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Advanced Surface Movement Guidance and Control System (A-SMGCS); Part 5: Harmonised Standard for access to radio spectrum for Multilateration (MLAT) equipment; Sub-part 2: Reference and Vehicle Transmitters

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Foreword

This Harmonised European Standard (EN) has been produced by ETSI Technical Committee Electromagnetic compatibility and Radio spectrum Matters (ERM).

The present document has been prepared under the Commission's standardisation request C (2015) 5376 final [i.3] 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 2, of a multi-part deliverable covering Advanced Surface Movement Guidance and Control System (A-SMGCS), as identified below:

Part 1: "Community Specification for A-SMGCS surveillance service including external interfaces";

Part 2: "Community Specification for A-SMGCS airport safety support service";

Part 3: "Community Specification for a deployed cooperative sensor including its interfaces";

Part 4: "Community Specification for a deployed non-cooperative sensor including its interfaces";

Part 5: "Harmonised Standard for access to radio spectrum for Multilateration (MLAT) equipment":

Sub-part 1: "Receivers and Interrogators";

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

Part 6: "Harmonised Standard for access to radio spectrum for deployed surface movement radar sensors";

Part 7: "Community Specification for A-SMGCS routing service";

Part 8: "Community Specification for A-SMGCS guidance service".

National transposition dates	
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Date of latest publication of new National Standard or endorsement of this EN (dop/e):	31 January 2023
Date of withdrawal of any conflicting National Standard (dow):	31 January 2024

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 (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.

1 Scope

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

1) devices transmitting in the 1 090 MHz band, used as ground-based reference transmitters in Mode S multilateration equipment in an Advanced Surface Movement Guidance and Control System (A-SMGCS);

2) devices transmitting in the 1 090 MHz band, used for ground vehicle tracking in an Advanced Surface Movement Guidance and Control System (A-SMGCS).

Antennas for this equipment are considered to be passive without an additional amplifier.

NOTE: The relationship between the present document and essential requirements of article 3.2 of Directive 2014/53/EU [i.1] is given in Annex A.

2 References

2.1 Normative 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.

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

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 necessary for the application of the present document.

[1] EUROCAE ED-117A (September 2016): "Minimum operational performance specification for Mode S Multilateration Systems for Use in Advanced Surface Movement Guidance and Control Systems (A-SMGCS)".

[2] ETSI EN 300 019-1-3 (V2.4.1) (04-2014): "Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-3: Classification of environmental conditions; Stationary use at weatherprotected locations".

[3] ETSI EN 300 019-1-4 (V2.2.1) (04-2014): "Environmental Engineering (EE); Environmental conditions and environmental tests for telecommunications equipment; Part 1-4: Classification of environmental conditions; Stationary use at non-weatherprotected locations".

[4] ICAO Annex 10, Volume IV: "Surveillance Radar and Collision Avoidance systems", 5th edition, July 2014, including amendments up to amendment 90, November 2018.

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.2] ETSI EG 203 336 (V1.2.1): "Guide for the selection of technical parameters for the production of Harmonised Standards covering article 3.1(b) and article 3.2 of Directive 2014/53/EU".

[i.3] 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.4] ERC Recommendation 74-01 (2019): "Unwanted emissions in spurious domain".

[i.5] EUROCAE ED-102B (December 2020): "MOPS for 1090 MHz Extended Squitter ADS-B and TIS-B".

[i.6] ICAO, Doc-9871: "Technical Provisions for Mode S Services and Extended Squitter", edition 2, 2012.

[i.7] ITU Radio Regulations (2020).

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

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

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

equipment under test: system of constituents provided by the manufacturer for qualification under the present 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 1 030 MHz

Mode S: particular type of transponder uplink or downlink message defined in ICAO Annex 10, Volume IV [4]

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.

observation bandwidth: bandwidth in which the energy of an equipment is considered for the purposes of assessing transmission timings

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: frequency span of the final filter that is applied to the input signal controlling the frequency resolution of the resulting spectrum

NOTE: Smaller resolution bandwidths provide finer frequency resolution and the ability to differentiate signals that have frequencies that are closer together.

sensor: aeronautical station equipment including at least one receiver designed to receive aeronautical mobile service signals at 1 030 MHz and/or 1 090 MHz

spurious emissions: power transmitted at frequencies below or above the Out of Band domain

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

unwanted signal: any signal other than the wanted signal or as described in a specific test case

wanted signal: in-band signal modulated according to the Mode S Specification

3.2 Symbols

For the purposes of the present document, the following symbols apply:

dB	deciBel
dBc	power in dB relative to carrier
dBm	power in dB relative to 1 milliwatt
f	measurement frequency
µs	microsecond
Ω	Ohm

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

AC	Alternating Current
ADS-B	Automatic Dependant Surveillance Broadcast
A-SMGCS	Advanced Surface Movement Guidance and Control System
AVOL	Aerodrome Visibility Operational Level
CL	Code Label
CW	Continuous Wave
DC	Direct Current
Doc	Document
ERC	European Radiocommunications Committee
EUROCAE	European Organization for Civil Aviation Equipment
EUT	Equipment Under Test
IC	Interrogator Code
ICAO	International Civil Aviation Organization

ITU	International Telecommunication Union
ITU-R	International Telecommunication Union - Radiocommunication
MOPS	Minimum Operational Performance Specification
NA	Not Applicable
OC	Operating Channel
OOB	Out Of Band
PEP	Peak Envelope Power
RBW_{ref}	Reference BandWidth
RF	Radio Frequency
RMS	Root Mean Square
SSR	Secondary Surveillance Radar

4 Technical requirements specifications

4.1 Environmental profile

The technical requirements of the present document apply under the environmental profile for operation of the equipment, which shall be in accordance with its intended use 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 at all times when operating within the boundary limits of the operational environmental profile defined by its intended use.

4.2 Conformance requirements

4.2.1 Equipment with and without integral antenna

For the purposes of conducted measurements on an EUT a 50 Ω RF connection point shall be provided for test purposes.

For EUT with integral antenna the connection point shall 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.

The unit provided to the test lab may be fitted with a temporary antenna connector with the integral antenna disconnected.

4.2.2 Transmitter operating frequency and frequency error

4.2.2.1 Definition

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 1 090 MHz.

4.2.2.2 Limits

The nominal value of carrier frequency of the transmissions shall be 1 090 MHz.

The absolute value of the frequency error shall not exceed 100 kHz.

4.2.2.3 Conformance

The conformance tests for this requirement shall be as defined in clause 5.3.1.

4.2.3 Spectrum mask

4.2.3.1 Definition

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 ±78 MHz from the measured operating frequency (i.e. 1 090 MHz ± frequency error). The frequencies outside 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.

4.2.3.2 Limits

The measured spectrum shall be below the limit lines shown in Figure 1.

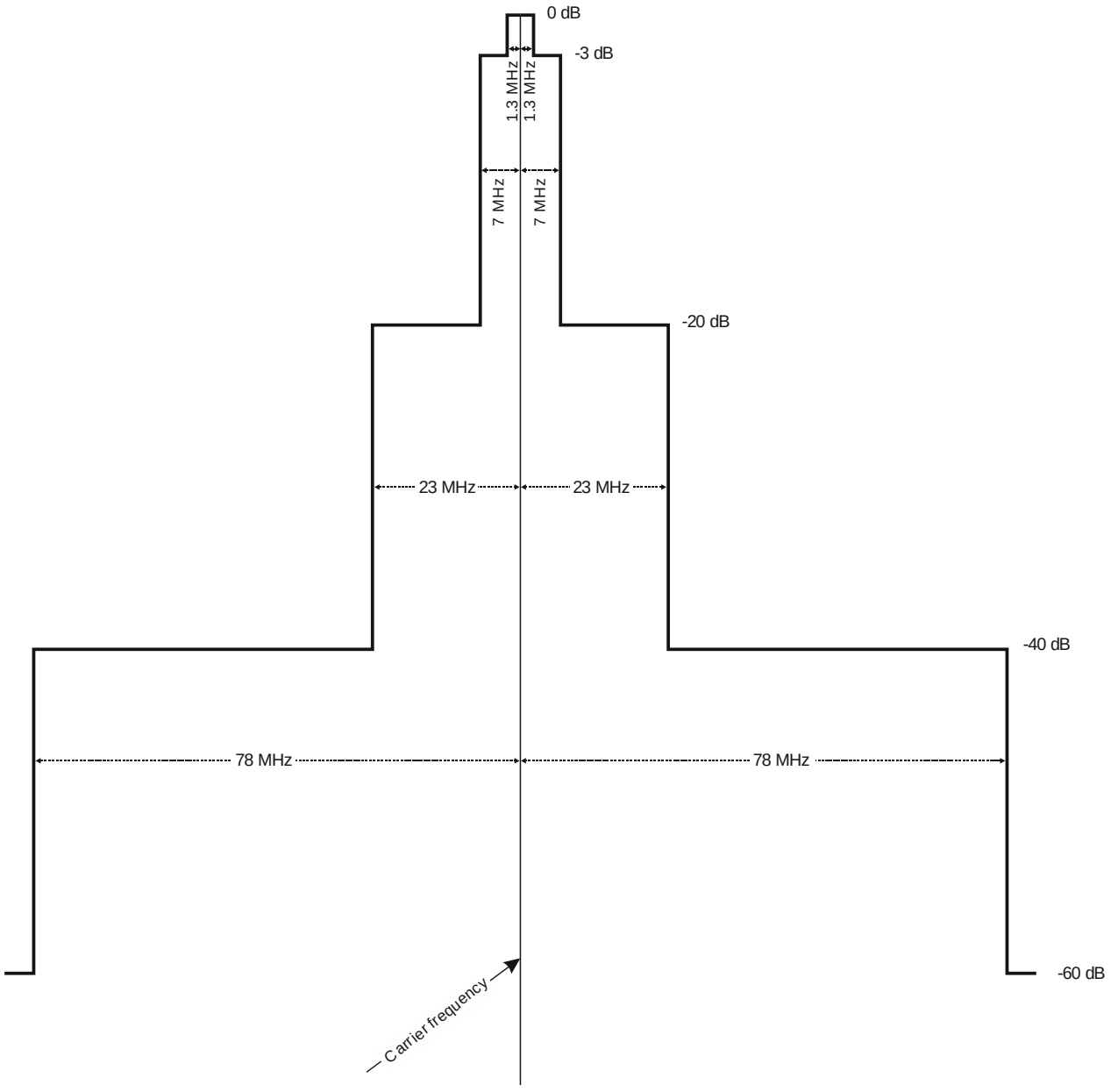

Figure 1: Spectrum mask

NOTE 1: The spectrum mask is consistent with the mask specified in ICAO Annex 10 Volume IV Figure 3.5 [4].

NOTE 2: Figure 1 shows the spectrum centred on the carrier frequency and will therefore shift in its entirety up to the tolerance specified in clause 4.2.2.2.

4.2.3.3 Conformance

The conformance tests shall be as defined in clause 5.3.3.

4.2.4 Residual Power Output

4.2.4.1 Definition

The residual power output is the power output when not in the active state.

4.2.4.2 Limits

The residual power output shall not exceed the limits shown in Table 1.

Table 1: Residual Power Output Limits

Frequency Range	Limit
9 kHz ≤ f ≤ 1 000 MHz	-57 dBm
1 000 MHz < f ≤ 1 087 MHz	-47 dBm
1 087 MHz < f ≤ 1 093 MHz	-70 dBm
1 093 MHz < f ≤ 6 000 MHz	-47 dBm

NOTE: These limits are specified in ERC Recommendation 74-01 [i.4], Table 2, and EUROCAE ED-102B [i.5], clause 2.2.2.2.11.

4.2.4.3 Conformance

The conformance tests for this requirement shall be as defined in clause 5.3.4.

4.2.5 Spurious emissions of transmitter in active mode

4.2.5.1 Definition

Spurious emissions are unwanted emissions in the spurious domain. For active transmitters, the spurious domain is all frequencies apart from the operating channel and the Out of Band domain.

4.2.5.2 Limits

The power of any unwanted emission in the spurious domain shall not exceed -13 dBm or 60 dB below PEP (whichever is less stringent).

NOTE: These limits are specified in Appendix 3, Table I of ITU Radio Regulations [i.7] for the Radiodetermination service category.

4.2.5.3 Conformance

The conformance tests for this requirement shall be as defined in clause 5.3.5.

4.2.6 Transmitter Intermodulation attenuation

4.2.6.1 Definition

The transmit intermodulation level is the power of the intermodulation products when an external signal is injected into the antenna connector at a mean power level of 30 dB lower than that of the mean power of the wanted signal.

It is specified as the ratio, in dB, of the PEP level to the power level of the third order intermodulation product.

4.2.6.2 Limits

The intermodulation attenuation ratio shall be at least 40 dB in the presence of the defined external signal within a frequency range from 962 MHz to 1 215 MHz.

4.2.6.3 Conformance

The conformance tests for this requirement shall be as defined in clause 5.3.6.

4.2.7 Duty Cycle

4.2.7.1 Definition

The duty cycle is the ratio expressed as a percentage, of the cumulative duration of transmissions within an observation interval and the interval itself, as measured in an observation bandwidth. The duty cycle is calculated based on the half power point of the individual pulses within a message with the maximum number of allowable pulses. This threshold takes into account maximum allowable pulse widths and expected random variation in transmission timing.

The duty cycle is controlled to limit the impact of each transmitter in a multi transmitter environment.

4.2.7.2 Limits

The duty cycle of the transmitter shall not exceed 0,05 %.

NOTE: This limit is consistent with the maximum average squitter rates as specified in ICAO Annex 10, clause 3.1.2.8 [4], EUROCAE ED-102B [i.5], clause 2.2.3.3.2.10, ICAO Doc-9871 [i.6], Table C-35. The squitter rate for transmitters used for this purpose is 6.2 messages per second. Squitters are scheduled with some randomness so any individual second may vary. The squitter rate of the transmitter could be up to 11 messages per second.

4.2.7.3 Conformance

The conformance tests for this requirement shall be as defined in clause 5.3.7.

4.2.8 Peak Output Power

4.2.8.1 Definition

The peak output power is the power level measured at the highest point in the time domain of the power envelope of the transmitted message.

4.2.8.2 Limits

For a reference transmitter, the peak output power shall not exceed 57 dBm (500 W).

NOTE: This limit is consistent with ICAO Annex 10, Volume IV [4], clause 3.1.1.7.11.1 and Table 5-2.

For a ground vehicle tracking transmitter, the peak output power shall not exceed 50 dBm (100 W).

4.2.8.3 Conformance

The conformance tests for this requirement shall be as defined in clause 5.3.2.

5 Testing for compliance with technical requirements

5.1 Environmental conditions for testing

5.1.1 General requirements

Tests defined in the present document shall be carried out at representative points within the boundary limits of the operational environmental profile defined by its intended use, which, as a minimum, shall be that specified in the test conditions contained in the present document.

Where technical performance varies subject to environmental conditions, tests shall be carried out under a sufficient variety of environmental conditions as specified in the present document to give confidence of compliance for the affected technical requirements.

5.1.2 Test conditions

5.1.2.1 Thermal Balance

Before measurements are made, the equipment shall have reached thermal balance in the test chamber. The thermal balance shall be checked by temperature measurements. When the equipment temperature is not changing more than 1 K per minute thermal balance is reached.

5.1.2.2 Environmental Test Conditions

5.1.2.2.1 Temperature and humidity

For equipment intended to be operated indoors (partly temperature-controlled locations as defined in clause 4.2 of ETSI EN 300 019-1-3 [2]), the temperature and humidity conditions for tests shall be a combination of temperature and humidity as defined in ETSI EN 300 019-1-3 [2], clause 4.2, Figure 2 (Climatogram for class 3.2).

For equipment intended to be operated in an on-site equipment room (temperature-controlled locations as defined in clause 4.1 of ETSI EN 300 019-1-3 [2]), the temperature and humidity conditions for tests shall be a combination of temperature and humidity as defined in ETSI EN 300 019-1-3 [2], clause 4.1, Figure 1 (Climatogram for class 3.1).

For equipment intended to be operated outdoors (on-site outdoors locations), the temperature and humidity conditions for tests shall be a combination of temperature and humidity as defined in ETSI EN 300 019-1-4 [3], clause 4.1, Figure 1 (Climatogram for class 4.1).

The actual values during the tests shall be recorded in the test report.

5.1.2.2.2 Power supply

The power supply for testing shall be the nominal mains voltage. For the purpose of the present document, the nominal voltage shall be the declared voltage or any of the declared voltages for which the equipment was designed.

The actual values during the tests shall be recorded in the test report.

5.1.2.3 Environmental range tests

5.1.2.3.1 Temperature range

For equipment intended to be operated in an on-site equipment room (temperature-controlled locations as defined in clause 4.1 of ETSI EN 300 019-1-3 [2]), measurements shall be made at the lowest and highest temperatures as defined in ETSI EN 300 019-1-3 [2], clause 4.1, Figure 1 (Climatogram for class 3.1) and Table 1 (class 3.1, normal).

For equipment intended to be operated indoors (partly temperature-controlled locations as defined in clause 4.2 of ETSI EN 300 019-1-3 [2]), measurements shall be made at the lowest and highest temperatures as defined in ETSI EN 300 019-1-3 [2], clause 4.2, Figure 2 (Climatogram for class 3.2) and Table 1 (class 3.2).

For equipment intended to be operated outdoors (on-site outdoors locations), measurements shall be made at the lowest and highest temperatures as defined in ETSI EN 300 019-1-4 [3], clause 4.1, Figure 1 (Climatogram for class 4.1) and Table 1 (class 4.1).

The actual values during the tests shall be recorded in the test report.

A device capable of operating in more than one of these environments only needs to be tested for the most extreme environment.

NOTE: The device may be tested at more extreme temperatures if desired.

5.1.2.3.2 Extreme Power supply

The power supply for testing shall be the nominal mains voltage ±10 % (for AC power supply) or ±20 % (for DC power supply). For the purpose of the present document, the nominal voltage shall be the declared voltage or any of the declared voltages for which the equipment was designed.

For an AC power supply, the frequency error of the test voltage shall not exceed 2 Hz.

The actual values during the tests shall be recorded in the test report.

5.2 Transmitter test signals

5.2.1 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 test signal A as defined in clause 5.2.2.

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 shall be recorded in the test report. All cable losses shall include all devices between the EUT and the test equipment. All cable losses shall be measured at the nominal transmit frequency.

5.2.2 Test signal A

Although transmit timing is typically randomized, for testing purposes the transmissions will be periodic unless otherwise noted in the test procedure.

A test signal shall be generated with the following characteristics unless otherwise specified in the test procedure:

- Transmission rate: Maximum transmission rate supported by the equipment, or 6.2 messages per second whichever is smaller.
- Waveform: Long (112 bits) Mode S Message as defined in clause 3.1.2.2 of ICAO Annex 10, Volume IV [4].
- Frequency: 1 090 MHz.
- Message content: DF18 as defined in clause 3.1.2.8.7.3 of ICAO Annex 10, Volume IV [4] and constant data content with valid parity, CL= 0 and IC = 0.

- Amplitude: Maximum rated power level.

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

5.3 Transmitter tests

5.3.1 Operating frequency and frequency error

5.3.1.1 Description

The purpose of this test is to establish that the transmitter is operating at the correct frequency and with a frequency error not exceeding the required limits.

5.3.1.2 Test conditions

The EUT shall be configured to generate test signal A.

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

The measurement shall be performed according to clause 5.1.2.2 and clause 5.1.2.3.

5.3.1.3 Method of measurement

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

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

- Trigger level: As required 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.

5.3.1.4 Measurement procedure

- Attach the EUT antenna port to the spectrum analyser with the required attenuation.
- Set the EUT to transmit mode.
- Set up the spectrum analyser with a resolution bandwidth of 1 MHz and a video bandwidth of 3 MHz.
- Measure the frequency of the peak of the spectrum and verify that it is within the limits defined in clause 4.2.2.2.

5.3.2 Peak Output Power

5.3.2.1 Description

This test will evaluate the transmitter peak envelope power to show that the measured power does not exceed the specified maximum.

5.3.2.2 Test conditions

The EUT shall be configured to generate test signal A.

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

The measurement shall be performed according to clause 5.1.2.2 and clause 5.1.2.3.

5.3.2.3 Method of measurement

The measurement shall be a conducted measurement using a connection to the EUT antenna interface. The measured value shall be increased by the measured cable losses.

5.3.2.4 Measurement procedure

1) Attach the EUT antenna port to the power meter with an attenuation to keep the power level in the range of the power meter.
2) Set the EUT to transmit mode.
3) Measure the peak envelope power.
4) Taking into account the measured cable losses, verify that the power level does not exceed the limit specified in clause 4.2.8.2.

5.3.3 Spectrum mask

5.3.3.1 Description

The emissions in the Operating Channel and Out of Band domains are measured for compliance of the EUT with the spectrum mask.

5.3.3.2 Test conditions

The EUT shall be configured to generate test signal A.

The measurement shall be performed with the EUT operating at its maximum rated power level. If the EUT power level is configurable for operational use, the measurement shall also be performed at the minimum rated power level.

The measurement shall be performed according to clause 5.1.2.2 and clause 5.1.2.3.

5.3.3.3 Method of measurement

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

If the peak level of the signal into the test equipment is so high as to cause broadening of the spectrum due to non-linear effects in the test equipment, an attenuator shall be used. Since the spectrum limits are relative to the peak amplitude, the exact cable losses are not critical for this test.

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: One sweep in "write mode".
- Sweep properties: As needed to capture a waveform without interruptions.

5.3.3.4 Measurement procedure

1) Attach the EUT antenna port to the spectrum analyser with the required attenuation.
2) Set up the spectrum analyser with a resolution bandwidth of 1 MHz and a video bandwidth of 3 MHz.
3) Set the EUT to transmit mode at the maximum rated power level.
4) Measure the spectrum from 1 012 MHz to 1 168 MHz and record the peak amplitude of the spectrum as a reference for 0 dBc.
5) Verify that the measurement to the spectrum mask does not exceed the limits specified in clause 4.2.3.2.
6) Repeat steps 1 to 5 with the minimum rated power level.

5.3.4 Residual Power Output

5.3.4.1 Description

The purpose of this test is to verify that the output power of the transmitter, when not in the active state, does not exceed the specified maximum.

5.3.4.2 Test conditions

The EUT shall be ready to transmit, but with no transmissions commanded externally and with no transmissions internally generated.

The measurement shall be performed according to clause 5.1.2.2.

5.3.4.3 Method of measurement

The measurement shall be a conducted using a connection to the EUT antenna interface. The measured value shall be increased by the measured cable losses.

5.3.4.4 Measurement procedure

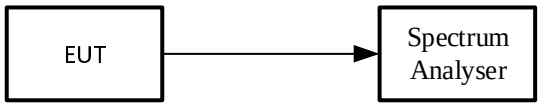

Figure 2: Test setup for residual power output test

1) Set the EUT so that it is ready to transmit, but no transmissions are generated.
2) Connect the spectrum analyser to the EUT antenna connector.
3) Measure the RMS power of the output signal.
4) Taking into account the measured cable losses, verify that the residual power output does not exceed the limit specified in clause 4.2.4.2 when the spectrum analyser is tuned over the frequency range shown in Table 2 below.

All measurements shall be made with a reference bandwidth as shown in Table 2.

Table 2: Reference Bandwidths

Frequency Range	RBW_{ref}
9 kHz ≤ f < 150 kHz	1 kHz
150 kHz ≤ f < 30 MHz	10 kHz
30 MHz ≤ f < 1 000 MHz	100 kHz
1 000 MHz < f ≤ 6 000 MHz	1 MHz
NOTE 1: f is the measurement frequency. NOTE 2: The Reference BandWidths (RBW_{ref}) are defined in ERC Recommendation 74-01 [i.4].	

5.3.5 Spurious emissions of transmitter in active mode

5.3.5.1 Description

The spurious domain is all frequencies apart from the channel on which the transmitter is intended to operate (OC) and the Out of Band domain.

5.3.5.2 Test conditions

The EUT shall be configured and operated in modes representative of normal operation as defined in EUROCAE ED-117A, clause 1.6 [1].

Measurements shall be performed with the EUT operating at its maximum operating power level at peak duty cycle.

The measurement shall be performed according to clause 5.1.2.2 and clause 5.1.2.3.

5.3.5.3 Method of measurement

For all EUT, the spurious emissions levels shall be established using the conducted measurement procedure in clause 5.3.5.4.

The measured values shall be increased by the measured cable losses.

5.3.5.4 Measurement Procedure

The antenna port of the EUT shall be connected to the spectrum analyser via a directional coupler and a dummy load (see Figure 3).

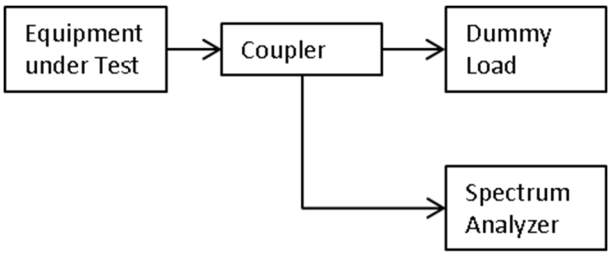

Figure 3: Measurement Arrangement for Spurious emissions of transmitter measurement

1) Connect the spectrum analyser to the EUT antenna connector with an attenuation such that the power level is in the measurement range of the spectrum analyser.

2) Tune the spectrum analyser subsequently to the frequency range shown in Table 3.

3) Activate the EUT.

4) Note the detected power levels at the spectrum analyser.

5) Taking into account the measured cable losses, verify that the power levels do not exceed the limits specified in clause 4.2.5.2.

All measurements shall be made with a reference bandwidth as shown in Table 3. The resolution bandwidth of the spectrum analyser shall be equal to the reference bandwidth.

Table 3: Reference Bandwidths

Frequency Range	RBW_{REF}
9 kHz ≤ f < 150 kHz	1 kHz
150 kHz ≤ f < 30 MHz	10 kHz
30 MHz ≤ f < f_{m1}	100 kHz
f_{m2} < f ≤ 6 000 MHz	1 MHz
NOTE 1: f is the measurement frequency. NOTE 2: f_{m1} is the lower edge of the Out of Band Domain and equals f_c - 78 MHz referenced to the transmit frequency. NOTE 3: f_{m2} is the upper edge of the Out of Band Domain and equals f_c + 78 MHz referenced to the transmit frequency. NOTE 4: The Out of Band Domain is defined in clause 4.2.3 (Spectrum mask). NOTE 5: The Reference BandWidths (RBW_{ref}) are defined in ERC Recommendation 74-01 [i.4].	

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.

5.3.6 Transmitter Intermodulation attenuation

5.3.6.1 Description

The purpose of this test is to establish that the transmitter does not generate unwanted signals in the presence of an external signal entering the transmitter via the antenna due to inter-modulation effects in the transmitter's non-linear elements.

5.3.6.2 Test Conditions

External test equipment will be used to create an interfering test signal with amplitudes and frequencies indicated in the procedure. External test equipment will be used for analysing the resulting transmitter output signal. The measurement shall be performed according to clause 5.1.2.2.

5.3.6.3 Method of Measurement

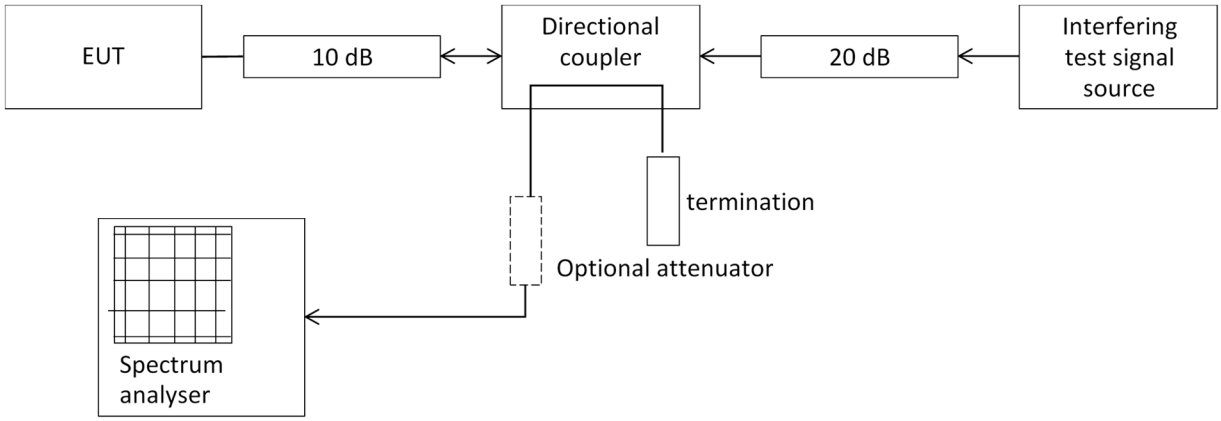

Figure 4: Measurement Arrangement

The measurement arrangement shown in Figure 4 shall be used.

The transmitter shall be connected to a 10 dB power attenuator and via a directional coupler to a spectrum analyser. An optional attenuator may be required between the directional coupler and the spectrum analyser to avoid overloading the spectrum analyser.

The interfering test signal source is connected to the other end of the directional coupler via a 20 dB power attenuator.

The interfering signal source shall be a signal generator and a linear power amplifier capable of delivering the same output power as the transmitter under test.

The directional coupler shall have an insertion loss of less than 1 dB, a bandwidth of at least 520 MHz and a directivity of more than 20 dB.

The EUT and the test signal source shall be physically separated by at least 2 meters to limit the influence of direct radiation.

5.3.6.4 Measurement Procedure

1) The EUT shall be set to transmit test signal A and the spectrum analyser adjusted to give a maximum indication with a resolution bandwidth of 1 MHz and a scan range of 1 090 MHz ± 260 MHz.

2) Record the peak of the spectrum as the carrier reference level.

3) The interfering test signal source shall be unmodulated (CW).

4) The power output of the interfering test signal source shall be adjusted to the same as the PEP of the EUT by the use of a power meter (the required 30 dB attenuation is produced by the test setup).

5) The interfering signal frequency shall initially be set to 1 100 MHz and then increased in steps of 1 MHz up to 1 215 MHz.

6) The peak of the intermodulation component shall be measured by direct observation on the spectrum analyser and the ratio of the largest third order intermodulation component to the recorded carrier reference level.

7) This measurement shall be repeated with the interfering test signal source at a frequency starting at 962 MHz and then increased in steps of 1 MHz up to 1 080 MHz.

8) Verify that for each frequency, the inter-modulation attenuation ratio does not exceed the limit specified in clause 4.2.6.2.

5.3.7 Duty Cycle

5.3.7.1 Description

The transmitter duty cycle is evaluated so that it does not exceed the specified maximum.

5.3.7.2 Test conditions

The EUT shall be configured and operated in a mode representative of normal operation. If the EUT can operate using different transmission rates, the highest operational rate shall be used (e.g. such as would be generated by a moving vehicle).

The measurement shall be performed with the EUT operating at its maximum rated power level and according to clause 5.1.2.2.

5.3.7.3 Method of measurement

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

5.3.7.4 Measurement procedure

1) Attach the EUT antenna port to a power detector rated for the transmit power and frequency.

2) Attach the output of the power detector to a digital counter with a bandwidth of at least 100 MHz. Attenuate the signal level so as to match the input of the digital counter. Configure the counter to accumulate the time when signal is present from the EUT at above the half power level in the frequency range of 1 090 MHz ± 8 MHz.

NOTE: Some counters may support a duty cycle measurement directly.

3) Set the EUT to transmit mode.

4) Reset the counter to zero and record the start time.

5) Stop transmissions after no less than 120 seconds and record the end time.

6) Calculate the duty cycle by dividing the counter accumulated time by the overall transmission time.

7) Verify that the duty cycle does not exceed the limit specified in clause 4.2.7.2.

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

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.3] 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.

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

Harmonised Standard ETSI EN 303 213-5-2					
Requirement				Requirement Conditionality	
No	Description	Essential requirements of Directive	Clause(s) of the present document	U/C	Condition
1	Transmitter operating frequency and frequency error	3.2	4.2.2	U	
2	Spectrum mask	3.2	4.2.3	U	
3	Residual Power Output	3.2	4.2.4	U	
4	Spurious emissions of transmitter in active mode	3.2	4.2.5	U	
5	Transmitter Intermodulation attenuation	3.2	4.2.6	U	
6	Duty Cycle	3.2	4.2.7	U	
7	Peak Output Power	3.2	4.2.8	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.

Essential requirements of Directive

Identification of article(s) defining the requirement in the Directive.

Clause(s) of the present document

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): Maximum Measurement Uncertainty

The measurements described in the present document are based on the following assumptions:

- the measured value related to the corresponding limit is 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 is included in the test report.

Table B.1 shows the recommended values for the maximum measurement uncertainty figures.

Table B.1: Maximum measurement uncertainty

Parameter	Uncertainty
Environment measurements	
Temperature	1 °C
Relative humidity	5 %
Supply Voltage	±2 %
Transmitter measurements	
Frequency	±1 ppm
Transmitted Power	±1 dB
Out-of-Band emissions	±4 dB
Spurious emissions	±4 dB
Transmitter Intermodulation Attenuation	±1 dB
Duty Cycle	±10 ppm

Annex C (informative): Checklist

This annex provides a traceability of the technical parameters for article 3.2 of Directive 2014/53/EU [i.1] defined in ETSI EG 203 336 [i.2] with the technical requirements for conformance defined in clause 4 of the present document.

If a technical parameter for article 3.2 of Directive 2014/53/EU [i.1] defined in ETSI EG 203 336 [i.2] has not been included in the present document, an explanation is provided.

An explanation is also provided whenever a technical parameter defined in ETSI EG 203 336 [i.2] is covered by an alternative technical requirement.

Table C.1: Checklist

Technical Parameters defined in ETSI EG 203 336 [i.2]	Clauses of the present document	Comments
Transmitter Parameters		
Transmit power limits and accuracy	4.2.8	Transmit power is subject to national regulations
Transmitter Spectrum mask	4.2.3	
Transmitter Frequency stability	4.2.2	
Transmitter Intermodulation attenuation	4.2.6	
Unwanted emissions (OOB and spurious domains)	4.2.4 4.2.5	
Transmitter Time domain characteristics (e.g. the duty cycle, turn-on and turn-off, frequency hopping cycle, dynamic changes of modulation scheme and others)	4.2.7	
Transmitter Transients	4.2.3	Transmitter transients are covered by the spectrum mask
Receiver Parameters		
Receiver sensitivity	NA	The equipment is transmit only
Receiver co-channel rejection	NA	The equipment is transmit only
Adjacent band/channel selectivity	NA	The equipment is transmit only
Spurious response rejection	NA	The equipment is transmit only
Receiver blocking	NA	The equipment is transmit only
Receiver spurious response rejection	NA	The equipment is transmit only
Receiver radio-frequency intermodulation	NA	The equipment is transmit only
Receiver unwanted emissions in the spurious domain	NA	The equipment is transmit only
Receiver dynamic range	NA	The equipment is transmit only
Reciprocal mixing	NA	The equipment is transmit only

Annex D (informative): Bibliography

- Recommendation ITU-R M.1177-4 (2011): "Techniques for measurement of unwanted emissions of radar equipment".
- Recommendation ITU-R SM.329-12 (2012): "Unwanted emissions in the spurious domain".
- 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".
- EUROCAE ED-129B (March 2016): "Technical Specification for a 1090 MHz Extended Squitter ADS-B Ground System".
- 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".

History

Document history			
V1.0.1	January 2022	EN Approval Procedure	AP 20220426: 2022-01-26 to 2022-04-26
V1.1.1	April 2022	Publication	