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NT-3004

Technical Standard

concerning

Radar intended for landslide and debris flow monitoring, avalanche detection, other similar safety-related applications and radar intended to detect bird migration.

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Entry into force: 16.12.2014

Titre en français: **Norme technique concernant les radars destinés à la surveillance des glissements de terrains et des coulées de débris, à la détection d'avalanches et à d'autres applications de sécurité similaires, ainsi qu'à la détection des oiseaux migrateurs.**

Titel auf Deutsch: **Technische Norm betreffend die Radare für die Ortung von Landrutsch- und Geröllbewegungen, die Lawinenortung und gleichartige Sicherheitsanwendungen sowie die Radare für die Ortung von Vogelmigrationen.**

Titolo in italiano: **Norma tecnica relativa ai radar destinati al monitoraggio dei movimenti di terreno e di detriti, al rilevamento di valanghe e ad applicazioni di sicurezza analoghe, come pure al rilevamento radar degli uccelli migratori.**

Contents

1 General

1.1 Foreword / Introduction / Einführung / Introduzione

This technical standard is applicable to radar intended for landslide monitoring, avalanche detection, debris flow and other similar safety-related applications, as well as for radar intended for bird migration. It specifies the essential requirements with regard to electromagnetic compatibility and for effective use of the spectrum, according to Article 7 paragraph 1 letter b and paragraph 3 TIO (Ordinance of 14 June 2002 on Telecommunications Installations [2]). Products manufactured in compliance with the requirements of this technical standard benefit from a presumption of conformity with the corresponding essential requirements. This standard is published in the Official Federal Gazette as designated technical standard in accordance with Article 31 paragraph 2 letter a TCA (Telecommunications Act of 30 April 1997 [1]) and Article 4 paragraph 2 TIO [2].

La présente norme technique s'applique aux radars destinés à la surveillance des glissements de terrains et des coulées de débris, à la détection d'avalanches et à d'autres applications de sécurité similaires, ainsi qu'à la détection des oiseaux migrateurs. Elle concrétise les exigences essentielles, en ce qui concerne la compatibilité électromagnétique, et d'utilisation efficace du spectre, inscrites à l'article 7, alinéa 1 lettre b et alinéa 3, OIT (Ordonnance sur les installations de télécommunication du 14 juin 2002 [2]). Son respect permet de présumer que cette exigence essentielle est remplie. Elle est publiée dans la Feuille fédérale comme norme désignée en application des article 31, alinéa 2, lettre a, LTC (Loi sur les télécommunications du 30 avril 1997 [1]) et article 4, alinéa 2, OIT [2]. Le reste du présent document est en langue anglaise.

Diese technische Norm ist anwendbar auf Radare für die Ortung von Landrutsch- und Geröllbewegungen, die Lawinenortung und gleichartige Sicherheitsanwendungen sowie auf die Radare zur Ortung von Vogelmigrationen. Sie legt die grundlegenden Anforderungen betreffend die elektromagnetische Verträglichkeit und bezüglich effizienter Nutzung des Spektrums in Übereinstimmung mit Artikel 7 Absatz 1 Buchstabe b und Absatz 3 der Verordnung über Fernmeldeanlagen vom 14. Juni 2002 (FAV) [2] fest. Wird diese technische Norm eingehalten, so wird vermutet, dass die grundlegenden Anforderungen erfüllt sind. Diese Norm ist im Bundesblatt als bezeichnete Norm in Übereinstimmung mit Artikel 31 Absatz 2 Buchstabe a des Fernmeldegesetzes vom 30. April 1997 (FMG [1]) und Artikel 4 Absatz 2 FAV [2] publiziert. Der Rest dieses Dokumentes ist in englischer Sprache verfasst.

Questa norma tecnica concretizza, per i radar destinati al monitoraggio dei movimenti di terreno e di detriti, al rilevamento di valanghe e ad applicazioni di sicurezza analoghe, come pure al rilevamento radar degli uccelli migratori, le esigenze fondamentali, per quanto concerne la compatibilità elettromagnetica, e per l'uso efficace dello spettro ai sensi dell'articolo 7 capoverso 1 lettera b e capoverso 3 dell'ordinanza sugli impianti di telecomunicazione del 14 giugno 2002 (OIT) [2]. Dal rispetto di questa norma tecnica si presume che siano adempite le esigenze fondamentali. Essa è pubblicata nel Foglio federale come norma tecnica designata ai sensi dell'articolo 31 capoverso 2 lettera a della legge del 30 aprile 1997 sulle telecomunicazioni (LTC) [1] e dell'articolo 4 capoverso 2 dell'OIT [2]. Il resto del documento è scritto in lingua inglese.

1.2 Scope

The present document specifies the technical characteristics, test methods, limits and the requirements for radar intended for landslide monitoring, avalanche detection, debris flow and other similar safety-related applications in the frequency range 10.000 to 10.050 GHz and bird migration detection radar in the frequency range 9300 to 9500 MHz.

Note: The requirements for spectrum use are defined in the relevant technical interface regulations (RIR).

1.3 References

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

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 reference document (including any amendments) applies.

[1] SR 784.10
Telecommunications Act of 30 April 1997 (TCA)

[2] SR 784.101.2
Ordinance of 14 June 2002 on Telecommunications Installations (TIO)

[3] Radio Regulations
Edition of 2012

[4] Recommendation ITU-R SM.329
Unwanted emissions in the spurious domain.

[5] Recommendation ITU-R M.1177
Techniques for measurement of unwanted emissions of radar systems

[6] Recommendation ITU-R SM.1541
Unwanted emissions in the out-of-band domain

[7] ETSI EN 301 489-1
Electromagnetic compatibility and Radio spectrum Matters (ERM); Electro Magnetic Compatibility (EMC) standard for radio equipment and services; Part 1: Common technical requirements.

[8] ETSI EN 301 126-3-1
Fixed Radio Systems; Conformance testing; Part 3-1: Point-to-Point antennas; Definitions, general requirements and test procedures.

[9] Cenelec EN 55022
Information technology equipment
Radio disturbance characteristics
Limits and methods of measurement

[10] Cenelec EN 55011
Industrial, scientific and medical (ISM) radio-frequency equipment
Electromagnetic disturbance characteristics
Limits and methods of measurement.

[11] CISPR 16

Specification for radio disturbance and immunity measuring apparatus and methods; Part 1: Radio disturbance and immunity measuring apparatus.

[12] ETSI TR 100 028 (all parts)

Electro Magnetic Compatibility and Radio Spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics.

The referenced laws and ordinances are available on the web site www.admin.ch. They can also be obtained from: OFCOM, Zukunftstrasse 44, Post Office Box, CH-2501 Biel/Bienne.

The Swiss technical standards and the technical interface regulations (RIR) are available on the web site www.ofcom.admin.ch. They can also be obtained from: OFCOM, Zukunftstrasse 44, Post Office Box, CH-2501 Biel/Bienne.

The Radio Regulations (RR) and the International Telecommunication Union (ITU)-R Recommendations can be obtained from: ITU, place des Nations, CH-1211 Genève 20, (www.itu.int).

The European Telecommunications Standardisation Institute (ETSI) documents can be obtained from: Institut européen des normes de télécommunication, 650 route des Lucioles, F-06921 Sophia Antipolis, France, (www.etsi.org).

The Cenelec standards can be obtained from: Schweizerischen Normen-Vereinigung, Bürglistrasse 29, CH-8400 Winterthur, (www.snv.ch).

The CISPR standards can be obtained from: IEC Central Office 3, rue de Varembé CH - 1211 Geneva 20 (http://www.iec.ch)

1.4 Abbreviations

AC	Alternating Current
CR	Continuous phenomena applied to Receivers
CSP	Channel Spacing
CT	Continuous phenomena applied to Transmitters
CW	Carrier Wave
dB	Decibel
dBpp	Decibels relative to the maximum value of the peak power, measured with the reference bandwidth within the occupied bandwidth. The in-band peak power is expressed in the same reference bandwidth as the OoB peak power. Both the in-band and the unwanted emissions should be evaluated in terms of peak values. For radar systems, the reference bandwidth should be selected according to Recommendation ITU-R M.1177 [5].
DC	Direct Current
e.i.r.p.p.	Within this standard e.i.r.p.p. is the max. allowed e.i.r. peak power level measured with a bandwidth resolution of 10 MHz.
EBL	Electronic Bearing Line
EMC	Electro Magnetic Compatibility
EUT	Equipment Under Test
FM	Frequency Modulation
FMCW	Frequency Modulated Carrier Wave
FTC	Fast Time Constant

HS	Harmonized Standard
ITU-R	International Telecommunication Union-Radiocommunications
LNA	Low Noise Amplifier
OATS	Open Area Test Site
OoB	out of band
PEP	Peak Envelope Power
PRF	Pulse Repetion Frequency
PRT	Pulse Repetition Time
PSD	Power Spectrum Density (Mean power per reference bandwidth)
RF	Radio Frequency
STC	Sensitivity Time Control
TR	Transient phenomena applied to Receivers
TT	Transient phenomena applied to Transmitters
VRM	Variable Range Marker
VSWR	Voltage Standing Wave

1.5 Definitions

-40 dB bandwidth	The occupied bandwidth of the power envelope of an emission which is delimited by the highest and lowest -40dBpp point referenced to the maximum PEP.
Adjacent channel mean power	Power integrated over the bandwidth of a channel adjacent to an occupied channel using measurements of the PSD or an equivalent method.
Bandwidth of the frequency deviation	Total frequency shift during the RF transmit power pulse generation (maximum value)
Mean power	Depending on the context mean power is either the average power supplied to the antenna transmission line by a transmitter during an interval of time sufficiently long compared to the lowest modulation frequency encountered under normal operating conditions or the power integrated over a specified frequency band using PSD or an equivalent measurement method.
Necessary bandwidth	For a given class of emission, the width of the frequency band which is just sufficient to ensure the transmission of information at the rate and with the quality required under specified conditions.
Occupied bandwidth	The width of a frequency band such that, below the lower and above the upper frequency limits, the mean power emitted are each equal to a specified percentage β/2 of the total mean power of a given emission. Unless otherwise specified in an ITU-R Recommendation for the appropriate class of emission, the value of β/2 should be taken as 0.5%.

OoB boundary	Frequency where the OoB domain emission range ends and the spurious emissions range starts. Each wanted emission is associated with an lower and an upper OoB boundary. The two frequencies are defined by the points where the value of the OoB limit mask falls to the spurious emissions limit levels.
OoB domain	(of an emission): the frequency range, immediately outside the -40 dB bandwidth but excluding the spurious domain, in which OoB (out-of-band) emissions generally predominate.
OoB domain emissions	Any emission in the OoB domain.
Power spectrum density	Power spectrum density (PSD) is the mean power per reference bandwidth.
Peak envelope power	(of a radio transmitter): The average power supplied to the antenna transmission line by a transmitter during one radio frequency cycle at the crest of the modulation envelope taken under normal operating conditions.
Peak power	Power measured with the peak detector using a filter the width and shape of which is sufficient to accept the signal bandwidth.
Pulse duration	The time interval between the point when the RF transmit power pulse rises at its first transition to 50% of the final level and the point when the level drops to 50%at its last transition.Pulse duration is also refert to as pulse length.
Pulse Repetition Frequency	Number of RF transmit power pulses per second.
Pulse Repetition Time	Time intervall, starting at the point where the RF transmit power pulse is switched on and reaches 50% of its final level at its first transition until it reaches the same level again at the first transition of the next directly following RF transmit power pulse.
Pulse fall time	Time interval starting at the point where the RF transmit power pulse drops to 90% of its final level at its last transition and reaches 10% of its final level at its last transition.
Pulse rise time	Time interval starting at the point where the RF transmit power pulse rises to 10% of its final level at its first transition and reaches 90% of its final level at its first transition.
Reference bandwidth	The bandwidth required for uniquely defining the OoB domain emission limits. If not explicitly given with the OoB domain emission limit, the reference bandwidth should be selected in line with Recommendation ITU-R M.1177 [5].
Spurious emissions	Emission on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products, but exclude out-of-band emissions.
Unwanted emissions	Unwanted emissions are emissions in both the out-of-band domain emissions and in the spurious emissions domain.

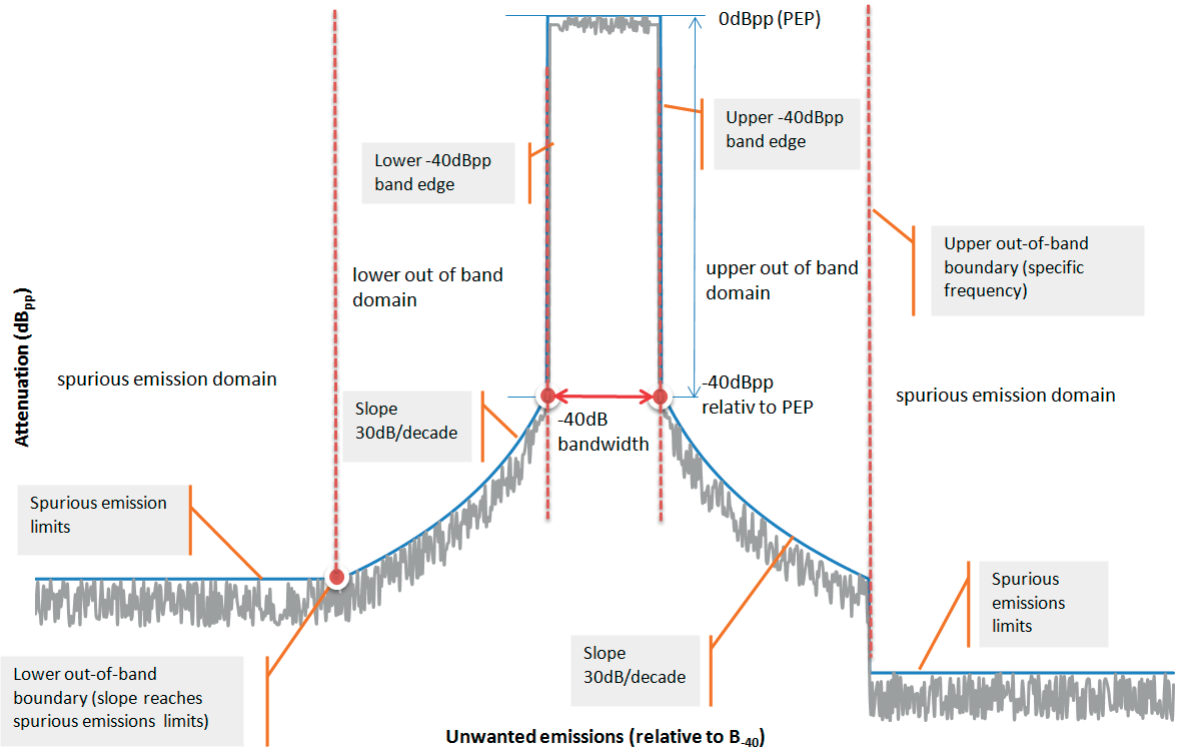

Figure 1 : Definition of the different parts of the emission's spectrum

1.6 Symbols

B_{-40}	-40 dB bandwidth
B_m	Measurement bandwidth
P_m	Peak envelope power
P_{PEP}	Peak envelope power
P_t	Transmission pulse power
t	Time
t_p	Transmission pulse duration
t_r	Pulse rise time

2 Test conditions

2.1 General

In relation to EMC testing the test conditions of EN 301 489-1 [7], clause 4, shall apply as appropriate. Further product related test conditions for radar systems are specified in the present document.

ITU.R M1177 [5] often refers to measurements performed after the rotary joint. For Radar systems that do not feature rotary joints these measurements are performed at the equivalent point which is coupling port of the antenna input.

The value of varying parameters (e.g. pulse rise or fall times) having an impacting on essential requirements are to be chosen at their most critical impact on the limits and not by their mean value.

2.2 Conditions for testing according the EMC requirements

For emission and immunity tests, the normal test modulation, test arrangements, etc. as specified in the present document, clauses 2.2.1 to 2.2.3, shall apply. During the test the Equipment under Test (EUT) shall be operated as intended.

2.2.1 Arrangements for test signals

The provisions of EN 301 489-1 [7], clause 4.2, shall apply.

2.2.2 Exclusion bands

For equipment operating at frequencies above 2.7 GHz and whose RF bandwidth does not extend to a frequency below 2.7 GHz, there is no exclusion band since no immunity tests are required above 2.7 GHz.

The frequencies on which the radar is intended to operate shall be excluded from conducted and radiated emission measurements when performed in transmit mode of operation.

Note: This applies only to EMC requirements.

The exclusion band is twice the intended operating frequency band centred on the centre frequency of the intended operating frequency band.

There shall be no frequency exclusion band applied to emission measurements of associated ancillary equipment.

2.2.3 Normal test modulation

The manufacturer shall specify the normal test modulation, if any.

2.2.4 Performance assessment

2.2.4.1 General

The provisions of EN 301 489-1 [7], clause 5.1 shall apply.

The manufacturer shall at the time of submission of the equipment for test, supply the necessary general information as requested in EN 301 489-1 [7] clause 5.1. Additionally he shall supply the following product-related information.

For the EUT the performance assessment is based on:

- the maintenance of function(s);
- the way the eventual loss of function(s) can be recovered;
- unintentional behaviour of the EUT.

Additionally the manufacturer shall specify the way the degradation in performance should be measured and expressed.

2.2.4.2 Equipment which can provide a continuous communications link

The provisions of EN 301 489-1 [7], clause 5.2, shall apply.

2.2.4.3 Equipment which does not provide a continuous communications link

The provisions of EN 301 489-1 [7], clause 5.3, shall apply.

2.2.4.4 Ancillary equipment

The provisions of EN 301 489-1 [7], clause 5.4 shall apply.

2.2.4.5 Equipment classification

The provisions of EN 301 489-1 [7], clause 5.5 shall apply.

2.2.5 Performance criteria

2.2.5.1 General performance criteria

The equipment shall meet the performance criteria as specified in the following clauses, for radar equipment.

Radar equipment, may not operate fully during immunity tests, but should recover and operate normally after the tests.

2.2.5.2 Performance table

Radar equipment during test:	May be loss of function (one or more).
	No unintentional responses.
Radar equipment after test:	Operate as intended.
	Lost function(s) shall be self-recoverable.
	No degradation of performance.
	No loss of stored data or user programmable functions.

2.2.5.3 Performance criteria for Continuous phenomena applied to Radar (CT)

For radar systems which continue to operating during the test, this shall be verified by appropriate means supplied by the manufacturer.

The tests shall be repeated with the transmitter of the EUT not switched on (standby mode), to ensure that no unintentional transmission occurs.

2.2.5.4 Performance criteria for Transient phenomena applied to Radar (TT)

The same conditions as in the previous clause apply.

2.2.5.5 Performance criteria for ancillary equipment tested on a standalone basis

The provisions of EN 301 489-1 [7], clause 6.4 shall apply.

2.3 Conditions for testing according the radio spectrum requirements

Tests defined in the present document shall be performed at representative points within the boundary limits of the declared operational environmental profile.

Where technical performance varies according to environmental conditions, tests shall be performed under a sufficient variety of environmental conditions (within the boundary limits of the declared operational environmental profile) to give confidence of compliance with the relevant technical requirements.

2.3.1 Standard operating mode of the radar equipment

Unless otherwise stated the radar equipment shall be set to the standard operating mode. If more than one mode is possible, the mode with the worst-case impact on the requirements must be used.

The test setup (range, antenna height etc. shall be noted in the test report).

The default parameters such as the pulse duration, the rise- and fall times and the PRF of the EUT shall be noted in the test report. Measurement instructions on pulse timing parameters are defined in ITU-R M.1177 [5] Appendix 3 to Annex 1.

If any of the default values are changed in a particular test case this fact as well as the changed values shall be noted in the test report.

2.3.2 Normal test conditions

2.3.2.1 Normal temperature and humidity

The temperature and humidity conditions for tests shall be a combination of temperature and humidity within the following ranges:

- temperature: +15 °C to +35 °C; or within the manufacturers stated operating range and stated in the report;
- relative humidity: 20 % to 75 %.

If the relative humidity is lower than 20 %, this shall be stated in the test report.

2.3.2.2 Normal test power supply

2.3.2.2.1 AC test power supply

The test voltage for equipment to be connected to an AC supply shall be the nominal mains voltage declared by the manufacturer -10 % to +10 %.

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 has been designed. The frequency of the test voltage shall be 50 Hz ± 1 Hz.

2.3.2.2.2 DC test power supply

Where the equipment is designed to operate from a DC source, the normal test voltage shall be the nominal voltage as declared by the manufacturer -10 % to +20 %.

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 testing the power source voltage shall be measured at the input terminals of the equipment.

During testing, the power source voltages shall be maintained within a tolerance of ±3 % relative to the voltage level at the beginning of each test.

2.3.3 Extreme test conditions

2.3.3.1 Extreme temperatures

The manufacturer shall declare the temperature and humidity range at which the EUT is intended to operate.

If the relative humidity is lower than 20 % during tests, this shall be stated in the test report.

2.3.3.2 Extreme power supply voltage test conditions

The extreme power supply test voltages applied to the equipment shall be according to the following values.

AC Power supply:

- Supply voltage variation ±10%
- Frequency variation ±5%

DC Power supply:

- Supply voltage variation +20% / -10%

2.3.4 Interpretation of the measurement results

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

- the measured value relating to the corresponding limit shall be used to determine 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 lower than the figures in the following table.

According to the present document, the measurement uncertainty figures for the test methods should be calculated and shall correspond to an expansion factor (coverage factor) k = 1.96 or k = 2 (which provide confidence levels of 95 % and 95.45 %, respectively, in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian)). Principles for the calculation of measurement uncertainty are contained in TR 100 028 [12], in particular in annex D of TR 100 028-2 [12]. The following values are based on such expansion factors.

- RF frequency — 1×10^{-7} of maximum uncertainty
- RF pulse power — 1.5 dB of maximum uncertainty
- Radiated emission of transmitter — 6 dB of maximum uncertainty

3 Requirements

3.1 Requirements related to EMC

3.1.1 Emission

3.1.1.1 General

EN 301 489-1 [7], table 1 contains the applicability of EMC emission measurements to the relevant ports of radar and/or associated ancillary equipment.

Note: The radiated spurious emissions requirements of the radar equipment itself are specified in the radio part of this standard.

3.1.1.2 Limits

The applicable limits are defined in EN 301 489-1 [7] clause 8.

3.1.1.3 Special conditions

No special conditions applicable

3.1.1.4 Conformance

Conformance tests as defined in clause 4.1.1 shall be carried out.

3.1.2 Immunity

3.1.2.1 General

EN 301 489-1 [7], table 2 contains the applicability of EMC immunity measurements to the relevant ports of the Radars equipment and/or associated ancillary equipment.

3.1.2.2 Limits

The applicable limits are defined in EN 301 489-1 [7] clause 9.

3.1.2.3 Special conditions

No special conditions applicable.

3.1.2.4 Conformance

Conformance tests as defined in clause 4.1.2 shall be carried out.

3.2 Requirements related to radio spectrum matters

3.2.1 Operating frequency

3.2.1.1 Definition

The transmitter produces short microwave pulses, which generates a broad frequency spectrum, depending on the pulse duration and the pulse repetition frequency (it should be noted that the maximum pulse repetition frequency is associated with the minimum pulse duration and vice versa). The operating frequency is to be understood as the frequency of the microwave during the transmitting pulse and is represented by the spectral line of highest amplitude.

3.2.1.2 Limits

3.2.1.2.1 Radar equipment operating in the frequency range 9300-9500 MHz

The operating frequency of the radar equipment shall be within ±30 MHz of the nominal frequency specified in the relevant technical interface regulations for all switchable distance ranges and pulse durations.

3.2.1.3 Conformance

Conformance tests as defined in clause 4.1.3 shall be carried out.

3.2.2 Transmitter pulse power

3.2.2.1 Definition

This requirement applies to radar equipment with pulsed transmitter power.

Transmitter pulse power P_t is to be understood as the mean value of the microwave power during the transmission pulse at the antenna side of the radar output. For the arithmetic mean value of the transmitter power, integrated over the PRT, the abbreviation P_m is used.

3.2.2.2 Limit

The transmitter pulse power P_t shall be within a tolerance of +1.5 dB to -3 dB of the value specified by the manufacturer.

Note: The maximum permitted pulse power is defined in the relevant technical interface regulations (RIR).

3.2.2.3 Conformance

Conformance tests as defined in clause 4.1.4 shall be carried out.

3.2.3 Transmitter peak envelope power

3.2.3.1 Definition

Transmitter power P_{PEP} is to be understood as the peak value of the microwave power during transmission at the antenna side of the radar output.

3.2.3.2 Limit

The transmitter pulse power P_{PEP} shall be within a tolerance of +1.5 dB to -3 dB of the value specified by the manufacturer.

Note: For non-pulsed equipment the maximum permitted PEP power is defined in the relevant technical interface regulations (RIR).

3.2.3.3 Conformance

Conformance tests as defined in clause 4.1.5 shall be carried out.

3.2.4 -40 dB bandwidth (B_{-40})

3.2.4.1 Definition

The width of a frequency band such that beyond its lower and upper limits any discrete spectrum component or continuous spectral power density is at least 40 dB lower than at the 0 dB reference level which is equal to the maximum PEP level.

The value of the -40 dB bandwidth is calculated from a given formula.

3.2.4.2 Limit

3.2.4.2.1 Radar equipment operating in the frequency range 9300-9500 MHz

- The transmitter pulse duration shall be greater than 50 ns.
- The Pulse Repetition Frequency PRF shall not exceed 3300 Hz
- The -40 dB bandwidth (B_{-40}) of the emission shall be fully contained within the frequency range 9300-9500 MHz.

3.2.4.2.2 Radar equipment operating in the frequency range 10.000-10.050 GHz

The maximum permitted -40 dB bandwidth (B_{-40}) is dependent on the chosen theoretical centre frequency of the emission and shall not exceed the values listed in the table below. The 40 dB bandwidth (B_{-40}) shall be fully contained in the allocated frequency band.

Allocated frequency band	Theoretical centre frequency	Maximum -40 dB bandwidth
10.000 - 10.040 GHz	10.0200 GHz	40 MHz
10.000 - 10.045 GHz	10.0225 GHz	45 MHz
10.000 - 10.050 GHz	10.0250 GHz	50 MHz

3.2.4.2.3 Conformance

The conformance procedure as defined in clause 4.1.6 shall be carried out.

3.2.5 Radiated out of band emissions

3.2.5.1 Definition

For emissions below the operating frequency:

The OoB mask starts at the -40 dBpp point of the main emission's PEP and falls with a gradient of 30 dB/Decade away from the main emission until it reaches the spurious emissions limit. This point is called the out-of-band boundary. Emissions in the domain between the -40 dBpp point and the associated out-of-band-boundary are considered to be out-of-band emissions (see Figure 1).

For emissions above the operating frequency:

The OoB mask starts at the -40 dBpp point of the main emission's PEP and falls with a gradient of 30 dB/Decade away from the main emission until a frequency of 10 GHz, for radar equipment operating in the frequency range 9300-9500 MHz, or 10.150 GHz, for radar equipments operating in the frequency range 10.000-10.050 GHz, where the out-of-band boundary is set in order to protect existing services. Emissions in the domain between the -40 dBpp point and the associated out-of-band-boundary are considered to be out-of-band emissions (see Figure 1).

3.2.5.2 Limit

3.2.5.2.1 Radar equipment operating in the frequency range 9300-9500 MHz

Within the out of band domain specified in clause 3.2.5.1 the limit decreases with a gradient of 30 dB/decade with the boundary defined by the point where the limit is equal to the radiated spurious emissions limits defined in clause 3.2.6.2.1.

The maximum radiated out of band-emission power level shall not exceed the limits determined by the 30dB/decade slope.

3.2.5.2.2 Radar equipments operating in the frequency range 10.000-10.050 GHz

Within the out of band domain specified in clause 3.2.5.1 the limit decreases with a gradient of 30 dB/decade with the boundary defined by the point where the limit is equal to the radiated spurious emissions limits defined in clause 0.

The maximum radiated out of band-emission power level shall not exceed the limits determined by the 30dB/decade slope.

3.2.5.3 Conformance

Conformance tests as defined in clause 4.1.7 shall be carried out.

3.2.6 Radiated spurious emissions

3.2.6.1 Definition

Spurious emissions are defined as the entirety of unwanted emissions outside the OoB-boundaries.

They include:

- harmonic emissions (integer multiples of the operating frequency);
- parasitic emissions (independent, accidentally);
- intermodulation (between oscillator- and operation frequency or between oscillator and harmonics);
- emissions caused by frequency conversions.

3.2.6.2 Limits

Note: Limits given in e.i.r.p.p. should to be measured with a bandwidth of 10 MHz.

3.2.6.2.1 Radar equipment operating in the frequency range 9300-9500 MHz

Any radiated spurious emission levels shall respect the limits defined in the following table.

<table>
<tr><td>Lower measurement band</td><td colspan="2">Upper measurement band</td></tr>
<tr><td>4.500 GHz to lower OoB-boundary</td><td>Upper OoB-boundary to 10.000 GHz</td><td>10.000 GHz to the 3rd harmonic (note 1)</td></tr>
<tr><td colspan="2">All radiated spurious emission levels shall be at least 100 dB below the PEP level of the radiated operating frequency without the need to be lower than -30 dBm e.i.r.p., measured with a bandwidth according ITU-R M.1177 [5] clause 3.</td><td>Any spurious emission level in the main beam direction of the antenna should be less than:
-10 dBm e.i.r.p.p. + antenna gain in dBi (note 2)
Any spurious emission level in the horizontal plane should be below -25 dBm e.i.r.p.p. (note 3)
Any other spurious emission level should be at least 100 dB below the PEP level of the radiated operating frequency without the need to be lower than
-30 dBm e.i.r.p., measured with a bandwidth according ITU-R M.1177 [5] clause 3.</td></tr>
</table>

Note 1: The upper frequency limit should be set to a value that makes it possible to measure the 3rd harmonic and its power envelope.

Note 2: E.g. the limit for spurious emissions with an antenna gain of 20 dBi is 10 dBm e.i.r.p.p.

Note 3: The wanted emission of bird migration radar is directed at an elevation of 90°. Emissions in the horizontal plane must be limited in order to protect other services.

3.2.6.2.2 Radar equipment operating in the frequency range 10.000-10.050 GHz

Any radiated spurious emission level shall respect the limits defined the following table.

Lower measurement band	Upper measurement band	
4.500 GHz to lower OoB-boundary	Upper OoB-boundary to 10.150 GHz	10.150 GHz to the 3rd harmonic (note 1),
All radiated spurious emission levels shall be 100 dB below the PEP level of the radiated operating frequency without the need to be lower than -30dBm e.i.r.p., measured with a bandwidth according ITU-R M.1177 [5] clause 3		max. -22 dBm e.i.r.p.p.

Note 1: The upper frequency limit should be set to a value that makes it possible to measure the 3rd harmonic and its power envelope.

3.2.6.3 Conformance

Conformance tests as defined in clause 4.1.8 shall be carried out.

3.2.7 Cabinet spurious radiation

3.2.7.1 Definition

Cabinet spurious radiation refers to unwanted emissions in the spurious domain (spurious emissions) which are radiated by the cabinet and equipment structures.

This requirement does not apply to emissions on frequencies above 4.500 GHz, which are covered by previous clauses.

3.2.7.2 Limits

The power of any cabinet spurious emission shall not exceed the values given in the following table.

Frequency ranges	**25MHz ≤ 1 000 MHz**	**Frequencies > 1 000 MHz**
State		
Measurement BW	100kHz/120kHz	1MHz
Operating	250 nW	1 µW
Standby	2 nW	20 nW

3.2.7.3 Conformance

Conformance tests as defined in clause 4.1.9 shall be carried out.

3.2.8 Antenna gain

3.2.8.1 Definition

The antenna gain requirements define the isotropic gain of the antenna assembly in the main propagation direction.

3.2.8.2 Limits

The measured antenna gain shall be within +1dB/-3dB of the antenna gain stated by the manufacturer.

3.2.8.3 Conformance

Conformance tests as defined in clause 4.1.10 shall be carried out.

4 Testing compliance with the technical requirements

4.1 Essential radio test suites

Essential test suites are referred to in annex III of the TIO [2].
The following essential test suites shall be used to assess the performance of equipment.

4.1.1 EMC Emissions test

The test methods are defined in EN 301 489-1 [7] clause 8.

The results obtained shall be compared to the limits in clause 3.1.1.2 in order to prove compliance with the requirement.

4.1.2 EMC Immunity test

The test methods are defined in EN 301 489-1 [7] clause 9.

The results obtained shall be compared to the limits in clause 3.1.2.2 in order to prove compliance with the requirement.

4.1.3 Operating frequency

The antenna shall be replaced by a suitable adapter to adapt the radar's output to a waveguide with a plane flange. This adapter shall be provided by the radar manufacturer.

On that flange a high-power directional coupler shall be mounted with its main port terminated by a matching high-power dummy load. The coupled port shall have adequate attenuation within the whole frequency band 8900 MHz to 9900 MHz to protect the measurement equipment.

A suitable spectrum analyser must be used to measure and display the transmitted signal. The highest amplitude spectral line is considered to be the operating frequency.
The results obtained shall be compared to the limits in clause 3.2.1.2 in order to prove compliance with the requirement.

4.1.4 Transmitter pulse power

The antenna shall be replaced by a suitable adapter to adapt the radar's output to a waveguide with a plane flange. This adapter shall be provided by the radar manufacturer.

On that flange a high-power directional coupler shall be mounted with its main port terminated by a matching high-power dummy load. The coupled port shall have a known attenuation of about 40 dB within a minimum frequency band beginning at the lower OoB boundary and ending at the upper OoB boundary.

To determine the pulse power, the use of both, a mean power meter or a suitable pulse power meter with direct reading of the transmitter pulse power is permitted.

In case of measurement with a mean power meter the transmission pulse duration tp and the pulse repetition time PRT have to be determined in a preceding step i.e. by use of a detector and an oscilloscope. Then the transmitter pulse power Pt is calculated as follows:

$$P_t = P_m \times PRT/t_p$$

Alternatively a spectrum analyser may be used. The settings of the spectrum analyser shall be as follows:

Frequency span:	0 Hz
Measurement bandwidth:	≥ B_{-40}
Detector:	RMS
Trigger:	Video
Sweep time:	2x pulse duration

The spectrum analyser should be set up in order to acquire the pulse with the highest power and then the time-domain measurement function is used to determine the mean power within the pulse.

The results obtained shall be compared to the limits in clause 3.2.2.2 in order to prove compliance with the requirement.

4.1.5 Peak envelope power

The antenna shall be replaced by a suitable adapter to adapt the radar's output to a waveguide with a plane flange. This adapter shall be provided by the radar manufacturer.

On that flange a high-power directional coupler shall be mounted with its main port terminated by a matching high-power dummy load. The coupled port shall have a known attenuation of about 40 dB within a minimum frequency band beginning at the lower OoB boundary and ending at the upper OoB boundary.

The peak envelope power shall be measured with a spectrum analyser using the following settings:

Span:	≥ B_{-40}
Measurement bandwidth:	B_m (according ITU-R M.1177 [5] clause 3)
Video bandwidth:	≥ B_m
Detector:	positive peak
Trace:	max hold
Sweep time:	long enough to capture all emissions

A marker shall be set to the maximum of the measured emission. The marker readout is P_{meas}.

Recommendation ITU-R M.1177 [5] clause 3 specifies the correction factors added to P_{meas} due to the peak envelope power bandwidth B_{pep} and the measurement bandwidth B_m.
This correction factor has to be added to the measured peak power P_{meas} in order to obtain the PEP.

The obtained PEP value shall be compared to the limits in clause 3.2.3.2 in order to prove compliance with the requirement.

Note: The obtained PEP value in this clause presents the conducted value before the antenna.
The PEP value used as a reference for the radiated unwanted emissions value is the one radiated from the antenna.

4.1.6 -40 dB bandwidth

The -40 dB bandwidth (B_{-40}) shall be calculated according to Recommendation ITU-R SM.1541 [6] Annex 8 clause 3.1
The calculation of B_{-40} shall be compared to the limits given in clause 3.2.4.2 and documented in the test report.

4.1.7 Radiated out of band emissions

To perform the measurement, the radar and the measuring equipment shall be installed as described in Recommendation ITU-R M.1177 [5]. Then the radar equipment shall be set to the shortest range (shortest pulse duration).

The measurement bandwidth B_m shall be chosen according to ITU-R M.1177 [5] clause 3 and documented in the test report. If a correction factor due to the selected bandwidth must be applied it should also be documented in the test report.

Measures described in Recommendation ITU-R M.1177 [5] shall be taken to ensure that interference caused by multiple reflections does not occur.

The power of the radiated out of band emissions within the frequency bands specified in the following table shall be measured according to Recommendation ITU-R M.1177 [5].

The results obtained shall be compared to the limits in clause 3.2.5.2 in order to prove compliance with the requirement.

Lower measurement band	**Upper measurement band**	
Lower OoB boundary to lower -40dBpp band edge	Radar equipment operating in the frequency range 9300-9500 MHz	Radar equipment operating in the frequency range 10.000-10.040 GHz
	Upper -40dBpp band edge to upper OoB boundary or to 10.000 GHz whichever is lower.	Upper -40dBpp band edge to upper OoB boundary or to 10.150 GHz whichever is lower.

4.1.8 Radiated spurious emissions

To perform the measurement, the radar and the measuring equipment shall be installed as described in Recommendation ITU-R M.1177 [5]. The radar equipment shall then be set to the shortest range (shortest pulse duration). All power levels including the PEP shall be determined by the same method and the same measuring parameters. Measures described in Recommendation ITU-R M.1177 [5] shall be taken to ensure that interference caused by multiple reflections does not occur.

The radiated spurious power emission shall be measured in several overlapping frequency sweep steps in the frequency bands given in the following table.

If required, a low noise amplifier (LNA), and a notch filter for the operating frequency should be used to reach the required dynamic amplitude measuring range.

The results obtained shall be compared to the limits in clause 3.2.6.2 in order to prove compliance with the requirement.

Lower measurement band: 4.5 GHz to lower OoB boundary
Upper measurement band: higher OoB boundary to the 3rd harmonic (note 1)

Note 1: The upper frequency limit should be set to a value that makes it possible to measure the 3rd harmonic and its power envelope.

4.1.9 Cabinet spurious radiation

For measurements above 1000 MHz the peak value shall be measured using a spectrum analyser. The "max hold" function of the spectrum analyser shall be used. For measurements up to 1000 MHz the quasi-peak detector set in accordance with the specification of CISPR 16 [11] shall be used.

The frequency of the measuring receiver shall be adjusted over the frequency range 25 MHz 4.500.

The test method shall be in accordance with EN 55022 [9], unless physical size is a restriction, in which case the test method shall be in accordance with EN 55011 [10].

The results obtained shall be compared to the limits specified in clause 3.2.7.2 in order to prove compliance with the requirement.

4.1.10 Antenna gain

The antenna gain shall be measured according to EN 301 126-3-1 [8] clause 6.3.

The results obtained shall be compared to the limits specified in clause 3.2.8.2 in order to prove compliance with the requirement.

5 Requirements and conformance test specifications table (normative)

The Requirements and conformance Test specifications Table (RTT) in table A.1 serves a number of purposes, as follows:

- it states all the essential requirements in words and by cross reference to (a) specific clause(s) in the present document or to (a) specific clause(s) in (a) specific referenced document(s);
- it qualifies each requirement to be either:
- Unconditional: meaning that the requirement applies in all circumstances; or
- Conditional: meaning that the requirement is dependent on the manufacturer having chosen to support optional functionality defined within the schedule;
- in the case of Conditional requirements, it associates the requirement with the particular optional service or functionality;
- it qualifies each test procedure to be either:
- Essential: meaning that it is included with the essential radio test suite and therefore the requirement shall be demonstrated to be met in accordance with the referenced procedures;
- Other: meaning that the test procedure is illustrative but other means of demonstrating compliance with the requirement are permitted.

The following requirements and test specifications are relevant to the presumption of conformity under the Article 7 paragraph 3 TIO (Ordinance on Telecommunications Installations) [2]:

Requirement			**Requirement Conditionality**		**Test Specification**	
No	**Description**	**Reference: Clause No**	**U/C**	**Condition**	**E/O**	**Reference: Clause No**
1	EMC Emission	3.1.1	U		E	4.1.1
2	EMC Immunity	3.1.2	U		E	4.1.2
3	Operating frequency	3.2.1	C	For radar equipment operating in the 9300-9500 MHz frequency band	E	4.1.3
4	Transmitter pulse power	3.2.2	C	For pulsed radars only	E	4.1.4
5	Peak Envelope Power	3.2.3	U		E	4.1.5
6	-40 dB bandwidth (B-40)	3.2.4	U		E	4.1.6
7	Radiated out of band emissions	3.2.5	U		E	4.1.7
8	Radiated spurious emissions	3.2.6	U		E	4.1.8
9	Cabinet spurious radiation	3.2.7	U		E	4.1.9
10	Antenna gain	3.2.8	U		E	4.1.10

Key to columns:

- Requirement:
  - **No:** A unique identifier for one row of the table which may be used to identify a requirement or its test specification.
  - **Description:** A textual reference to the requirement.
  - **Clause No:** 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 to be *unconditionally* applicable (U) or is *conditional* upon the manufacturer's claimed functionality of the equipment (C).
  - **Condition:** Explains the conditions when the requirement shall or shall not be applicable for a technical requirement which is classified as "conditional".

- Test Specification:
  - **E/O:** Indicates whether the test specification forms part of the essential radio test suite (E) or whether it is one of the other test suite (O).
    Note: All tests whether "E" or "O" are relevant to the requirements. Rows designated "E" collectively make up the essential radio test suite; those designated "O" make up the Other Test Suite; for those designated "X" there is no test specified corresponding to the requirement. The completion of all tests classified "E" as specified with satisfactory outcomes is a necessary condition for a presumption of conformity. Compliance with requirements associated with tests classified "O" or "X" is a necessary condition for presumption of conformity, although conformance with the requirement may be claimed by an equivalent test or by manufacturer's assertion supported by appropriate entries in the technical construction file.
  - **Clause Number:** Identification of clause(s) defining the test specification in the present document unless another document is referenced explicitly. Where no test is specified (that is, where the previous field is "X") this field remains blank.

Repealed documents

None

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Federal Office of Communications OFCOM

Philipp Metzger
Director