to- A3 Rx.....</u>	O-18
<u>Figure O-9: Case 3 – Low Density A3 Tx -to- A3 Rx.....</u>	O-19
<u>Figure P-1: Comparison of “Mapped” APL Receiver Performance Model Prediction with FAATC Simulation Results</u>	P-8
<u>Figure P-2: 95-95 State Vector Update Rate for A3-to-A3 Air-to-Air Reception in LA-[24k].....</u>	P-11
<u>Figure P-3: 95-95 TSR Update Rate for A3-to-A3 Air-to-Air Reception in LA-[24k]</u>	P-11
<u>Figure P-4: 95-95 State Vector Update Rate for A2-to-A3 Air-to-Air Reception in LA-[24k].....</u>	P-12
<u>Figure P-5: 95-95 TSR Rate for A2-to-A3 Air-to-Air Reception in LA-[24k].....</u>	P-12
<u>Figure P-6: 95-95 State Vector Update Rate for A3-to-A3 Air-to-Air Reception in LA-[30k].....</u>	P-13
<u>Figure P-7: 95-95 TSR Update Rate for A3-to-A3 Air-to-Air Reception in LA-[30k]</u>	P-13
<u>Figure P-8: 95-95 State Vector Update Rate for A2-to-A3 Air-to-Air Reception in LA-[30k].....</u>	P-14
<u>Figure P-9: 95-95 TSR Update Rate for A2-to-A3 Air-to-Air Reception in LA-[30k]</u>	P-14

<u>Figure P-10:</u> 95-95 State Vector Update Rate for A3-to-A2 Air-to-Air Reception in LA-[24k].....	P-15
<u>Figure P-11:</u> 95-95 TSR Rate for A3-to-A2 Air-to-Air Reception in LA-[24k].....	P-15
<u>Figure P-12:</u> 95-95 State Vector Update Rate for A2-to-A2 Air-to-Air Reception in LA-[24k].....	P-16
<u>Figure P-13:</u> 95-95 TSR Update Rate for A2-to-A2 Air-to-Air Reception in LA-[24k]	P-16
<u>Figure P-14:</u> 95-95 State Vector Update Rate for A3-to-A3 Air-to-Air Reception in 5000 Mode A/C per Second in the Low Density Scenario	P-18
<u>Figure P-15:</u> 95-95 TSR Update Rate for A3-to-A3 Air-to-Air Reception in 5000 Mode A/C per Second in the Low Density Scenario	P-19
<u>Figure P-16:</u> Overview of the Pulse-Level Simulation	P-22
<u>Figure P-17:</u> Top and Bottom Antenna Fruit, LA-[24k].....	P-24
<u>Figure P-18:</u> Reception Probability versus Received Power for A3-to-A3	P-25
<u>Figure P-19:</u> Pulse-Level Simulation Results (bottom antenna receptions).....	P-26
<u>Figure P-20:</u> Curve Fit to Simulation Results	P-27
<u>Figure P-21:</u> Future A3-to-A3 System Performance in the Los Angeles Basin.....	P-29
<u>Figure P-22:</u> State Vector Update Performance for A3-to-A3.....	P-30
<u>Figure P-23:</u> State Vector Update Rate for A3-to-A2 in LA [24k].....	P-32
<u>Figure P-24:</u> TSR Update Rate for A3-to-A2 in LA [24k]	P-32
<u>Figure P-25:</u> Effects of Transmitting Aircraft Altitude (A3-A2, LA-[24k]) on State Vector	P-33
<u>Figure P-26:</u> Effects of Transmitting Aircraft Altitude (A3-A2, LA-[24k]) on TSR Update Rate.....	P-34
<u>Figure P-27:</u> Reception Probability in the Low Density Environment	P-36
<u>Figure P-28:</u> State Vector Updates in the Low Density Environment for A3-to-A3 with 1250 Mode A/C Fruit	P-37
<u>Figure P-29:</u> Measurements of Aircraft Density at Two Times.	P-41
<u>Figure P-30:</u> Range Distribution of Aircraft, Measured and Modeled.....	P-42
<u>Figure S-1:</u> Exact 0.2 UTC Sub-Epoch Encoding	S-3
<u>Figure S-2a:</u> Time Mark – UTC Synchronization Flow Diagram (Part 1)	S-8
<u>Figure S-2b:</u> Time Mark – UTC Synchronization Flow Diagram (Part 2)	S-9
<u>Figure S-3:</u> Exact 0.2 UTC sub-epoch Encoding with sub-epoch _{base} and sub-epoch _{base} + 1	S-10
<u>Figure T-1:</u> Latitude Zone Boundaries (Red is Even; Blue is Odd).....	T-5
<u>Figure T-2:</u> Longitude Zone Boundaries (Red is Even; Blue is Odd)	T-6
<u>Figure T-3:</u> Latitude Zone Indexing.....	T-7
<u>Figure T-4:</u> Definition of Latitude Zone Sizes.....	T-8
<u>Figure T-5:</u> Latitude Zones and Bins	T-9
<u>Figure T-6:</u> YZ for Even and Odd Latitude Zones at 43.054N.....	T-9
<u>Figure T-7:</u> Reduction in Number of Longitude Zones at High Latitudes.....	T-10
<u>Figure T-8:</u> NL Values and Transition Latitudes	T-11
<u>Figure T-9:</u> Even and Odd Longitude Zones With Transition Latitudes	T-12
<u>Figure T-10:</u> XZ for Even and Odd Longitude Zones at 76.06°W	T-12
<u>Figure T-11:</u> YZ _i When Latitude is in Northernmost 1/2 Bin of Latitude Zone.....	T-14
<u>Figure T-12:</u> Principle of Global Decoding	T-16
<u>Figure T-13:</u> Points in Zones With Different Zone Index Numbers	T-18
<u>Figure T-14:</u> Relationship Between j and Zone Index	T-19
<u>Figure T-15:</u> Local Decoding Sliding Region Behavior	T-24
<u>Figure T-16:</u> Local Decoding Zone Index Determination when $f_{RP} > 1/2$	T-26
<u>Figure T-17:</u> Local Decoding Zone Index Determination when $f_{RP} < 1/2$	T-27
<u>Figure T-18:</u> Example of relationships between input latitude, $Rlat_i$ and NL	T-30
<u>Figure T-19:</u> Longitude Zone Length	T-51
<u>Figure T-20:</u> Example of Arcs Used in Application of Spherical Law of Cosines	T-52
<u>Figure U-1:</u> Functional Architecture Diagram	U-3
<u>Figure U-2:</u> The General Timing Diagram	U-4

<u>Figure U-3: Timing of two consecutive position updates</u>	U-6
<u>Figure V-1: System Diagram for Initial and Mid-Term Ground-Based Wake Applications Using ADS-B</u>	V-6
<u>Figure V-2: Wind Triangle for Modeling Aircraft Velocity Relationships</u>	V-24
<u>Figure V-3: Derivation of Wind Vector from Received ARV and State Vector Data</u>	V-26

LIST OF TABLES

Table 2-1: ADS-B Aircraft System Classes	24
Table 2-2: ADS-B Message To Requirement Cross-Reference Table	25
Table 2-3: ADS-B Class A Transmitter Equipment To Message Coverage	26
Table 2-4: ADS-B Class B Transmitter Equipment To Message Coverage	27
Table 2-5: ADS-B Class A Receiver Equipment To Report Coverage.....	29
Table 2-6: ADS-B Class C Receiver Equipment To Report Coverage.....	30
Table 2-7: ADS-B Transmission Message Spectrum.....	38
Table 2-8: “CA” Field Code Definitions.....	41
Table 2-9: “CF” Field Code Definitions	44
Table 2-10: “AF” Field Code Definitions	45
Table 2-11: Determining The Type of Address in the AA Field	46
Table 2-12: Determining ADS-B Message Type (DF=17 or DF=18 and CF=0, 1 or 6, or DF=19 and AF=0)	49
Table 2-13: Determining TIS-B or ADS-R Message Type (DF=18, CF=2 to 6)	50
Table 2-14: “TYPE” Subfield Code Definitions (DF=17 or 18)	52
Table 2-15: “Surveillance Status” Subfield Code Definitions	58
Table 2-16: “Movement” Subfield Code Definitions	74
Table 2-17: “Status Bit for Heading/Ground Track” Encoding.....	75
Table 2-18: “Heading/Ground Track” Encoding	75
Table 2-19: “ADS-B Emitter Category SET” Code Definitions.....	86
Table 2-20: Airborne Velocity Message “Subtype” Code Field Encoding.....	90
Table 2-21: “Intent Change Flag” Encoding.....	90
Table 2-22: Determining NAC _V Based on Position Source Declared Horizontal Velocity Error	91
Table 2-23: “East/West Direction Bit” Encoding	92
Table 2-24: “East/West Velocity” (subsonic) Encoding.....	92
Table 2-25: “North/South Direction Bit” Encoding.....	93
Table 2-26: “North/South Velocity” (subsonic) Encoding	93
Table 2-27: “Source Bit for Vertical Rate” Encoding.....	94
Table 2-28: “Sign Bit for Vertical Rate” Encoding	94
Table 2-29: “Vertical Rate” Encoding	94
Table 2-30: “Difference From Barometric Altitude Sign Bit” Encoding.....	95
Table 2-31: “Difference From Barometric Altitude” Encoding.....	96
Table 2-32: “East/West Velocity” (supersonic) Encoding.....	97
Table 2-33: “North/South Velocity” (supersonic) Encoding	98
Table 2-34: “Heading Status Bit” Encoding	101
Table 2-35: “Heading” Encoding.....	101
Table 2-36: “Airspeed Type” (subsonic) Encoding	102
Table 2-37: “Airspeed” (IAS or TAS) (subsonic) Encoding	102
Table 2-38: “Airspeed Type” (supersonic) Encoding.....	105
Table 2-39: “Airspeed” (IAS or TAS) (supersonic) Encoding	105
Table 2-40: “Subtype” Code Subfield Encoding	108
Table 2-41: “SIL Supplement” Subfield Encoding.....	109

Table 2-42: “Selected Altitude Type” Subfield Encoding	110
Table 2-43: “MCP/FCU Selected Altitude or FMS Selected Altitude” Subfield Encoding	111
Table 2-44: “Barometric Pressure Setting (Minus 800 millibars)” Subfield Encoding	112
Table 2-45: “Selected Heading Status” Subfield Encoding	113
Table 2-46: “Selected Heading Sign” Subfield Encoding	113
Table 2-47: “Selected Heading Status, Sign and Data” Subfields Encoding	114
Table 2-48: “Status of MCP/FCU Mode Bits” Subfield Encoding	116
Table 2-49: “Autopilot Engaged” Subfield Encoding	117
Table 2-50: “VNAV Engaged” Subfield Encoding	117
Table 2-51: “Altitude Hold Mode” Subfield Encoding	118
Table 2-52: “Approach Mode” Subfield Encoding	118
Table 2-53: “TCAS Operational” Subfield Encoding	118
Table 2-54: “LNAV” Mode Engaged” Subfield Encoding	119
Table 2-55: “Subtype” Code Subfield in Aircraft Operational Status Messages Encoding	121
Table 2-56: Airborne Capability Class (CC) Code Format in Version 2 Transmitting Subsystems	122
Table 2-57: Surface Capability Class (CC) Code Format in Version 2 Transmitting Subsystems	122
Table 2-58: Encoding of “1090ES IN” CC Subfield in Aircraft Operational Status Messages	123
Table 2-59: ARV Report Capability Encoding	124
Table 2-60: TS Report Capability Encoding	124
Table 2-61: TC Report Capability Encoding	124
Table 2-62: Encoding of “UAT IN” CC Subfield in Aircraft Operational Status Messages	125
Table 2-63: Airborne Operational Mode (OM) Subfield Format	126
Table 2-64: Surface Operational Mode (OM) Subfield Format	127
Table 2-65: “System Design Assurance” OM Subfield in Aircraft Operational Status Messages	129
Table 2-66: Lateral Axis GPS Antenna Offset Encoding	130
Table 2-67: Longitudinal Axis GPS Antenna Offset Encoding	131
Table 2-68: ADS-B Version Number Subfield Encoding	132
Table 2-69: Navigation Integrity Category (NIC) Encoding	133
Table 2-70: Navigation Accuracy Category for Position (NAC _p) Encoding	134
Table 2-71: Encoding of the Geometric Vertical Accuracy (GVA) Subfield in Aircraft Operational Status Messages	135
Table 2-72: “SIL” Subfield Encoding	136
Table 2-73: “NIC _{BARO} ” Subfield Encoding	136
Table 2-74: “Aircraft/Vehicle Length and Width Code” Encoding	138
Table 2-75: Track Angle/Heading Encoding	138
Table 2-76: Horizontal Reference Direction (HRD) Encoding	139
Table 2-77: "Subtype" Subfield in Surface System Status Messages	141
Table 2-78: “Emergency/Priority Status” Subfield Encoding	142
Table 2-79: 1090 MHz Extended Squitter ADS-B Message Broadcast Rates	145
Table 2-80: Event-Driven Message Lifetime	152
Table 2-81: ADS-B Class “A” Equipment Receiver Sensitivity	162
Table 2-82: ADS-B Receiver Out -of- Band Rejection	163
Table 2-83: ADS-B State Vector Data Elements - Source Data Mapping To Report Structure	199
Table 2-84: ADS-B Report Type Coding	202
Table 2-85: ADS-B State Vector Report Structure Coding	203
Table 2-86: ADS-B State Vector Report Validity Flag Requirements	205
Table 2-87: Address Qualifier Coding	206
Table 2-88: Report Time of Applicability Parameter Coding	207
Table 2-89: Report Mode Encoding	219
Table 2-90: ADS-B Mode Status Data Elements - Source Data Mapping To Report Structure	221

Table 2-91: ADS-B Mode Status Report Structure Coding	224
Table 2-92: ADS-B Mode Status Report Validity Flag Requirements	225
Table 2-93: Emitter Category Encoding	227
Table 2-94: Capability Code Mapping.....	229
Table 2-95: Operational Mode Code Mapping	230
Table 2-96: True/Magnetic Heading Encoding.....	232
Table 2-97: ADS-B Target State Data Elements - Source Data Mapping To Report Structure	234
Table 2-98: ADS-B Target State Report – Structure Parameter Coding.....	237
Table 2-99: ADS-B Target State Report Validity Flag Requirements.....	237
Table 2-100: ADS-B Air Referenced Velocity Data Elements - Source Data Mapping To Report Structure	240
Table 2-101: ADS-B Air Referenced Velocity Report – Structure Parameter Coding.....	242
Table 2-102: ADS-B Air Referenced Velocity Report – Validity Flag Coding	242
Table 2-103: Airspeed Type Encoding	243
Table 2-104: ADS-B Class A Equipment Reporting Requirements	246
Table 2-105: ADS-B State Vector Required Report Elements	247
Table 2-106: ADS-B Mode Status Required Report Elements	248
Table 2-107: ADS-B Target State Required Report Elements.....	249
Table 2-108: ADS-B Air Referenced Velocity Required Report Elements.....	249
Table 2-109: Minimum Participant Track File Capacity	265
Table 2-110: “CF” Field Code Definitions in DF=18 ADS-B and TIS-B Messages.....	279
Table 2-111: Ground Speed Encoding	287
Table 2-112: Environmental Test Groups.....	301
Table 2-113: Performance Test Requirements During Environmental Tests	302
Table 2-114: Input A: Preamble Pulse Characteristics	325
Table 2-115: Input B: Preamble Pulse Characteristics.....	326
Table 2-116: Input C: Preamble Pulse Characteristics.....	326
Table 2-117: Input D: Preamble Pulse Characteristics	326
Table 2-118: Input A: Preamble Pulse Characteristics	328
Table 2-119: Input B: Preamble Pulse Characteristics.....	328
Table 2-120: Input C: Preamble Pulse Characteristics.....	328
Table 2-121: Input D: Preamble Pulse Characteristics	328
Table 2-122: Input E: Preamble Pulse Characteristics.....	329
Table 2-123: Input F: Preamble Pulse Characteristics	329
Table 2-124: Success Criteria for Preamble and Data Block Tests with Mode A/C Fruit – Class A1S and A1 Equipment	334
Table 2-125: Success Criteria for Preamble and Data Block Tests with Mode A/C Fruit – Class A2 Equipment	334
Table 2-126: Success Criteria for Preamble and Data Block Tests with Mode A/C Fruit – Class A3 Equipment	334
Table 2-127: Success Criteria for Data Block Tests with Mode S Fruit – Class A1S and A1 Equipment	335
Table 2-128: Success Criteria for Data Block Tests with Mode S Fruit – Class A2 Equipment.....	335
Table 2-129: Success Criteria for Data Block Tests with Mode S Fruit – Class A3 Equipment.....	336
Table 2-130: Success Criteria for Re-Triggering Test with Varying Position Mode S Fruit – Class A1S and A1 Equipment	337
Table 2-131: Success Criteria for Re-Triggering Test with Varying Position Mode S Fruit – Class A2 Equipment	337
Table 2-132: Success Criteria for Re-Triggering Test with Varying Position Mode S Fruit – Class A3 Equipment	338

Table 2-133: ADS-B Receiving Subsystem Environmental Test Scenario	341
Table 2-134: Air/Ground Status Determination.....	363
Table 2-135: On-Ground Override.....	364
Table 2-136: “PI” Field Encoding.....	367
Table 2-137: Barometric Altitude Data Inputs.....	375
Table 2-138: GNSS Height (HAE) Data Inputs.....	376
Table 2-139: Airborne Position Encoding Values	379
Table 2-140: Verification of Transition Table	413
Table 2-141: Surface Position Encoding Values.....	415
Table 2-142: Discrete Values for East/West Velocity	446
Table 2-143: Discrete Values for North/South Velocity.....	450
Table 2-144: Vertical Rate Discrete Values.....	455
Table 2-145: Difference from Barometric Altitude Discrete Values	458
Table 2-146: East/West Velocity Discrete Values.....	461
Table 2-147: North/South Velocity Discrete Values	464
Table 2-148: “Heading” Subfield Discrete Values	469
Table 2-149: Discrete Values for “Airspeed” (subsonic).....	472
Table 2-150: Discrete Values for “Airspeed” (supersonic).....	475
Table 2-151: MCP/FCU Selected Altitude in Target State and Status Messages (ARINC Label ‘102’),.....	480
Table 2-152: FMS Selected Altitude in Target State and Status Messages (ARINC Label ‘102’)	480
Table 2-153: Barometric Pressure Setting in Target State and Status Messages (ARINC Label ‘234’) ..	482
Table 2-154: Selected Heading Data in Target State and Status Messages (ARINC Label ‘101’)	483
Table 2-155: Geometric Vertical Accuracy Validation Values	504
Table 2-156: Event-Driven Messages to Test the Scheduling Function.....	524
Table 2-157: Input A: Preamble Pulse Characteristics	558
Table 2-158: Input B: Preamble Pulse Characteristics.....	559
Table 2-159: Input C: Preamble Pulse Characteristics.....	559
Table 2-160: Input D: Preamble Pulse Characteristics	559
Table 2-161: Input A: Preamble Pulse Characteristics	567
Table 2-162: Input B: Preamble Pulse Characteristics.....	568
Table 2-163: Input C: Preamble Pulse Characteristics.....	568
Table 2-164: Input D: Preamble Pulse Characteristics	569
Table 2-165: Input E: Preamble Pulse Characteristics.....	569
Table 2-166: Input F: Preamble Pulse Characteristics	570
Table 2-167: Inputs G through W: Preamble Pulse Characteristics.....	570
Table 2-168: Success Criteria for Preamble and Data Block Tests with Mode A/C Fruit – Class A1S and A1 Equipment	583
Table 2-169: Success Criteria for Preamble and Data Block Tests with Mode A/C Fruit – Class A2 Equipment	584
Table 2-170: Success Criteria for Preamble and Data Block Tests with Mode A/C Fruit – Class A3 Equipment	584
Table 2-171: Success Criteria for Data Block Tests with Mode S Fruit – Class A1S and A1 Equipment	585
Table 2-172: Success Criteria for Data Block Tests with Mode S Fruit – Class A2 Equipment.....	586
Table 2-173: Success Criteria for Data Block Tests with Mode S Fruit – Class A3 Equipment.....	586
Table 2-174: Success Criteria for Re-Triggering Test with Varying Position Mode S Fruit – Class A1S and A1 Equipment	588
Table 2-175: Success Criteria for Re-Triggering Test with Varying Position Mode S Fruit – Class A2 Equipment	588

Table 2-176: Success Criteria for Re-Triggering Test with Varying Position Mode S Fruit – Class A3 Equipment	588
Table 2-177: Success Criteria for Re-Triggering Test with Fixed Position Mode S Fruit – Class A1S and A1 Equipment	589
Table 2-178: Success Criteria for Re-Triggering Test with Fixed Position Mode S Fruit – Class A2 Equipment	589
Table 2-179: Success Criteria for Re-Triggering Test with Fixed Position Mode S Fruit – Class A3 Equipment	590
Table 2-180: ADS-B Message Reception	631
Table 2-181: Report Structure Identification Bit Test Data	634
Table 2-182: Position Message Contents for Position TOA Verification When T=0.....	640
Table 2-183: Messages for Position TOA Verification when T=1	641
Table 2-184: Velocity Time of Applicability Example Test Data	643
Table 2-185: Longitude Test Data	645
Table 2-186: Latitude Test Data	646
Table 2-187: Geometric Altitude Test Data (Q Bit = 1)	648
Table 2-188: Geometric Altitude Test Data (Q Bit = 0)	649
Table 2-189: Difference From Barometric Altitude (w/ Sign) Test Data	650
Table 2-190: North/South Velocity (Subsonic) Test Data	652
Table 2-191: North/South Velocity (Supersonic) Test Data	653
Table 2-192: East/West Velocity (Subsonic) Test Data.....	654
Table 2-193: East/West Velocity (Supersonic) Test Data.....	655
Table 2-194: Ground Speed Test Data.....	656
Table 2-195: Heading Subfield Test Data.....	657
Table 2-196: Barometric (Pressure) Altitude Test Data (Q Bit = 1)	658
Table 2-197: Barometric (Pressure) Altitude Test Data (Q Bit = 0)	659
Table 2-198: Geometric (WGS-84) Vertical Rate Test Data	661
Table 2-199: Vertical Rate Test Data.....	662
Table 2-200: Interpretation of NUC _p Codes from Version Zero Transmitting Subsystems When Received by Version One or above ADS-B Receiving Subsystems.....	664
Table 2-201: Estimated Longitude Test Data	666
Table 2-202: Estimated Latitude Test Data.....	667
Table 2-203: Surveillance Status Test Conditions	675
Table 2-204: Intent Change Flag Test Conditions	676
Table 2-205: Report Mode Encoding.....	677
Table 2-206: Mode Status Report Call Sign Encoding.....	681
Table 2-207: Mode Status Report Emitter Category Meaning	683
Table 2-208: True Air Speed (Subsonic) Test Data	711
Table 2-209: True Air Speed (Supersonic) Test Data.....	712
Table 2-210: Indicated Air Speed (Subsonic) Test Data.....	713
Table 2-211: Indicated Air Speed (Supersonic) Test Data.....	714
Table 2-212: “Heading” Subfield Test Data	717
Table 2-213: Input Data for Global Unambiguous Airborne Decode Zone Checks.....	725
Table 2-214: Input Data for Global Unambiguous Surface Decode Zone Checks	729
Table 2-215: Input Data for Local Unambiguous Airborne Decode Zone Checks.....	733
Table 2-216: Input Date for Local Unambiguous Surface Decode Zone Check	739
Table 2-217: Participant Track File Stimulus Requirements	742
Table 2-218: Extended Squitter Monitor Time Allocation	754
Table 2-219: “Ground Track Angle” Encoding.....	789
Table 2-220: 12-bit CPR Airborne Position Encoding Values	792

Table 3-1: Example System	810
Table 3-2: Minimum Ranges for Receiving Reliability	815
Table A-1: Register Allocation	A-4
Table A-2: “TYPE” Subfield Code Definitions (DF = 17 or 18).....	A-8
Table A-3: Coding of the Movement Field.....	A-19
Table A-4: Aircraft Identification Character Coding	A-21
Table A-5: Determining NAC _v Based on Position Source Declared Horizontal Velocity Error	A-23
Table A-6: “SIL Supplement” Subfield Encoding.....	A-29
Table A-7: “Selected Altitude Type” Subfield Encoding	A-30
Table A-8: “MCP/FCU Selected Altitude or FMS Selected Altitude” Subfield Encoding	A-31
Table A-9: “Barometric Pressure Setting (Minus 800 millibars)” Subfield Encoding	A-32
Table A-10: “Selected Heading Status” Subfield Encoding	A-32
Table A-11: “Selected Heading Sign” Subfield Encoding.....	A-32
Table A-12: “Selected Heading Status, Sign and Data” Subfields Encoding	A-33
Table A-13: Encoding of Navigation Accuracy Category for Position (NAC _p)	A-34
Table A-14: NIC _{BARO} Encoding.....	A-35
Table A-15: Source Integrity Level (SIL) Encoding	A-36
Table A-16: “Status of MCP/FCU Mode Bits” Subfield Encoding.....	A-36
Table A-17: “Autopilot Engaged” Subfield Encoding.....	A-37
Table A-18: “VNAV Engaged” Subfield Encoding	A-37
Table A-19: “Altitude Hold Mode” Subfield Encoding.....	A-37
Table A-20: “Approach Mode” Subfield Encoding.....	A-38
Table A-21: “TCAS/ACAS Operational” Subfield Encoding	A-38
Table A-22: “LNAV” Mode Engaged” Subfield Encoding.....	A-39
Table A-23: Airborne Capability Class (CC) Code for Version 2 Systems.....	A-40
Table A-24: Surface Capability Class (CC) Code for Version 2 Systems.....	A-41
Table A-25: Airborne Operational Mode (OM) Subfield Format.....	A-42
Table A-26: Surface Operational Mode (OM) Subfield Format.....	A-43
Table A-27: Version Number Encoding	A-44
Table A-28: Navigation Integrity Category (NIC) Encoding	A-45
Table A-29: Encoding of the Geometric Vertical Accuracy (GVA) Subfield in Aircraft Operational Status Messages	A-46
Table A-30: A/V Length and Width Code	A-47
Table A-31: Horizontal Reference Direction (HRD) Encoding.....	A-48
Table A-32: “System Design Assurance” OM Subfield in Aircraft Operational Status Messages.....	A-49
Table A-33: Lateral Axis GPS Antenna Offset Encoding	A-51
Table A-34: Longitudinal Axis GPS Antenna Offset Encoding	A-52
Table A-35: Event-Driven Message Lifetime	A-59
Table A-36: CF Field Code Definitions in DF=18 ADS-B and TIS-B Messages	A-88
Table E-1: Summary of Transmitter and Receiver Requirements	E-3
Table E-2: Air-to-Air Range as Limited by Power	E-3
Table H-1: 1090 MHz ADS-B Message Types	H-5
Table H-2: State Vector Report Data	H-6
Table H-3: Mode Status Report Data.....	H-7
Table H-4: Target State Report Data.....	H-9
Table H-5: Air Referenced Velocity Report Data.....	H-10
Table I-1: Combining Odd and Even Outputs	I-17
Table J-1: Platform Dynamics for the Horizontal Velocity Accuracy Test	J-5
Table J-2: Platform Dynamics for the Vertical Velocity Accuracy Test	J-7
Table J-3: Heading Accuracy (RMS degrees).....	J-9

<u>Table K-1: Run Time For Kalman Filter Update</u>	K-11
<u>Table L-1: Undetected Report Error Rate</u>	L-3
<u>Table N-1: Version Zero (0) ADS-B Message Types.....</u>	N-4
<u>Table N-2: Format TYPE Codes for Version 0 and Version 2 Messages.....</u>	N-5
<u>Table N-3: ADS-B State Vector Data Elements – Version Zero (0) 1090 MHz ADS-B Messages to Report Structure Mapping.....</u>	N-7
<u>Table N-4: Version Zero (0) Format Type Code Mapping to Navigation Source Characteristics</u>	N-10
<u>Table N-5: ADS-B Mode Status Data Elements – Version Zero (0) 1090 MHz ADS-B Messages to Report Structure Mapping.....</u>	N-12
<u>Table N-6: En-Route Operational Capabilities Encoding.....</u>	N-15
<u>Table N-7: Type Code to NAC_P Mapping</u>	N-16
<u>Table N-8: SIL Reporting</u>	N-17
<u>Table N-9: Track/Heading and HRD Subfield.....</u>	N-18
<u>Table N-10: ADS-B State Vector Data Elements – Version One (1) 1090 MHz ADS-B Messages to Report Structure Mapping.....</u>	N-21
<u>Table N-11: Version One (1) Format Type Code Mapping to Navigation Source Characteristics</u>	N-24
<u>Table N-12: ADS-B Mode Status Data Elements – Version One (1) Source Data Mapping To Report Structure</u>	N-26
<u>Table N-13: Version One (1) “Aircraft/Vehicle Length and Width Code” Decoding.....</u>	N-29
<u>Table N-14: Capability Code Mapping.....</u>	N-30
<u>Table N-15: True/Magnetic Heading Encoding.....</u>	N-31
<u>Table O-1: Proposed Trajectory Change (TC) Report Definition.....</u>	O-4
<u>Table O-2: Proposed TC Message SUBTYPE Values.....</u>	O-5
<u>Table O-3: Bit Allocation for Messages Supporting Trajectory Change Reports</u>	O-6
<u>Table O-4: Case 1 – TC Message Reception Probability.....</u>	O-10
<u>Table O-5: Case 1 – TC Report Performance</u>	O-10
<u>Table O-6: Case 2 – TC Message Reception Probability.....</u>	O-13
<u>Table O-7: Case 2 – TC Report Performance</u>	O-14
<u>Table O-8: Case 3 – TC Message Reception Probability.....</u>	O-16
<u>Table O-9: Case 3 – TC Report Performance</u>	O-17
<u>Table O-10: Summary of TC Performance</u>	O-21
<u>Table P-1: APL Air-to-Air 1090 ES Performance Relative to ADS-B MASPS.....</u>	P-17
<u>Table P-2: LL A3-to-A3 Performance as a Function of Range for LA-[24k].....</u>	P-29
<u>Table P-3: LL Simulation Results for A2-to-A2 in LA [24k].....</u>	P-31
<u>Table P-4: LL Simulation Results for A3-to-A2 in LA [24k].....</u>	P-31
<u>Table P-5: LL Performance in the Low Density Environment</u>	P-36
<u>Table P-6: Simulation Summaries for State Vector Report Update Ranges</u>	P-38
<u>Table P-7: Simulation Summaries for Target State Report Update Ranges</u>	P-38
<u>Table P-8: Four Interference Environments for Evaluating A1S Air-to-Air ADS-B Performance</u>	P-42
<u>Table P-9: A1-S Air-to-Air ADS-B Performance in Four Interference Environments.....</u>	P-44
<u>Table P-10: A3 Air-to-Air ADS-B Performance in Four Interference Environments</u>	P-44
<u>Table P-11: Air-to-Air Range Comparison For Eight Cases of Increasing Interference</u>	P-45
<u>Table Q-1: Proposed Runway Threshold Speed Encoding.....</u>	Q-4
<u>Table R-1: Airborne Steady State Conditions.....</u>	R-3
<u>Table R-2: Airborne with Mode A Code Change</u>	R-4
<u>Table R-3: Airborne, TSS, Permanent Alert State (7500, 7600, 7700)</u>	R-5
<u>Table R-4: Airborne, no TSS, NAC/SIL Change.....</u>	R-6
<u>Table R-5: Airborne, no TSS, TCAS/NAC/SIL Change, Mode A Code Change</u>	R-7
<u>Table R-6: On-the-Ground, Moving, Mode A Code Change, NIC_{SUPP}/NAC/SIL Change</u>	R-8
<u>Table S-1: Observed GPS Output UTC TIME Data</u>	S-5

<u>Table S-2: ARINC Label “150” Data Format</u>	S-6
<u>Table S-3: ARINC Label “140” Data Format</u>	S-6
<u>Table T-1: Message bits required for position encoding with and without CPR</u>	T-3
<u>Table T-2: CPR Latitude Encoding Resolution</u>	T-9
<u>Table T-3: 32bAWB boundaries for NL Transition latitudes - surface even encoding</u>	T-32
<u>Table T-4: 32bAWB Boundaries for NL Transition Latitudes - Surface Odd Encoding</u>	T-35
<u>Table T-5: 32bAWB Boundaries for NL Transition Latitudes - Airborne Even Encoding</u>	T-38
<u>Table T-6: 32bAWB boundaries for NL Transition latitudes - airborne odd encoding</u>	T-41
<u>Table T-7: 32bAWB Boundaries for NL Transition Latitudes - TIS-B Even Encoding</u>	T-44
<u>Table T-8: 32bAWB Boundaries for NL Transition Latitudes - TIS-B Odd Encoding</u>	T-48
<u>Table V-1: Data Element Received Update Frequency Requirements</u>	V-11
<u>Table V-2: Proposed Meteorological Squitter Format 1</u>	V-17
<u>Table V-3: Proposed Meteorological Squitter Format 2</u>	V-19
<u>Table V-4: Proposed Weight Encoding for Meteorological Squitter Format 2 (For Aircraft Identification Category A)</u>	V-20
<u>Table V-5: Availability of Meteorological and State Vector Data for ADS-B OUT Data Broadcasts...</u>	V-32

1.0 PURPOSE AND SCOPE

1.1 Introduction

This document contains Minimum Operational Performance Standards (MOPS) for airborne equipment for Automatic Dependent Surveillance-Broadcast (ADS-B) and Traffic Information Service – Broadcast (TIS-B) utilizing 1090 MHz Mode-S Extended Squitter (1090ES). The supporting hardware can be incorporated within other on-board equipment, or alternatively, the ADS-B equipment may be a separate avionics unit.

Note: *Definitions of acronyms (e.g., MOPS, ADS-B, 1090ES) and of many other terms (e.g., “Extended Squitter”) can be found in Appendix B of these MOPS. Throughout this document, the term “TIS-B” refers to the Fundamental TIS-B Service as defined in the TIS-B MASPS, RTCA/DO-286B, §1.4.1. The acronym “ADS-R” refers to the ADS-B Rebroadcast Service as defined in the TIS-B MASPS, RTCA/DO-286B, §1.4.1. The Fundamental TIS-B Service provides traffic information that is derived from ground surveillance (e.g., radar) systems. The ADS-B Rebroadcast Service provides the Rebroadcast on 1090 MHz of an ADS-B Message from an alternate data link using the same TYPE Codes and Message Formats as are defined for Downlink Format (DF) = 17 ADS-B Messages, with the exception of bits modified as identified in §2.2.18.*

Compliance with these standards by manufacturers, installers and users is recommended as one means of assuring that the equipment will satisfactorily perform its intended functions under conditions encountered in routine aeronautical operations. The regulatory application of these standards is the responsibility of appropriate government agencies. For example, in the United States, the Federal Aviation Administration (FAA) publishes and maintains a Technical Standard Order (TSO C166) for 1090ES ADS-B equipment to reference the requirements and bench test procedures in Section 2 of this document. In the European Union, the European Aviation Safety Agency (EASA) publishes and maintains a European Technical Standard Order (ETSO C166) for 1090ES ADS-B equipment to reference the requirements and bench test procedures in Section 2 of this document.

Since the equipment implementation includes a computer software package, the most recent version of the *Software Considerations in Airborne Systems and Equipment Certification*, (RTCA DO-178B/EUROCAE ED-12B) is applicable. When determining the level of software requirements, as defined in RTCA DO-178B/EUROCAE ED-12B, or subsequent versions, the equipment manufacturer should consider the criticality appropriate for the installation certification, equipment failure analysis, and the fault monitoring being accomplished.

In addition, since the measured values of equipment performance characteristics may be a function of the measurement method, standard test conditions and methods of test are recommended in this document.

Section 1 of this document provides information and assumptions needed to understand the rationale for equipment characteristics and requirements stated in the remaining sections. It describes typical equipment applications and operational goals and, along with RTCA DO-242A, *Minimum Aviation System Performance Standards for ADS-B*, forms the basis for the standards stated in Sections 2 and 3.