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Advanced Surface Movement Guidance and Control System (A-SMGCS);

Part 5: Harmonized Standard for access to the radio spectrum for

multilateration equipment;

Sub-part 1: Receivers and Interrogators

<

**HARMONISED EUROPEAN STANDARD**

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Contents

Intellectual Property Rights 6

Foreword 6

Modal verbs terminology 7

Introduction 7

1 Scope 7

2 References 8

2.1 Normative references 8

2.2 Informative references 8

3 Definitions, symbols and abbreviations 10

3.1 Definitions 10

3.2 Symbols and Abbreviations 11

4 Technical requirements specifications 12

4.1 Applicability 12

4.1.1 Equipment with multiple functions 12

4.1.2 Equipment with integral antenna 12

4.1.3 Environmental profile 12

4.2. General 12

4.2.1 Transmitter duty cycle 12

4.3 Transmitter requirements 13

4.3.1 Operating frequency and frequency error 13

4.3.1.1 Description 13

4.3.1.2 Limits 13

4.3.1.3 Conformance 13

4.3.2 Transmitter peak envelope power 13

4.3.2.1 Description 13

4.3.2.2 Limits 13

4.3.2.3 Conformance 13

4.3.3 Spectrum mask 13

4.3.3.1 Description 13

4.3.3.2 Limits 14

4.3.3.3 Conformance 14

4.3.5 Residual Power Output 14

4.3.5.1 Description 14

4.3.5.2 Limits 14

4.3.5.3 Conformance 15

4.4 Receiver requirements 15

4.4.1 Operating frequency range 15

4.4.1.1 Description 15

4.4.1.2 Limits 15

4.4.1.3 Conformance 15

4.4.2 RF selectivity and spurious responses 15

4.4.2.1 Description 15

4.4.2.2 Limits 15

4.4.2.3 Conformance 15

4.4.3 Inter-modulation response rejection 16

4.4.3.1 Description 16

4.4.3.2 Limits 16

4.4.3.3 Conformance 16

4.4.4 Co-channel rejection 16

4.4.4.1 Description 16

4.4.4.2 Limits 16

4.4.4.3 Conformance 16

4.4.5 Blocking 16

4.4.5.1 Description 16

4.4.5.2 Limits 16

4.4.5.3 Conformance 16

4.4.6 Receiver dynamic range / maximum usable sensitivity 17

4.4.6.1 Description 17

4.4.6.2 Limits 17

4.4.6.3 Conformance 17

4.5 Receiver and transmitter Requirements 17

4.5.1 Spurious emissions 17

4.5.1.1 Description 17

4.5.1.2 Limits 17

4.5.1.3 Conformance 17

5 Testing for compliance with technical requirements 18

5.1 Test Conditions 18

5.1.1 General 18

5.1.2 Power Sources and Ambient Conditions 18

5.1.2.1 Normal Test Conditions 18

5.1.2.1.1 Normal Temperature and Humidity 18

5.1.2.1.2 Normal Power Source 18

5.1.2.2 Extended and Extreme Test Conditions 18

5.1.2.2.1 Extended Temperatures 19

5.1.2.2.1 Extreme Temperatures 19

5.1.2.2.2 Extended Power Source Voltages 19

5.1.3 Procedure for Tests at Extended and Extreme Temperatures 19

5.1.3.1 All Equipment 19

5.1.3.2 Equipment including Transmitters 20

5.2 Interpretation of the measurement results 20

5.3 Test and General Conditions 20

5.3.1 Transmitter test signals 20

5.3.1.0 General Considerations 20

5.3.1.1 Test signal 1 21

5.3.1.2 Test signal 2 21

5.3.2 Simulated received signals 21

5.3.2.0 General Considerations 21

5.3.2.1 Test signal 3 21

5.3.2.2 Test signal 4 21

5.4 Transmitter tests 22

5.4.1 Operating frequency and frequency error 22

5.4.1.1 Description 22

5.4.1.2 Test conditions 22

5.4.1.3 Method of measurement 22

5.4.1.4 Measurement procedure 22

5.4.2 Transmitter peak envelope power 22

5.4.2.1 Description 22

5.4.2.2 Test conditions 22

5.4.2.3 Method of measurement 23

5.4.2.4 Measurement procedure 23

5.4.3 Spectrum mask 23

5.4.3.1 Description 23

5.4.3.2 Test conditions 23

5.4.3.3 Method of measurement 23

5.4.3.4 Measurement procedure 24

5.4.5 Residual power output 24

5.4.5.1 Description 24

5.4.5.2 Test conditions 24

5.4.5.3 Method of measurement 24

5.4.5.4 Measurement procedure 24

5.5 Receiver Tests 25

5.5.1 Operating frequency range 25

5.5.1.1 Description 25

5.5.1.2 Test conditions 25

5.5.1.3 Method of measurement 25

5.5.1.4 Measurement procedure 25

5.5.2 channel selectivity and spurious responses 25

5.5.2.1 Description 25

5.5.2.2 Test conditions 26

5.5.2.3 Method of measurement 26

5.5.2.4 Measurement procedure 26

5.5.3 Inter-modulation response rejection 27

5.5.3.1 Description 27

5.5.3.2 Test conditions 27

5.5.3.3 Method of measurement 27

5.5.3.4 Measurement procedure 27

5.5.4 Co-channel rejection 28

5.5.4.1 Description 28

5.5.4.2 Test conditions 28

5.5.4.3 Method of measurement 28

5.5.4.4 Measurement procedure 28

5.5.5 Blocking 29

5.5.5.1 Description 29

5.5.5.2 Test conditions 29

5.5.5.3 Method of measurement 29

5.5.5.4 Measurement procedure 29

5.5.6 Receiver dynamic range / Maximum usable sensitivity 30

5.5.6.1 Description 30

5.5.6.2 Test conditions 30

5.5.6.3 Method of measurement 30

5.5.6.4 Measurement procedure 30

5.6 Receiver and transmitter tests 30

5.6.1 Spurious emissions 30

5.6.1.1 Description 30

5.6.1.2 Test conditions 30

5.6.1.3 Method of measurement 31

5.6.1.3.1 Conducted measurement 31

5.6.1.3.2 Radiated measurement 31

Annex A (informative): Relationship between the present document and the essential requirements of Directive 2014/53/EU 33

Annex B (informative): Bibliography 35

Annex C (informative): Change history 36

History 36

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# Foreword

This draft Harmonized European Standard (EN) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM) and is now submitted for the combined Public Enquiry and Vote phase of the ETSI standards EN Approval Procedure.

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.6] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.1].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in table A.1 confers, within the limits of the scope of the present document, a presumption of conformity with the corresponding essential requirements of that Directive, and associated EFTA regulations.

The present document is part 5, sub-part 1, of a multi-part deliverable covering Advanced Surface Movement Guidance and Control System (A-SMGCS), as identified below.

Part 1: "Community Specification for application under the Single European Sky Interoperability Regulation EC 552/2004 for A-SMGCS surveillance service including external interfaces";

Part 2: "Community Specification for application under the Single European Sky Interoperability Regulation EC 552/2004 for A-SMGCS airport safety support service";

Part 3: "Community Specification for application under the Single European Sky Interoperability Regulation EC 552/2004 for a deployed cooperative sensor including its interfaces";

Part 4: "Community Specification for application under the Single European Sky Interoperability Regulation EC 552/2004 for a deployed non-cooperative sensor including its interfaces";

**Part 5: "Harmonized Standard for access to radio spectrum for multilateration equipment";**

**Sub-part 1: "Receivers and Interrogators";**

Sub-part 2: "Reference and Vehicle Transmitters";

Part 6: "Harmonized Standard for access to radio spectrum for deployed surface movement radar sensors".

Part 7: "Community Specification for application under the Single European Sky Interoperability Regulation EC 552/2004 for A-SMGCS routing service ";

Part 8: "Community Specification for application under the Single European Sky Interoperability Regulation EC 552/2004 for A-SMGCS guidance service";

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# Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](https://portal.etsi.org/Services/editHelp%21/Howtostart/ETSIDraftingRules.aspx) (Verbal forms for the expression of provisions).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

# Introduction

A-SMGCS are systems providing routing, guidance, surveillance and control to aircraft and affected vehicles in order to maintain movement rate under all local weather conditions within the Aerodrome Visibility Operational Level (AVOL) whilst maintaining the required level of safety.

The present document states the minimum performance requirements for receivers and interrogators used in multilateration equipment in an Advance Surface Movement Guidance and Control System (A-SMGCS) necessary for a harmonised standard covering article 3.2 of the Radio Equipment Directive [i.1].

# 1 Scope

The present document specifies technical characteristics and methods of measurements for the following equipment:

1. Interrogators transmitting in the 1030 MHz band, used in multilateration equipment in an Advanced Surface Movement Guidance and Control System (A-SMGCS);
2. Receivers, receiving in the 1090 MHz band, used in multilateration equipment in an Advanced Surface Movement Guidance and Control System (A-SMGCS);

The present document does not apply to equipment which includes a transponder function.

NOTE1: For the purpose of the present document, ground vehicle locators and reference transmitters which do not contain receivers for the purpose of replying to interrogation are included in the transponder definition.

NOTE 2: Antennas for this equipment are considered to be passive without additional amplifier.

The present document covers requirements to demonstrate that radio equipment both effectively uses and supports the efficient use of radio spectrum in order to avoid harmful interference.

NOTE 3: The relationship between the present document and essential requirements of article 3.2 of Directive 2014/53/EU is given in Annex A.

In addition to the present document, other ENs that specify technical requirements in respect of essential requirements under other parts of article 3 of the Radio Equipment Directive 2014/53/EU [i.1] as well as essential requirements under the SES Interoperability Regulation 552/2004 [i.7] and related implementing rules and/or essential requirements under the EASA basic regulation 216/2008 [i.8] as amended by Regulation No 1108/2009 [i.9] may apply to equipment within the scope of the present document.

# 2 References

## 2.1 Normative references

References are specific, identified by date of publication and/or edition number or version number. Only the cited version applies.

Referenced documents which are not found to be publicly available in the expected location might be found at <https://docbox.etsi.org/Reference/>.

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The following referenced documents are necessary for the application of the present document.

[1] ICAO Annex 10, Volume IV, ”Surveillance and Collision Avoidance systems“, 5th edition, July 2014, including amendments up to amendment 89.

[2] EUROCAE ED-117A (September 2016): "MOPS for Mode S Multilateration Systems for Use in A-SMGCS".

[3] ERC/Recommendation 74-01 (2011): "Unwanted emissions in spurious domain".

[4] EUROCAE ED-129B (March 2016): Technical Specification for a 1090 MHz Extended Squitter ADS-B Ground System

## 2.2 Informative references

References are either specific (identified by date of publication and/or edition number or version number) or non‑specific. For specific references, only the cited version applies. For non-specific references, the latest version of the referenced document (including any amendments) applies.

NOTE: While any hyperlinks included in this clause were valid at the time of publication, ETSI cannot guarantee their long term validity.

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC.

 [i.3] ITU-R Recommendation SM.329-12 (2012): “Unwanted emissions in the spurious domain”.

[i.4] ETSI EN 300 113 (latest version to be added): Land Mobile Service; Radio equipment intended for the transmission of data (and/or speech) using constant or non-constant envelope modulation and having an antenna connector; Harmonised Standard covering the essential requirements of article 3.2 of the Directive 2014/53/EU.

[i.5] ETSI EN 300 676-1 (latest version to be added): Electromagnetic compatibility and Radio spectrum Matters (ERM); Ground-based VHF hand-held, mobile and fixed radio transmitters, receivers and transceivers for the VHF aeronautical mobile service using amplitude modulation; Part 1: Technical characteristics and methods of measurement.

[i.6] Commission Implementing Decision C(2015) 5376 final of 4.8.2015 on a standardisation request to the European Committee for Electrotechnical Standardisation and to the European Telecommunications Standards Institute as regards radio equipment in support of Directive 2014/53/EU of the European Parliament and of the Council.

[i.7] EC Regulation No 552/2004 of the European Parliament and of the Council of 10 March 2004 on the interoperability of the European Air Traffic Management network (interoperability Regulation), OJ L 96, 31.03.2004, p. 26 as amended by Regulation (EC) No 1070/2009, OJ L 300, 14.11.2009, p. 34.

[i.8] Regulation (EC) 216/2008 of the European Parliament and of the Council of 20 February 2008 on common rules in the field of civil aviation and establishing a European Aviation Safety Agency, and repealing Council Directive 91/670/EEC, Regulation (EC) No 1592/2002 and Directive 2004/36/EC.

[i.9] Regulation (EC) No 1108/2009 of the European Parliament and of the Council of 21 October 2009 amending Regulation (EC) No 216/2008 in the field of aerodromes, air traffic management and air navigation services and repealing Directive 2006/23/EC.

[i.10] ETSI TR 100 028 (all parts) (V1.4.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".

[i.11] ETSI TR 100 028-2 (V1.4.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 2".

# 3 Definitions, symbols and abbreviations

## 3.1 Definitions

For the purposes of the present document, the terms and definitions given in the RE Directive [i.1] and the following apply:

**conducted measurements:** measurements which are made using a wired connection to the EUT

**duty cycle:** ratio expressed as a percentage, of the cumulative duration of transmissions within an observation interval and in an observation bandwidth

**environmental profile:** range of environmental conditions under which the EUT is declared by the manufacturer to comply with the provisions of this document

**ground based multilateration equipment or ground station:** aeronautical station equipment intended for use in an A-SMGCS multilateration component

NOTE: A ground station can include sensor, interrogator and/or transponder components. A ground station can be fixed or mobile.

**inactive state:** entire period between transmissions, less 100 μs transition periods preceding and following the transmission.

**integral antenna:** antenna which is integrated into the EUT without the use of an external connector, and which is considered to be part of the EUT.

**interrogator:** aeronautical station equipment including at least one transmitter designed to produce aeronautical mobile service signals at 1030 MHz.

**multilateration:** surveillance technique which provides position derived from the secondary surveillance radar (SSR) transponder signals (replies or squitters) primarily using time difference of arrival (TDOA) techniques.

NOTE: Additional information, including identification, can be extracted from the received signals.

**operating channel (OC):** frequency range in which the transmission from the EUT occurs, or in which the EUT is intended to receive transmissions

**operating frequency:** centre of the OC

**out of band emissions:** power transmitted at frequencies outside the OC but within the specified spectral mask

**probability of detection:** rate of correctly received and decoded squitter messages

**radiated measurements:** measurements which involve the measurement of a radiated field in the vicinity of the EUT

**receiver:** EUT which includes the capability to convert RF signals into binary content.

**resolution bandwidth:** bandwidth that is used for measurements used for spectral measurements.

**sensor:** aeronautical station equipment including at least one receiver designed to receive aeronautical mobile service signals at 1030 and/or 1090 MHz.

**spurious emissions:** power transmitted at frequencies outside the specified spectral mask.

NOTE: Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude Out Of Band emissions.

**transmission:** radio emission consisting of one uplink or downlink Mode S message.

**transmitter:** EUT which includes the capability to convert binary content into RF signals.

**transponder:** aeronautical station equipment including at least one transmitter designed to produce aeronautical mobile radionavigation service signals at 1090 MHz and zero or more receivers designed to receive aeronautical mobile radionavigation service signals at 1030 MHz

**equipment under test (EUT):** system of constituents provided by the manufacturer for qualification under this document.

## 3.2 Symbols and Abbreviations

AC Alternating Current

ADS-B Automatic Dependant Surveillance Broadcast

A-SMGCS Advanced Surface Movement Guidance and Control System

dB deciBel

dBm power in dB relative to 1 milliwatt

DME Distance Measuring Equipment

EUT Equipment Under Test

ICAO International Civil Aviation Organization

IFF Interrogate Friend or Foe

λ Wavelength

µs Microsecond

MLAT Multilateration

MOPS Minimum Operational Performance Specification

Ω Ohm

OC Operating Channel

OoB Out-of-Band

PD Probability of detection

PEP Peak Envelope Power

RBW Resolution Bandwidth (Measurement Bandwidth for emission measurement)

RBWref Reference Bandwidth

RED Radio Equipment Directive

RF Radio Frequency

SSR Secondary Surveillance Radar

t Time

# 4 Technical requirements specifications

## 4.1 Applicability

### 4.1.1 Equipment with multiple functions

Any ground station which includes the interrogator function shall comply with the requirements in section 4.3.

Any ground station which includes the sensor function shall comply with the requirements in section 4.4.

### 4.1.2 Equipment with integral antenna

For the purposes of conducted measurements of EUT with integral antenna, a 50 Ω RF connection point shall be provided for test purposes. The connection point should correspond to the input of the integral antenna. The connection point may be a modification made for the purposes of testing and need not be a permanent part of the EUT when made available for sale.

### 4.1.3 Environmental profile

The technical requirements of the present document apply under the environmental profile for operation of the equipment, which shall be declared by the manufacturer in accordance to the requirements stated in EUROCAE ED-117A [2], Chapter 4 (Requirements REQ 73 to REQ 78), but as a minimum, shall be that specified in the test conditions contained in the present document. The equipment shall comply with all the technical requirements of the present document which are identified as applicable in annex A at all times when operating within the boundary limits of the declared environmental profile.

## 4.2. General

### 4.2.1 Transmitter duty cycle

The duty cycle is determined with the equation:

$$DC=\left(\frac{T\_{on\\_cum}}{T\_{obs}}\right)\_{Fobs}$$

where

* Ton\_cum is the cumulative duration of the message from the 50% voltage point on the rising edge of the first pulse to the 50% voltage point on the falling edge of the last pulse.
* Tobs.is at least one second and sufficiently long to capture the steady state operation of the transmitter
* Fobs is the frequency band to evaluate centred at 1030 MHz and extending at least +/- 4 MHz

The required duty cycle is a function of the airport and depends on the fit-for-purpose requirements.

The manufacturer shall declare the rated duty cycle of the transmitter that is necessary to fulfil all the operational requirements stated in ED-117A [2].

NOTE: For the purposes of the present document, the rated duty cycle is a limit to be respected during testing in order to avoid damage to the EUT.

## 4.3 Transmitter requirements

### 4.3.1 Operating frequency and frequency error

#### 4.3.1.1 Description

The operating frequency is the nominal value of the carrier frequency.

The frequency error is the difference between the actual carrier frequency and its nominal value of 1030 MHz.

#### 4.3.1.2 Limits

The nominal value of carrier frequency of the interrogation and control transmissions shall be 1030 MHz.

The absolute value of the frequency error shall not exceed 0,01 MHz

NOTE: this value is specified in clause 3.1.2.1.1 of ICAO Annex 10 Volume IV [1].

#### 4.3.1.3 Conformance

The conformance tests for this requirement shall be as defined in clause 5.4.1.

NOTE: the test procedure ignores frequency excursions during the phase reversal. Further information is given in 3.1.2.1.1. ICAO Annex 10 Volume IV [1].

### 4.3.2 Transmitter peak envelope power

#### 4.3.2.1 Description

Peak envelope power is the average power supplied to the antenna transmission line during one radio frequency cycle at the crest of the modulation envelope.

The transmitter power needs to achieve the value needed to meet operational performance.

The manufacturer shall announce the rated output power of the transmitter.

 Note: This figure is required by the operator to determine a minimum distance to receiving units.

#### 4.3.2.2 Limits

The peak envelope power of the transmitter measured under normal test conditions as required in ED-117A [1], REQ78, shall not vary by more than 2 dB from the rated output power and shall not exceed the maximum output power declared by the manufacturer.

The peak envelope power of the transmitter measured under extreme test conditions as required in ED-117A [1], REC30, shall not vary by more than + 2 dB and -3 dB from the rated output power and shall not exceed the power limit indicated in the individual Frequency Licence

#### 4.3.2.3 Conformance

The conformance tests for this requirement shall be as defined in clause 5.4.2.

### 4.3.3 Spectrum mask

#### 4.3.3.1 Description

A spectrum mask is a set of limit lines applied to a plot of a transmitter spectrum. The purpose is to constrain emissions at frequencies in the Out of Band domain which lies immediately outside the intended Operating Channel.

For the purposes of the present document, the out of band domain extends to +/- 125 MHz about the nominal operating frequency of 1030 MHz. The frequencies below or above the Out of Band domain are defined as the spurious domain.

The definition of the spectrum mask is chosen as an alternative method to the specification of Out of Band domain emissions.

#### 4.3.3.2 Limits

The measured spectrum shall be below the limit lines shown in Figure 1 OR -13 dBm, whichever is less stringent.



Figure 1 - Required spectrum limits for interrogator transmitter (mask from ICAO Annex 10, Volume 4, figure 3-2 [1] modified to be consistent with ITU-RR article 3 [i.3]

Note: *The ICAO mask was extrapolated from the last three steps to determine when the mask would intercept the -60 dB point. A value of approximately 125 MHz was reached. 125 MHz is also the point reached when extrapolating the mask from the -40 dB (i.e., 40 MHz) by -40 dB per decade -- as described in ECC REC (02) 05, Figure A2.1 Emission Mask for radars -- until the spurious limit is reached.*

*It had been decided not to have a more stringent requirement on the spectrum mask than ICAO*

*CEPT 74-01 and REC329 (ITU) are conflicting:*

*• CEPT 74-01: multilateration systems fall into “aids to air navigation” (not a radar system)*

*• ITU REC 329: fixed radio determination systems: there is a limit -30dBm or -100dBc, whichever is less stringent*

#### 4.3.3.3 Conformance

The conformance tests for this requirement shall be as defined in clause 5.4.3.

### 4.3.5 Residual Power Output

#### 4.3.5.1 Description

The residual power output is the power output when in the inactive state.

#### 4.3.5.2 Limits

The residual power output shall be not greater than -47dBm as specified in Table 2 of REC 74-01 [3].

#### 4.3.5.3 Conformance

The conformance tests for this requirement shall be as defined in clause 5.4.4.

## 4.4 Receiver requirements

### 4.4.1 Operating frequency range

#### 4.4.1.1 Description

The operating frequency range is the frequency range around the nominal operating frequency over which reception of signals can be achieved.

#### 4.4.1.2 Limits

The sensitivity shall not degrade by more than 3 dB as the incoming signal is offset over the frequency ranges +/- 1 MHz.

#### 4.4.1.3 Conformance

The conformance tests for this requirement shall be as defined in clause 5.5.1

### 4.4.2 RF selectivity and spurious responses

#### 4.4.2.1 Description

RF selectivity and spurious response rejection are the ability of the EUT to avoid erroneous reception of signals from outside the desired frequency band.

Limits are evaluated assuming the signal is constructed as a valid Mode S waveform except that the frequency is altered. Although the 1090 MHz IFF system has only a single frequency channel, DME systems may occupy adjacent frequency allocations within the aviation band. It is important that the receiver rejects signals which are out of band while retaining sufficient bandwidth for acceptable multilateration performance.

#### 4.4.2.2 Limits

The EUT shall not respond to valid signals at the frequency offsets and levels indicated in ED-129 [4], summarized in Table 1.

Table 1 - minimum input level for messages from outside the desired frequency band

|  |  |
| --- | --- |
| ***Frequency (MHz)*** | ***Minimum Input Level Above Specified Receiver Sensitivity (dB)*** |
| +/- 12.5 | >=3 |
| +/- 19 | >= 20 |
| +/- 29 | >= 40 |
| +/- 46 | >=60 |

Where do these values come from? Please specify in the requirement

#### 4.4.2.3 Conformance

The conformance tests for this requirement shall be as defined in clause 5.5.2.

### 4.4.3 Inter-modulation response rejection

#### 4.4.3.1 Description

The intermodulation response rejection is a measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of two or more unwanted signals with a specific frequency relationship relative to the receiver frequency.

#### 4.4.3.2 Limits

At any frequency combination from -78 MHz to -10 MHz and from +10 MHz to +78 MHz from the receiver frequency of 1090 MHz, the unwanted signals shall not reduce the probability of detection by more than 5 percentage points if their signal level is 12 dB or more below the level of the wanted signal.

#### 4.4.3.3 Conformance

The conformance tests for this requirement shall be as defined in clause 5.5.3.

### 4.4.4 Co-channel rejection

#### 4.4.4.1 Description

Co-channel rejection is the receiver's ability to receive a wanted signal in the presence of an unwanted signal, with both signals being at the nominal receiver frequency. An unwanted signal is a signal that has a signal level 12 dB or more below the level of the wanted signal.

#### 4.4.4.2 Limits

The unwanted signal shall not reduce the rate of correctly received and decoded squitter messages from the wanted Mode S signal by more than 5 %.

#### 4.4.4.3 Conformance

The conformance tests for this requirement shall be as defined in clause 5.5.4.

### 4.4.5 Blocking

#### 4.4.5.1 Description

Blocking is a measure of the capability of the receiver to receive a wanted signal without exceeding a given degradation due to the presence of a strong unwanted signal.

#### 4.4.5.2 Limits

The rate of correctly received and decoded squitter messages from the wanted Mode S signal shall be reduced by no more than 5% in the presence of unwanted signals specified in Table 2.

Table 2 - unwanted signal levels

|  |  |
| --- | --- |
| Frequency | Level |
| -78 MHz to -15 MHz relative to 1090 MHz | 20 dB above the level of the wanted signal |
| +15 MHz to +78 MHz relative to 1090 MHz | 20 dB above the level of the wanted signal |

#### 4.4.5.3 Conformance

The conformance tests for this requirement shall be as defined in clause 5.5.5.

### 4.4.6 Receiver dynamic range / maximum usable sensitivity

#### 4.4.6.1 Description

The receiver dynamic range is the ratio between maximum and minimum possible received power of the receiver without the receiver being driven in the overload.

The receiver sensitivity is the ability to receive a wanted signal at low input signal levels while providing a pre-determined level of performance.

#### 4.4.6.2 Limits

Receivers shall operate throughout the receiver dynamic range for signals with a carrier frequency of 1090 MHz with a PD of not less than 90% in order to meet the required PTR defined in EUROCAE ED-117A [2], REQ 58.

The manufacturer of the EUT shall declare the dynamic range and sensitivity and with the conformance test the declared performance shall be tested.

#### 4.4.6.3 Conformance

The conformance tests for this requirement shall be as defined in clause 5.5.6.

## 4.5 Receiver and transmitter Requirements

### 4.5.1 Spurious emissions

#### 4.5.1.1 Description

.

For active transmitters, the spurious domain is all frequencies apart from the operating channel and the Out of Band domain.

For Receivers and inactive transmitters the spurious domain is all frequenciesas they are not supposed to transmit any signal. the spurious emissions requirement which is more stringent than the recommendation in 3.1.2.11.3.1. of ICAO [1].

#### 4.5.1.2 Limits

The power of any unwanted emission in the spurious domain shall not exceed the values given in Table 3 that are defined in [REFERENCE]. See that document on how to apply the limits

Table 3 - maximum power levels for spurious emissions

|  |  |  |  |
| --- | --- | --- | --- |
|  FrequencyState | 47 MHz to 74 MHz87,5 MHz to 118 MHz174 MHz to 230 MHz470 MHz to 790 MHz | Other frequencies below 1 000 MHz | Frequencies above 1 000 MHz |
| TX mode (excluding spectrum mask) | -54 dBm | -36 dBm | -30 dBm |
| RX and all other modes | -57 dBm | -57 dBm | -47 dBm |

#### 4.5.1.3 Conformance

The conformance tests for this requirement shall be as defined in clause 5.6.1.

# 5 Testing for compliance with technical requirements

## 5.1 Test Conditions

### 5.1.1 General

Type tests shall be made under normal test conditions and where stated also under extended and – if applicable – extreme test conditions. The test conditions and procedures shall be as specified in clauses 5.1.2.1 and 5.1.2.2

### 5.1.2 Power Sources and Ambient Conditions

During type tests the power source of the equipment shall be replaced by a test power source, capable of producing normal and extreme test voltages as specified in clauses 5.1.2.1 and 5.1.2.2. The internal impedance of the test power source shall be low enough for its effect on the test results to be negligible. For the purpose of tests, the voltage of the power source shall be measured at the input terminals of the equipment. If the equipment is provided with a permanently connected power cable, the test voltage shall be that measured at the point of connection of the power cable to the equipment. In equipment with incorporated batteries the test power source shall be applied as close to the battery terminals as practicable. During tests the power source voltages shall be maintained within a tolerance of ±1 % relative to the voltage at the beginning of each test.

#### 5.1.2.1 Normal Test Conditions

##### 5.1.2.1.1 Normal Temperature and Humidity

The normal temperature and humidity conditions for tests shall be any convenient combination of temperature and humidity within the common range fulfilling all of the following requirements:

* temperature +15 C to +35 C (degrees Celsius);
* relative humidity 5 % to 75 %;
* intended operational humidity range of the equipment.

When it is impracticable to carry out the tests under the conditions stated above, the actual temperature and relative humidity during the tests shall be recorded in the test report.

##### 5.1.2.1.2 Normal Power Source

The normal test voltage for equipment to be connected to the mains shall be the nominal mains voltage. For the purpose of these specifications, the nominal voltage shall be the declared voltage or any of the declared voltages for which the equipment was designed. The frequency of the test power source corresponding to the mains shall be between 49 Hz and 51 Hz.

When the radio equipment is intended for operation from the usual types of regulated lead-acid battery power source of vehicles, the normal test voltage shall be 1,1 times the nominal voltage of the battery (6 V, 12 V, etc.).

For operation from other power sources or types of battery (primary or secondary) the normal test voltage shall be that declared by the equipment manufacturer.

#### 5.1.2.2 Extended and Extreme Test Conditions

The following four test condition combinations are applied while testing the equipment under extended or extreme test conditions:

* LTLV: lower temperature and lower voltage;
* LTHV: lower temperature and higher voltage;
* HTLV: higher temperature and lower voltage;
* HTHV: higher temperature and higher voltage.

Unless otherwise stated tests to be conducted under extended and extreme test conditions shall include all the above temperature and voltage combinations.

##### 5.1.2.2.1 Extended Temperatures

For tests at extended temperatures, measurements shall be made over the limits of the operating temperature range as declared by the manufacturer in which the unit will comply to all requirements without limitation unless this range does not cover the following minimum range:

* for equipment intended for indoor use, the limits of ETSI EN 300 019 1-3 Class 3.2 shall apply:

lower temperature: -5°C

upper temperature: +45°C

* for equipment intended for outdoor use, the limits of ETSI EN 300 019 1-4 Class 4.1 shall apply:

lower temperature: -30°C

upper temperature: +40°C

The extended humidity conditions shall be the same as the normal humidity conditions specified in clause 5.1.2.1.

##### 5.1.2.2.1 Extreme Temperatures

If the manufacturer declares an operational temperature range beyond the extended temperature range in which the equipment will perform with limitations, measurements shall be made over the extremes of this maximum operating temperature range as declared by the manufacturer.

The extreme humidity conditions shall be the same as the normal humidity conditions specified in clause 5.1.2.1.

##### 5.1.2.2.2 Extended Power Source Voltages

The extended test voltages for equipment to be connected to an A/C mains source shall be the nominal mains voltage ±10 %.

When the equipment is intended for operation from the usual types of regulated lead-acid battery power sources of vehicles the extended test voltages shall be 1,3 and 0,9 times the nominal voltage of the battery (6 V, 12 V, etc.).

The extended test voltages for equipment with power sources using non regulated batteries shall be as follows. The upper extended test voltage shall be the normal test voltage. The lower extended test voltage shall be:

* for the Leclanche or the lithium-type of battery, 0,85 times the nominal voltage of the battery;
* for the mercury-type or nickel cadmium type of battery, 0,9 times the nominal voltage of the battery;
* for other types of batteries, end point voltage declared by the equipment manufacturer.

However, the lower extended test source voltages shall be those agreed between the equipment manufacturer and the testing laboratory for the following equipment:

* designed to use other power sources;
* capable of being operated from a variety of power sources;
* designed to include a shut-down facility to ease operation of the equipment at source voltages other than those referred to above.

The conditions shall be recorded in the test report and in the latter case the purpose of including this facility.

### 5.1.3 Procedure for Tests at Extended and Extreme Temperatures

#### 5.1.3.1 All Equipment

Before measurements are made, the equipment shall have reached thermal balance in the test chamber. The equipment shall be switched off during the temperature stabilizing period. In the case of equipment containing temperature stabilization circuits designed to operate continuously, the temperature stabilization circuits may be switched on for 15 minutes after thermal balance has been obtained, the equipment shall then meet the specified requirements. If the thermal balance is not checked by measurements, a temperature stabilizing period of at least one hour, or such period as may be decided by the testing laboratory shall be allowed. The sequence of measurements shall be chosen, and the humidity content in the test chamber shall be controlled so that excessive condensation does not occur.

#### 5.1.3.2 Equipment including Transmitters

Before tests at the upper temperature, the equipment shall be placed in the test chamber and left until thermal balance is attained. The equipment shall then be switched on in the transmit state for a period of 30 minutes after which the equipment shall meet the specified requirements.

## 5.2 Interpretation of the measurement results

The interpretation of the results recorded in a test report for the measurements described in the present document shall be as follows:

* the measured value related to the corresponding limit will be used to decide whether an equipment meets the requirements of the present document;
* the value of the measurement uncertainty for the measurement of each parameter shall be included in the test report;
* the recorded value of the measurement uncertainty shall be, for each measurement, equal to or less than the figures in table 4.

For the test methods, according to the present document, the measurement uncertainty figures shall be calculated and shall correspond to an expansion factor (coverage factor) k = 1,96 or k = 2 (which provide confidence levels of respectively 95 % and 95,45 % in the case where the distributions characterising the actual measurement uncertainties are normal (Gaussian)). Principles for the calculation of measurement uncertainty are contained in ETSI TR 100 028 [i.10], in particular in annex D of the ETSI TR 100 028-2 [i.11].

Table 4 is based on such expansion factors.

Table 4: Maximum measurement uncertainty

|  |  |
| --- | --- |
| Parameter | Uncertainty  |
| Blocking and desensitization | ±4 dB |
| Operating Frequency error | ±100 Hz |
| Peak envelope power  | ±0,75 dB |
| Receiver dynamic range | ±2 dB |
| Receiver sensitivity | ±3 dB |
| Spectrum, Residual and spurious emissions:below 1 GHzabove 1 GHz | ±3 dB±6 dB |
| Spurious response rejection | ±4 dB |

## 5.3 Test and General Conditions

### 5.3.1 Transmitter test signals

#### 5.3.1.0 General Considerations

For the purposes of the present document a transmitter test signal is a modulated carrier generated by the EUT to facilitate a particular test. The EUT shall be capable of generating the following test signals:

* Test signal 1: Maximum duty cycle, short Mode S interrogations with all “0” data content – see clause 5.3.1.1
* Test signal 2: Maximum duty cycle, short Mode S interrogations with all “1” data content – see clause 5.3.1.2

Test signals may be generated autonomously by the EUT when configured for test mode, or by applying external commands or other stimulation. Operation in a test mode may involve suitable temporary internal modifications of the EUT or the use of special software. Details of the method chosen and the test signals shall be recorded in the test report.

#### 5.3.1.1 Test signal 1

When test signal 1 is specified below, a signal shall be generated with the following characteristics:

* Transmission rate: Maximum constant rate such that the manufacturer’s rated maximum duty cycle is not exceeded.
* Waveform: Short Mode S Interrogation as defined in clauses 3.1.2.1 and 3.1.2.11.4 of ICAO Annex 10, Volume 4[1].
* Frequency: 1030 MHz
* Message content: All “zeroes” (i.e., the minimum number of phase transitions)
* Amplitude: Maximum rated power level

Note: The following example shows the calculation for a rated maximum duty cycle of 1%. The short Mode S interrogation contains the P1, P2 and P6 pulses [1]. The cumulative time from the 50% point of the rising edge of P1 to the 50% point on the falling edge of P6 is 19,75 microseconds. The maximum transmission rate that does not exceed 1% (i.e., 10 milliseconds per second of transmission time) is 506 Hz.

#### 5.3.1.2 Test signal 2

When test signal 2 is specified below, a signal shall be generated with the following characteristics:

* Transmission rate: Maximum rate such that the manufacturer’s rated maximum duty cycle is not exceeded.
* Waveform: Short Mode S Interrogation as defined in clauses 3.1.2.1 and 3.1.2.11.4 of ICAO Annex 10, Volume 4[1]
* Frequency: 1030 MHz
* Message content: All “ones” (i.e., the maximum number of phase transitions)
* Amplitude: Maximum rated power level

### 5.3.2 Simulated received signals

#### 5.3.2.0 General Considerations

For the purposes of the present document a receiver test signal is an unmodulated or modulated carrier applied to the EUT to facilitate a particular test. The EUT shall be capable of tolerating the following test signals:

* Test signal 3: Modulated Mode S Extended Squitter message (desired signal) – see clause 5.3.2.1
* Test signal 4: Modulated Mode S Extended Squitter message (undesired signal) – see clause 5.3.2.2

 When multiple test signals are used in the same test, the frequency sources for each test signal shall be non-coherent.

The EUT shall be able to report each message received. The report shall include the complete Mode S message and the time of receipt at the receiver or the recording device with at least 10 millisecond resolution. Message reports from multilateration receivers can generally be collected using a computer and standard communication network analysis software. Operation of the EUT in a test mode is permissible and may involve suitable temporary internal modifications of the EUT or the use of special software. Details of the method chosen and how the reports were collected shall be recorded in the test report.

#### 5.3.2.1 Test signal 3

When test signal 3 is specified below, a signal shall be injected with the following characteristics:

* Transmission rate: 100 Hz
* Waveform: Mode S Extended squitter as defined in clause 3.1.2.2 of ICAO Annex 10, Volume 4 [1]
* Frequency: 1090 MHz, unless otherwise specified by the test
* Message content: Arbitrary data content with a known Aircraft Address and valid CRC -
* Amplitude: As specified by the test
* Pulse on/off ratio: At least 40 dB

EXAMPLE: 0x88234567125054D4C72CF4 is a valid DF-17 squitter with the Aircraft Address of “234567”.

#### 5.3.2.2 Test signal 4

When test signal 4 is specified below, a signal shall be injected with the following characteristics:

* Transmission rate: 6000 Hz
* Waveform: Mode S Extended squitter as defined in clause 3.1.2.2 of ICAO Annex 10, Volume 4[1]
* Frequency: As specified by the test
* Message content: Arbitrary data content with a known Aircraft Address and valid CRC
* Amplitude: As specified by the test
* Pulse on/off ratio: At least 40 dB

NOTE: The data content is distinct from Test signal 3.

EXAMPLE: 0x90BADBADC1123480101D00675B4B is a valid DF-18 squitter with the Aircraft Address of “BADBAD”.

## 5.4 Transmitter tests

### 5.4.1 Operating frequency and frequency error

#### 5.4.1.1 Description

The purpose of this test is to establish that the transmitter is operating at the correct frequency and within the required frequency error. All tests are performed at the maximum rated transmit power and duty cycle to show that the frequency is correct under these conditions. Since the modulation of the Mode A/C interrogation is a subset of the Mode S interrogation only the Mode S interrogation is tested.

#### 5.4.1.2 Test conditions

The EUT shall be configured to generate test signal 1 as indicated in the procedure.

The measurement shall be performed with the EUT operating at its maximum rated power level, as declared by the manufacturer.

#### 5.4.1.3 Method of measurement

The measurement shall be a conducted measurement using a connection to the EUT antenna interface.

Unless otherwise noted below, the spectrum analyzer shall be configured to the following settings:

1. Trigger level: As appropriate for input power and attenuation.
2. Trace properties: Normal (e.g., not max hold)
3. Sweep properties: As needed to capture a waveform without interruptions due to duty cycle
4. Receiver BW, resolution BW and video BW:
	* 1 MHz for frequencies >= 905 MHz
	* 100 kHz, for frequencies < 905 MHz

#### 5.4.1.4 Measurement procedure

1. Attach the EUT antenna port to the spectrum analyzer with appropriate attenuation.
2. Configure the EUT to produce test signal 1 at the maximum rated power level and duty cycle.
3. Set up the spectrum analyzer with a receiver bandwidth of 1 kHz and a video bandwidth of 1 kHz.
4. Measure the frequency of the peak of the spectrum and compare to limits defined in clause 4.3.1.2.

### 5.4.2 Transmitter peak envelope power

#### 5.4.2.1 Description

The transmitter peak envelope power is evaluated over various environmental conditions to show that the rated power is achieved within the allowed tolerance.

#### 5.4.2.2 Test conditions

The EUT shall be configured to generate test signal 2 as indicated in the procedure.

The measurement shall be performed with the EUT operating at its maximum rated power level as declared by the manufacturer.

#### 5.4.2.3 Method of measurement

The measurement shall be a conducted measurement using a connection to the EUT antenna interface. All amplitudes shall be adjusted for cable loss to be representative of the antenna interface of the EUT.

#### 5.4.2.4 Measurement procedure

1. Attach the EUT antenna port to the power meter with appropriate attenuation to keep the power level in the acceptable range for the power meter.
2. Configure the EUT to produce test signal 2 at the rated power level.
3. Measure the peak envelope power. Verify that the power level is within the allowed tolerance of the rated power as defined in clause 4.3.2.2.
4. Repeat the measurement within the defined environment conditions.
5. Verify that each power level is within the allowed tolerance of the rated power for the respective test condition as defined in clause 4.3.2.2.
6. .

### 5.4.3 Spectrum mask

#### 5.4.3.1 Description

The in band and out of band domains are measured for compliance of the EUT with the spectrum mask. All tests are performed at the maximum rated transmit power and duty cycle to show that the spectrum is met under these conditions. Since the modulation of the Mode A/C interrogation is a subset of the Mode S interrogation only the Mode S interrogation is tested. It is suggested to perform the test with different transmit power levels to show compliance to the requirement with different power settings. It is encouraged that the system performance is ensured throughout all power settings and throughout all specified environmental conditions.

#### 5.4.3.2 Test conditions

The EUT shall be configured to generate test signals 1 and 2 as indicated in the procedure.

The measurement shall be performed with the EUT operating at its maximum rated power level, minimum rated power level and somewhere at a testpoint between minimum and maximum power level, as declared by the manufacturer.

The nominal transmitter output power shall be determined under normal and extreme conditions and with only short Mode S uplink messages. It is recommended to use the defined environmental conditions for transmitter and receiver.

For conformance testing a video bandwidth and resolution bandwidth of 1MHz for the spectrum analyzer shall be used.

#### 5.4.3.3 Method of measurement

The measurement shall be a conducted measurement using a connection to the EUT antenna interface. All amplitudes shall be adjusted for cable loss to be representative of the antenna interface of the EUT.

Note: Care should be taken that the peak level of the signal into the test equipment is not so high as to cause broadening of the spectrum due to non-linear effects in the test equipment.

Unless otherwise noted below, the spectrum analyser shall be configured to the following settings:

* Trigger level: As appropriate for input power and attenuation.
* Trace properties: Normal (e.g., not max hold)
* Sweep properties: As needed to capture a waveform without interruptions due to duty cycle
* Receiver BW, resolution BW and video BW: 1 MHz

NOTE: ITU-R recommendation <REFERENCE> indicates that a spectrum analyzer receiver bandwidth of 1 MHz be used for frequencies of 1 GHz and above, and a bandwidth of 100 kHz be used below 1 GHz. However, since the spectrum mask of the desired signal spans the 1 GHz boundary, a receiver bandwidth of 1 MHz will be used for frequencies of 905 MHz and above.

#### 5.4.3.4 Measurement procedure

1. Attach the EUT antenna port to the spectrum analyzer with appropriate attenuation (see clause 5.4.3.3).
2. Configure the EUT to produce test signal 1 at the power level corresponding to the requirement and duty cycle.
3. Set up the spectrum analyzer with a receiving bandwidth of 1 MHz and a video bandwidth of 1 MHz.
4. Measure the spectrum from 905 MHz to 1155 MHz and record the peak amplitude of the spectrum as a reference for 0 dBc.
5. Switch the EUT to produce test signal 2 at the same power level and duty cycle.
6. Measure the spectrum from 905 MHz to 1155 MHz and compare it to the spectrum mask limits defined in clause 4.3.3

 Repeat the test with each applicable power level and environmental condition .

### 5.4.5 Residual power output

#### 5.4.5.1 Description

 ????The purpose of this test is to verify that the output power of the transmitter between transmissions does not exceed the specified maximum.

#### 5.4.5.2 Test conditions

The measurement shall be performed with the EUT operating.

#### 5.4.5.3 Method of measurement

The measurement shall be a conducted using a connection to the EUT antenna interface. All amplitudes shall be adjusted for cable loss to be representative of the antenna interface of the EUT.

Unless otherwise noted below, the spectrum analyser shall be configured to the following settings:

* Trigger level: As appropriate for input power and attenuation.
* Trace properties: Normal (e.g., not max hold)
* Sweep properties: As needed to capture a waveform without interruptions due to duty cycle
* Receiver BW, resolution BW and video BW:
	+ 1 MHz for frequencies >= 905 MHz
	+ 100 kHz, for frequencies < 905 MHz

#### 5.4.5.4 Measurement procedure

1. Connect the power measuring equipment to EUT antenna connector. Switch on the EUT and set it into standard operating mode (i.e. transmitting) at the lowest possible interrogation rate.
2. Measure the power of the output signal over the period between transmission bursts, starting 10 µs after the end of one interrogation and ending 10 µs prior to the start of the next interrogation. The power is determined by calculating the RMS value of the signal during the measurement time.
3. Verify that the residual power output does not exceed the limit specified in clause 4.3.5.2.

## 5.5 Receiver Tests

### 5.5.1 Operating frequency range

#### 5.5.1.1 Description

The purpose of this test is to establish that the receiver is operating at the intended frequency and is able to tolerate a certain degree of frequency offset.

#### 5.5.1.2 Test conditions

External test equipment will be used to stimulate the EUT with test signal 3 at the amplitudes indicated in the procedure. External test equipment will be used to collect the reception reports for each injected message.

#### 5.5.1.3 Method of measurement

The test waveform shall be injected using conduction into the EUT antenna interface. All amplitudes shall be adjusted for cable loss to be representative of the antenna interface of the EUT. The message receipt reports will be collected and the average rate of message receipt will be calculated at each amplitude and frequency.

#### 5.5.1.4 Measurement procedure

1. Configure the EUT to receive and report messages for recording.
2. Configure the recording device to record message reports.
3. Verify that no message reports are being generated.
4. Configure the signal generator to produce test signal 3 at the manufacturer’s rated sensitivity and inject messages for at least 100 seconds.
5. Review the recorded reports to count the number of reports which match the expected message content.
6. Divide the number of successfully received messages by the expected number of input messages (i.e., elapsed time multiplied by message rate) and verify that the required PD (section 4.4.6.2) was achieved.
7. Decrease the signal level in 1 dB steps until the probability of detection is no longer achieved. The lowest amplitude at which the required PD (section 4.3.2 ????) was achieved will be used as the reference amplitude for the following steps and subsequent tests.
8. Repeat the test with the signal generator configured to produce test signal 3 with the following modifications:
	1. Change the signal level to reference sensitivity plus 3 dB
	2. Change the frequency to operating frequency plus tolerance (section 4.3.1??)
9. Verify that at least the required PD (section 4.3.2 ???) is achieved.
10. Repeat the test with the signal generator configured to produce test signal 3 with the following modifications:
	1. Change the signal level to reference sensitivity plus 3 dB
	2. Change the frequency to operating frequency minus tolerance (section 4.3.1???)
11. Verify that at least the required PD (section 4.3.2???) is achieved.

### 5.5.2 channel selectivity and spurious responses

#### 5.5.2.1 Description

The purpose of this test is to establish the selectivity of the receiver by measuring the rate of detection of properly formed messages injected outside of the intended operating frequency. The amplitude of injected messages is adjusted to verify that an appropriate number of messages are rejected.

Table 5 - references for receiver pass band and receiver selectivity

|  |  |  |
| --- | --- | --- |
| **Frequency** | **Amplitude Relative to Rated Sensitivity in dB** | **Reference** |
| +/- 12.5 MHz | >=3 | ED-129 2.6.2 Table 2 for MLAT |
| +/- 19 MHz | >= 20 | ED-129 2.6.2 Table 2 for MLAT |
| +/- 29 MHz | >= 40 | ED-129 2.6.2 Table 2 for MLAT |
| +/- 46 MHz | >=60 | ED-129 2.6.2 Table 2 for MLATED-129 2.6.2 is consistent with chapter 3.1.1.11.2 Spurious Responses in ICAO Annex 10 [1] at +/- 46MHz |

#### 5.5.2.2 Test conditions

External test equipment will be used to stimulate the EUT with test signal 3 at the amplitudes and frequencies indicated in the procedure. External test equipment will be used to collect the reception reports for each injected message.

#### 5.5.2.3 Method of measurement

The test waveform shall be injected using conduction into the EUT antenna interface. All amplitudes shall be adjusted for cable loss to be representative of the antenna interface of the EUT. The message receipt reports will be collected and the average rate of message receipt will be calculated.

#### 5.5.2.4 Measurement procedure

1. Record the reference sensitivity as determined in test 5.5.1 Operating Frequency.
2. Configure the EUT to receive and report messages for recording.
3. Configure the recording device to record message reports.
4. Configure the signal generator to produce test signal 3 at 3 dB higher than the reference sensitivity at 1102,5 MHz and inject messages for at least 100 seconds.
5. Review the recorded reports to count the number of reports which match the expected message content.
6. Divide the number of successfully received messages by the expected number of input messages (i.e., elapsed time multiplied by message rate) and verify that the probability of detection was reduced.
7. Repeat steps 4 through 6 for the following frequencies and amplitudes.

Table 6 - input levels for receiver sensitivity test

|  |  |
| --- | --- |
| ***Frequency (MHz)*** | ***Injected Input Level Above Rated Receiver Sensitivity (dB)*** |
| 1077,5 | 3 |
| 1109 | 20 |
| 1071 | 20 |
| 1119 | 40 |
| 1061 | 40 |
| 1136 | 60 |
| 1044 | 60 |

### 5.5.3 Inter-modulation response rejection

#### 5.5.3.1 Description

The purpose of this test is to establish that inter-modulation caused by two unwanted out-of-band signals does not degrade the reception probability when their signal level is below the specified limit.

#### 5.5.3.2 Test conditions

This test will be performed under normal test conditions.

#### 5.5.3.3 Method of measurement



Figure 3 - measurement arrangement

#### 5.5.3.4 Measurement procedure

The measurement procedure shall be as follows:

1. Three signal generators, A, B and C, shall be connected to the receiver via a combining network.
* The wanted signal, provided by signal generator A, shall be at the nominal frequency of the receiver and shall produce test signal 3.
* The first unwanted signal, provided by signal generator B, shall be unmodulated and adjusted to a frequency f1 at 10 MHz above the nominal frequency of the receiver.
* The second unwanted signal, provided by signal generator C, shall be modulated with test signal 4 and adjusted to a frequency f2 at 20 MHz above the nominal frequency of the receiver.
1. Initially, signal generators B and C (unwanted signals) shall be switched off (maintaining the output impedance).
* The level of the wanted signal from generator A shall be adjusted to the level which is 20 dB above the manufacturer’s rated sensitivity.
1. Record the Pd of the wanted signal.
2. Signal generators B and C shall then be switched on; and set to a level 12 dB below the wanted signal as referenced to the input of the receiver under test.
3. Record the Pd of the wanted signal.
4. Verify that the Pd from step 5 is no less than the Pd from step 3 minus five percentage points.
5. The measurement shall be repeated with the unwanted signal generator B at the frequency 10 MHz below that of the wanted signal and the frequency of the unwanted signal generator C at the frequency 20 MHz below that of the wanted signal.
6. Repeat the test steps 1. to 6. with at least 3 other of the following frequency combinations that fulfil

fc = 2 \* f1 - f2

with an offset of f2 in the range of +20MHz to +78MHz and -20MHz to -78MHz.

f1 = 1051, f2 = 1012 (f2=-78MHz)

f1 = 1060, f2 = 1030 (because 1030 is relevant)

f1 = 1080, f2 = 1070 (f2=-20MHz)

f1 = 1100, f2 = 1110 (f2=+20MHz)

f1 = 1129, f2 = 1168 (f2=+78MHz)

1030 MHz should be included. Other than that there are potential DME interferers at 1 MHz steps from 962 to 1213.

### 5.5.4 Co-channel rejection

#### 5.5.4.1 Description

This test verifies that the receiver's reception probability is not degraded in the presence of an unwanted modulated signal at the same frequency when its signal level is below the specified limit.

#### 5.5.4.2 Test conditions

This test will be performed under normal test conditions.

#### 5.5.4.3 Method of measurement



Figure 4 - measurement arrangement

#### 5.5.4.4 Measurement procedure

1. Two signal generators A and B shall be connected to the test fixture via a combining network. The wanted signal, represented by signal generator A, shall be at the nominal frequency of the receiver and shall have normal test modulation (Test signal 2).
2. The unwanted signal, represented by signal generator B, shall be modulated with the same signal.
3. Both input signals shall be at the nominal frequency of the receiver under test.
4. Initially the unwanted signal shall be switched off (maintaining its output impedance).
5. The level of the wanted signal from generator A shall be adjusted to a level which is 20 dB above the manufacturer’s rated sensitivity.
6. Record the Pd for the wanted signal.
7. The unwanted signal from generator B shall then be switched on and its level shall be adjusted to 12 dB below the wanted signal as referenced at the input of the receiver under test.
8. Record the Pd for the wanted signal.
9. Verify that the Pd from step 8 is no less than the Pd from step 6 minus five percentage points.
10. The measurement shall be repeated for displacements of the unwanted signal of ±1.2 MHz.

### 5.5.5 Blocking

#### 5.5.5.1 Description

With this test it will be verified that a single unwanted out-of-band signal cannot degrade the reception probability when its signal level is below the specified limit.

#### 5.5.5.2 Test conditions

This test will be performed under normal test conditions.

#### 5.5.5.3 Method of measurement



Figure 5 - measurement arrangement

#### 5.5.5.4 Measurement procedure

1. Two signal generators A and B shall be connected to the receiver via a combining network.
2. The wanted signal, represented by signal generator A, shall be at the nominal frequency of the receiver and shall have normal test modulation (Test signal 2)
3. The unwanted signal, provided by signal generator B, shall be unmodulated and shall be at a frequency from 15 MHz to 78 MHz away from the nominal frequency of the receiver.
4. Initially the unwanted signal shall be switched off.
5. The level of the wanted signal from generator A shall be adjusted to a level which is 6 dB above the manufacturer’s rated sensitivity.
6. Record the Pd of the wanted signal.
7. The unwanted signal shall then be switched on and its level shall be adjusted to be 20 dB higher than the level of the wanted signal.
8. Record the Pd of the wanted signal.
9. Verify that the Pd from step 8 is no less than the Pd from step 6 minus five percentage points.
10. The measurement shall be repeated for frequencies within the range defined in step 3 at 1 MHz steps.

### 5.5.6 Receiver dynamic range / Maximum usable sensitivity

#### 5.5.6.1 Description

The purpose of this test is to establish the sensitivity and dynamic range of the receiver at the intended operating frequency. Although the sensitivity is declared by the manufacturer, the levels are needed as a reference for other tests.

#### 5.5.6.2 Test conditions

External test equipment will be used to stimulate the EUT with desired test signal 3 at the amplitudes indicated in the procedure. External test equipment will be used to collect the reception reports for each injected message.

#### 5.5.6.3 Method of measurement

The test waveform shall be injected using conduction into the EUT antenna interface. All amplitudes shall be adjusted for cable loss to be representative of the antenna interface of the EUT. The message receipt reports will be collected and the average rate of message receipt will be calculated.

#### 5.5.6.4 Measurement procedure

1. Record the reference sensitivity as determined in the Operating Frequency test described in clause 5.5.1.
2. Configure the EUT to receive and report messages for recording.
3. Configure the recording device to record message reports.
4. Verify that no message reports are being generated.
5. Configure the signal generator to produce test signal 3 at the power level of the reference sensitivity and inject messages for at least 100 seconds.
6. Review the recorded reports to count the number of reports which match the expected message content.
7. Divide the number of successfully received messages by the expected number of input messages (i.e., elapsed time multiplied by message rate) and verify that the required PD (4.3.2????) was achieved.
8. Repeat the test at the midpoint and maximum amplitude of the manufacturer’s declared dynamic range.

### 5.6 Receiver and transmitter tests

### 5.6.1 Spurious emissions

#### 5.6.1.1 Description

Spurious emissions are unwanted emissions in the spurious domain radiated by the equipment or its antenna.

For transmitters, or EUT in transmit mode,, the spurious domain is all frequencies apart from the channel on which the transmitter is intended to operate and the Out of Band domain.

For receivers, or EUT in receive mode, the spurious domain is all frequencies.

#### 5.6.1.2 Test conditions

The EUT shall be configured and operated in modes representative of normal operation.

For transmitters, measurements shall be performed with the EUT operating at its maximum operating power level.

#### 5.6.1.3 Method of measurement

For all EUT with an integral antenna, the spurious emissions levels shall be established as the radiated measurement procedure in clause 5.6.1.3.2, with the integral antenna connected.

For EUT with an external antenna connector the spurious emissions levels shall be established as:

i) the conducted measurement procedure in clause 5.6.1.3.1; and

ii) the radiated measurement procedure in clause 5.6.1.3.2, with the antenna port terminated in a dummy load.

##### 5.6.1.3.1 Conducted measurement

The antenna port of the EUT shall be connected to the dummy load and the output of the dummy load connected to the measuring receiver.

The measuring receiver shall be tuned over the frequency range shown in table 7.

Table 7 - conducted Spurious Radiations Measurement Frequency Range

|  |  |  |
| --- | --- | --- |
| Operating Mode | Frequency Range | RBWREF(see note 2) |
| Transmit mode | 9 kHz ≤ f < 150 kHz | 1 kHz |
| 150 kHz ≤ f < 30 MHz | 10 kHz |
| 30 MHz ≤ f < fm1 | 100 kHz |
| fm2 < f ≤ 12GHz | 1 MHz |
| Receive modeTransmitter Inactive modeAll other modes | 9 kHz ≤ f < 150 kHz | 1 kHz |
| 150 kHz ≤ f < 30 MHz | 10 kHz |
| 30 MHz ≤ f ≤ 1 GHz | 100 kHz |
| 1 GHz < f ≤ 12 GHz | 1 MHz |
| NOTE 1: f is the measurement frequency. fm1 is the lower edge of the Out of Band Domain.fm2 is the upper edge of the Out of Band Domain.The Out of Band Domain is defined in clause 4.2.3 Spectrum maskNOTE 2: See clause tbd if the value of RBW used for measurement is different from RBWREF. |

At each frequency at which a spurious component is detected, the spurious emission power level shall be noted as the average power level delivered into the dummy load.

##### 5.6.1.3.2 Radiated measurement

A suitable test site should be selected from those described in Annex B of EN 300 113 [i.4].

The EUT antenna port shall be connected to a dummy load with termination.

The measurements shall be performed using the appropriate radiated measurement methods described in clause B.6.

The measuring receiver shall be tuned over the frequency range shown in table 8.

Table 8 - radiated Spurious Radiations Measurement Frequency Range

|  |  |  |
| --- | --- | --- |
| Operating Mode | Frequency Range | RBWREF(see note 2) |
| Transmit mode | 25 MHz ≤ f < fm1 | 100 kHz |
| fm2 < f ≤ 12GHz | 1 MHz |
| Receive modeTransmitter Idle modeAll other modes |  |  |
|  |  |
| 25 MHz ≤ f ≤ 1 GHz | 100 kHz |
| 1 GHz < f ≤ 12GHz | 1 MHz |
| NOTE 1: f is the measurement frequency. fm1 is the lower edge of the Out of Band Domain.fm2 is the upper edge of the Out of Band Domain.The Out of Band Domain is defined in clause 4.2.3 Spectrum maskNOTE 2: See clause tbd if the value of RBW used for measurement is different from RBWREF. |

# Annex A (informative):Relationship between the present document and the essential requirements of Directive 2014/53/EU

The present document has been prepared by ETSI in response to mandate M/405 from the European Commission to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC radio Equipment Directive [i.1].

Once the present document is cited in the Official Journal of the European Union under that Directive, compliance with the normative clauses of the present document given in table A.1 confers, within the limits of the scope of the present document, a presumption of conformity with the corresponding essential requirements of that Directive, and associated EFTA regulations.

Table A.1: Relationship between the present document and
the essential requirements of Directive 2014/53/EU

| Harmonised Standard ETSI EN 303 213-5-1 |
| --- |
| Requirement | Requirement Conditionality |
| No | Description | Essential requirements of Directive 2014/53/EU | Clause(s) of the present document | U/C | Condition |
| 1 | **transmitter operating frequency** | **3.2** | **4.3.1** | U |  |
| 2 | **transmitter peak envelope power** | **3.2** | **4.3.2** | U |  |
| 3 | **transmitter spectrum mask** | **3.2** | **4.3.3** | U |  |
| 4 | transmitter residual power output | **3.2** | 4.3.5 | U |  |
| 5 | Receiver operating frequency | **3.2** | 4.4.1 | U |  |
| 6 | Receiver adjacent channel selectivity and spurious emissions | **3.2** | 4.4.2 | U |  |
| 7 | Receiver inter-modulation response rejection | **3.2** | 4.4.3 | U |  |
| 8 | Receiver co-channel rejection | **3.2** | 4.4.4 | U |  |
| 9 | Receiver blocking | **3.2** | 4.4.5 | U |  |
| 11 | Receiver and transmitter spurious emissions | **3.2** | 4.5.1 | U |  |
|  |  |  |  |  |  |

**Key to columns:**

**Requirement:**

**No** A unique identifier for one row of the table which may be used to identify a requirement.

**Description** A textual reference to the requirement.

**Clause Number** Identification of clause(s) defining the requirement in the present document unless another document is referenced explicitly.

**Requirement Conditionality:**

**U/C** Indicates whether the requirement is unconditionally applicable (U) or is conditional upon the manufacturer's claimed functionality of the equipment (C).

**Condition** Explains the conditions when the requirement is or is not applicable for a requirement which is classified "conditional".

Presumption of conformity stays valid only as long as a reference to the present document is maintained in the list published in the Official Journal of the European Union. Users of the present document should consult frequently the latest list published in the Official Journal of the European Union.

Other Union legislation may be applicable to the product(s) falling within the scope of the present document.

# Annex B (informative):Bibliography

* ETSI EG 201 399: "Electromagnetic compatibility and Radio spectrum Matters (ERM); A guide to the production of candidate Harmonized Standards for application under the RE Directive".
* ECC/Recommendation (02)05 (2012): "Unwanted emissions".
* ERC/Recommendation 74-01 (2011): "Unwanted emissions in spurious domain".
* ITU Recommendation M.1177-4 (2011): "Techniques for measurement of unwanted emissions of radar equipment".
* ITU-R Recommendation SM.329-12 (2012): “Unwanted emissions in the spurious domain”.

NOTE: More stringent requirements envisioned for future versions of ITU-R Recommendations, ECC/Recommendations and ERC Recommendations may need to be considered in a future version of the present document.

* ITU Recommendation ITU-R SM.1541-5 (08/2013) “Unwanted emissions in the out-of-band domain”
* EUROCAE ED-73E (2011): "MOPS for Secondary Surveillance Radar Mode S Transponders".
* Recommendation ITU-R SM.1541-5 (2013): "Unwanted emissions in the out-of-band domain".

# Annex C (informative):Change history

| Version | Information about changes |
| --- | --- |
| 1.1.1 | First stable draft to be presented to TG AERO |
|  |  |
|  |  |

# History

|  |
| --- |
| **Document history** |
| <Version> | <Date> | <Milestone> |
| 0.0.9 | 05.02.2015 | Complete document review during STF Meeting (STF 485) |
| 0.0.10 | 13.03.2015 | Early internal draft for internal STF discussion (STF 485) |
| 0.0.26 | 07.02.2017 | Major document restructuration and adoption of new skeleton |
| 0.0.31 | 12.05.2017 | Finalisation of document and preparation for TG Review |

*Latest changes made on 2017-05-12*