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NT-3002 V1.3.0

Technical Standard

concerning

PMR Repeaters

to be operated inside tunnels, galleries, buildings and underground car parks.

Titre en français:	**Norme technique** concernant les **réémetteurs PMR** destinés à être exploités dans les tunnels, galeries couvertes, immeubles et dans les garages souterrains.
Titel auf Deutsch:	**Technische Norm** betreffend die **PMR Umsetzer**, welche in Tunnels, Überdeckungen, Häusern und in Tiefgaragen eingesetzt werden.
Titolo in italiano:	**Norma tecnica** relativa **a ripetitori PMR** destinati ad essere esercitati nei tunnel, nelle gallerie coperte, nelle case e nei garage sotterranei.

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General

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This technical standard specifies, for PMR Repeater to be operated into tunnels, galleries, buildings and underground car parks, the essential requirement of effective use of the spectrum according article 7 paragraph 2 TIO (Ordinance on Telecommunications Installations [I.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 [I.1]) and Article 4 paragraph 2 TIO [I.2].

Cette norme technique concrétise pour les réémetteurs PMR destinés à être exploités dans les tunnels, galeries couvertes, immeubles et dans les garages souterrains, l'exigence essentielle d'utilisation efficace du spectre selon l'art. 7 al. 2 de l'OIT (Ordonnance sur les installations de télécommunication [I.2]). Son respect permet de présumer que cette exigence essentielle est remplie. Elle est publiée dans la Feuille fédérale comme norme désignée selon l'art. 31, al. 2, let. a, LTC (Loi sur les télécommunications du 30 avril 1997 [I.1]) et art. 4, al. 2, OIT ([I.2]).
Le reste de ce document est rédigé en langue anglaise.

Diese technische Norm legt für PMR Umsetzer, welche in Tunnels, Überdeckungen, Häusern und unterirdischen Parkhäusern eingesetzt werden, die grundlegenden Anforderungen bezüglich effizienter Nutzung des Spektrums in Übereinstimmung mit Art. 7 Abs. 2 FAV (Verordnung über Fernmeldeanlagen [I.2]) fest. Werden die in dieser technischen Norm aufgeführten Anforderungen eingehalten, so wird vermutet, dass diese grundlegende Anforderung erfüllt ist. Diese Norm ist im Amtsblatt als bezeichnete Norm in Übereinstimmung mit Art. 31 Abs. 2 Bst. a FMG (Fernmeldegesetz vom 30. April 1997 [I.1]) und Art. 4 Abs. 2 FAV [I.2] publiziert.
Der Rest dieses Dokumentes ist in englischer Sprache verfasst.

Questa norma tecnica concretizza, per i ripetitori PMR destinati ad essere esercitati nei tunnel, nelle gallerie coperte, nelle case e nei garage sotterranei, l'esigenza fondamentale per l'uso efficace dello spettro ai sensi dell'art. 7 cpv. 2, OIT (Ordinanza sugli impianti di telecomunicazione [I.2]). Il rispetto di questa norma tecnica presume che questa esigenza fondamentale sia adempiuta. Questa norma è pubblicata nel Foglio federale come norme designata ai sensi dell'art. 31, cpv. 2, lett. a, LTC (Legge del 30 aprile 1997 sulle telecomunicazioni [I.1]) e dell'art. 4, cpv. 2, OIT (Ordinanza sugli impianti di telecomunicazione [I.2]).
Il resto del documento è scritto in lingua inglese.

1 Scope

The present document specifies the technical characteristics, test methods, limits and the requirements for PMR Repeater to be operated inside tunnels, galleries, buildings and underground car parks. The present document is applicable to PMR repeater systems operating on radio frequencies in the VHF and UHF ranges of 68 MHz to 470 MHz.

The types of equipment covered by the present document are as follows:

- Band selective PMR repeater equipment, also called "broadband repeater" or "broadband frequency changing repeater".;
- Channel selective PMR repeater equipment, also called "channelized repeater", "single carrier repeater" or "multi-channel narrowband carrier repeater".

2 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 published version of the reference document (including any amendments) applies.

2.1 Normative references

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

[1] ETSI EN 300 086-1 (V1.4.1): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Land Mobile Service; Radio equipment with an internal or external RF connector intended primarily for analogue speech; Part 1: Technical characteristics and methods of measurement".

[2] 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".

[3] ETSI TS 101 789-1 (V1.1.2) "TETRA TMO Repeaters, Part 1: Requirements, test methods and limits".

[4] ETSI EG 200 053 "Electromagnetic compatibility and Radio spectrum Matters (ERM); Radio site engineering for radio equipment and systems".

2.2 Legal references

The following referenced documents are legal documents.

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

[l.2] SR 784.101.2; Ordinance of 25 November 2015 on Telecommunications Installations (TIO).

[l.3] SR 784.101.21 / RIR0507; Technical interfaces regulations PMR / PAMR. The technical interface regulations are published in annex 2 of the decree of OFCOM on telecommunication equipment OOIT; SR 784.101.21.

2.3 Informative references

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 relating to the making available on the market of radio equipment (RED).

3 Definitions and abbreviations

3.1 Definitions

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

50 Ω: 50 ohm non-reactive impedance

adjacent channel: Channel which centre frequency has an offset of ± one channel spacing from the centre frequency of the wanted channel

NOTE: See figure 1.

alternate channels: Channel which centre frequency has an offset of ± two channel spacing from the centre frequency of the wanted channel

NOTE: See figure 1.

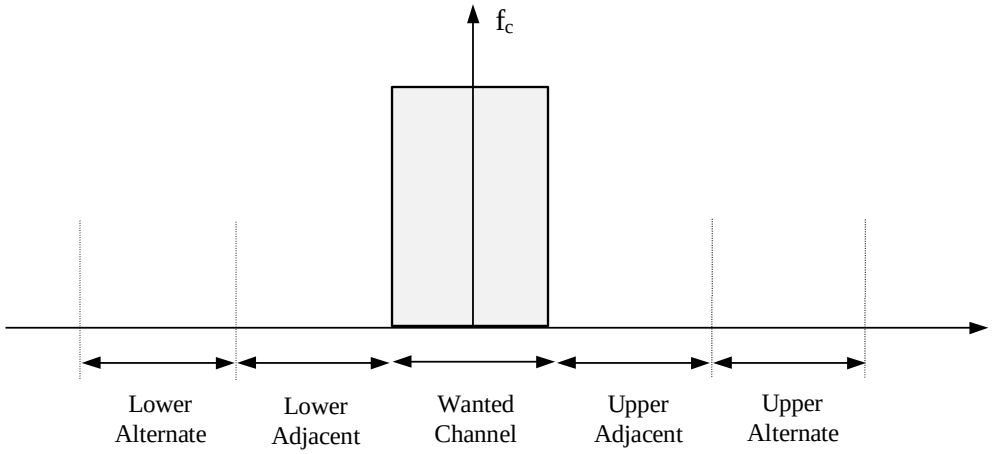


Figure 1: Adjacent and alternate channel definitions

angle modulation: either phase modulation or frequency modulation.

band selective repeater: repeater which is designed for operation on a whole frequency band.

base station: equipment fitted with an antenna connector, for use with an external antenna, and intended to be used in a fixed location.

channel selective repeater: repeater which is designed for operation on a specified subset of PMR channels within the operating band of the repeater.

NOTE: The subset of the PMR channels may be determined during the manufacture of the repeater, or may be programmable.

conducted measurements: measurements which are made using a direct 50 Ω connection to the equipment under test.

frequency changing repeater: repeater which is designed in such a way that the transmit frequency is not equal to the received frequency.

intermodulation attenuation ratio: ratio between the carrier power level and intermodulation component level.

repeater: bi-directional Radio Frequency (RF) amplifier which is used to amplify and transmit a received Mobile Station (MS) signal in the PMR band (e.g. MS located into the tunnel), simultaneously it can amplify and transmit a received Mobile Station (MS) or Base Station (BS) RF signal in the PMR band (e.g. located outside the tunnel).

spurious emissions: emissions at frequencies other than those of the carrier and sidebands associated with normal modulation and switching.

trunked mode operation: mode of operation where a network is used for communication.

3.2 Abbreviations

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

ACP	Adjacent Channel Power
BS	Base Station
dBc	Decibels relative to carrier power
dBm	Decibels relative to 1 mW
MS	Mobile Station
PMR	Private Mobile Radio
RF	Radio Frequency
TMO	Trunked Mode Operation
TX	Transmitter

4 Technical requirements specifications

4.1 Introduction

A repeater may be designed to amplify the whole transmit RF band or just a part of the band. In the latter case the repeaters mode of operation may be either broadband, with frequency band selective filtering, or channelized, with channel selective filtering. The repeater shall operate within the frequency bands defined in the Technical interfaces regulations PMR / PAMR; RIR0507 [I.3].

4.2 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 of the equipment. The equipment shall comply with all the technical requirements of the present document at all times when operating within the boundary limits of the declared operational environmental profile.

4.3 Requirements

4.3.1 Basic rules, EG 200 053

The basic rules described in the ETSI guide "Radio site engineering for radio equipment and systems in the mobile service, EG 200 053" [4] apply to equipment that fall within the scope of this document. The rules stated in clause 5.5 "Repeaters", where installation recommendations (clause 5.5.4) are listed are particularly noteworthy. For example these rules are applicable:

- antenna coupling,
- maximum gain (which will depend on the antennas coupling loss or isolation),
- necessary isolation between several systems,
- the use of filters to obtain the necessary protection against co-located radiocommunication equipment,
- etc.

Annexe H, "Equipment used to avoid radio frequency problems", will provide useful information on the connection between several radiocommunication equipment.

Annexe N, "Radiocommunication in confined spaces", applies particularly to equipment intended to be operated in tunnels and confined spaces.

The design principle, the installation rules, the specification calculation described in the EG 200 053 are to be considered and taken into account.

4.3.2 Frequency error

4.3.2.1 Definition

The frequency error is defined in EN 300 086-1 [1], clause 7.1.

4.3.2.2 Limit

The frequency error shall not exceed the limits defined in EN 300 086-1 [1], clause 7.1.3 (base station limit) under normal and extreme test conditions.

4.3.2.3 Conformance

Conformance tests as defined in clause 5.3.1 of this document shall be carried out.

4.3.3 Adjacent and alternate channel power

4.3.3.1 Definition

The adjacent and alternate channel power is defined in EN 300 086-1 [1], clause 7.5.

4.3.3.2 Limit

The adjacent and alternate channel power shall not exceed the limits defined in EN 300 086-1 [1], clause 7.5.3 under normal test conditions.

4.3.3.3 Conformance

Conformance tests as defined in clause 5.3.2 of this document shall be carried out.

4.3.4 TX intermodulation products

4.3.4.1 Definition

The TX intermodulation products are the power levels of intermodulation components. It is a measure of the capability of the repeater to inhibit the generation of signals in its non-linear elements caused by the presence of the useful carrier and an interfering signal reaching the repeater via its antenna.

4.3.4.2 Limits

Under normal test conditions, the intermodulation attenuation ratio shall be at least 60 dB.

In any case no requirement less than -36 dBm shall apply to intermodulation components.

4.3.4.3 Conformance

Conformance tests as defined in clause 5.3.3 of this document shall be carried out.

4.3.5 Spurious emissions and Wideband noise

4.3.5.1 Definition

Spurious emissions are defined as conducted and radiated emissions at frequencies outside the allocated channel.

4.3.5.2 Limits

The spurious emission and the wideband noise shall not exceed the limits defined in TS 101 789-1 [3], clause 5.5.1.3.

4.3.5.3 Conformance

Conformance tests as defined in clause 5.3.4 of this document shall be carried out.

4.3.6 Out of band gain

4.3.6.1 Definition

Out of band gain refers to the nominal gain of the repeater outside the declared transmit bands.

4.3.6.2 Limits

The out of band gain shall not exceed the limits defined in TS 101 789-1 [3], clause 5.5.3.3.

4.3.6.3 Conformance

Conformance tests as defined in clause 5.3.5 of this document shall be carried out.

5 Testing for compliance with technical requirements

5.1 Environmental conditions for testing

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

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

5.1.1 Normal and extreme test conditions

Measurements shall be made under normal test conditions, and also, where stated, under extreme test conditions.

The test conditions and procedures shall be as specified in EN 300 086-1 [1], clauses 5.3 to 5.5.

5.1.2 Test power source

The test power source shall meet the requirements of EN 300 086-1 [1], clause 5.2.

5.1.3 Nominal input test signal

The nominal input test signal (applied to the input of the repeater) is a modulated test signal (the modulation frequency shall be 1250 Hz and the resultant frequency deviation shall be 12 % of the channel separation (e.g. 10 kHz, 12.5 kHz, 20 kHz, 25 kHz) where the level is adjusted to produce a nominal output power level (measured at the output of the repeater) as defined by the manufacturer.

5.1.4 Choice of samples for test suites

Measurement shall be performed, according to the present document, on samples of equipment defined in EN 300 086-1 [1], clause 4.1.

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 compared to the corresponding limit shall 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 value of the measurement uncertainty shall be, for each measurement, equal to or lower than the figures given in clause 10 (table 13) in EN 300 086-1 [1].

For the test methods, according to the present document, the measurement uncertainty figures shall be calculated in accordance with TR 100 028 [1] and shall correspond to an expansion factor (coverage factor) k = 1,96 or k = 2 (which provide confidence levels of 95 % respectively 95,45 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian)).

The particular expansion factor used for the evaluation of the measurement uncertainty shall be stated.

The absolute measurement uncertainties are given in clause 10 (table 13) in EN 300 086-1[1].

5.3 Essential requirements

Essential requirement referred to article 7 paragraph 2 of TIO [l.2] (or article 3.2 of RED Directive [i.1]). The following requirements are relevant to the presumption of conformity.

5.3.1 Frequency error

The frequency error shall be measured to determine the difference between the measured carrier frequency in the absence of modulation and the nominal frequency of the transmitter.

This test applies only to frequency changing repeaters.

The measurements specified in EN 300 086-1 [1], clause 7.1.2 shall be carried out.

5.3.2 Adjacent and alternate channel power

The adjacent and alternate channel power shall be measured to determine the part of the total power output of a repeater under defined conditions of a modulated input signal, which falls within a specified pass-band centred on the nominal frequency of either of the adjacent and alternate channels. This power is the sum of the mean power produced by the modulation, hum and noise of the repeater.

This test applies only to channel selective repeaters.

The repeater shall be set to maximum gain. The measurements specified in EN 300 086-1 [1], clause 7.5.2 shall be carried out. The input test signal for this test shall be as defined in according NT-3002, clause 5.1.3.

5.3.3 Intermodulation attenuation

This test shall be used to verify that the level of intermodulation products, generated in non-linear elements of the repeater, in the presence of two RF input signals, do not exceed the specified limits.

This requirement applies to all types of repeaters.

The repeater shall be set to maximum gain. Two continuous sinusoidal RF signals shall be fed to the input antenna port of the repeater using a combining device. The frequencies of both RF signals shall be within the repeater's operating band. The spacing between both RF signals shall be lower than the declared operational frequency band of the repeater (e.g. 500 kHz). This spacing should be chosen according the one that is awaited in service mode. The input signals and resulting third order product shall be within the declared operational frequency band of the repeater.

The level of both RF input signals shall be increased simultaneously, until the maximum rated output power, as declared by the manufacturer, is reached.

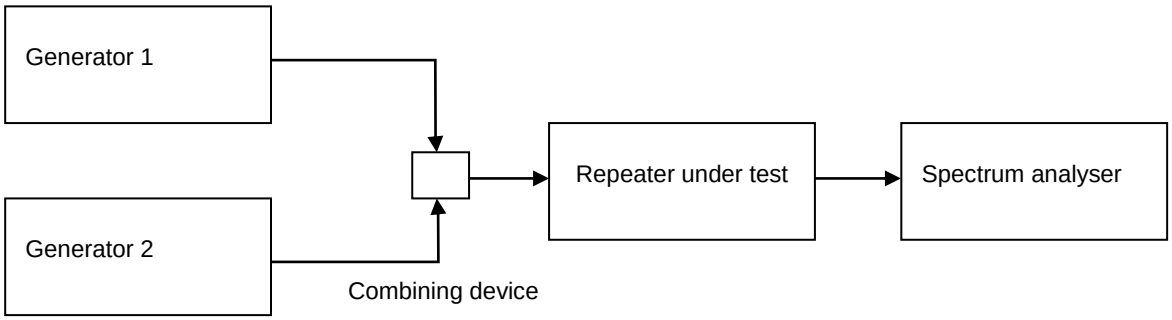
In case of a repeater only supporting one channel, one RF input signal shall be set to the operating frequency and the other RF input signal at an offset of 100 kHz to either side successively. In this case the input signal at the repeaters operating frequency shall be increased, until the maximum rated output power per channel, as declared by the manufacturer, is reached. The second signal shall be set to the same input level.

The level of the third order intermodulation products shall be measured by means of a selective measurement device presenting to the repeater a load with an impedance of 50 Ω.

The test shall be repeated with both RF input signals increased by 10 dB each.

NOTE: In this case, the automatic gain (level) control may reduce the gain to a value less than maximum gain in order to keep the maximum rated output power per channel, as declared by the manufacturer. An average power measurement shall be performed using a bandwidth of 3 kHz.

The measurements shall be performed on all antenna ports of the repeater.



5.3.4 Spurious emissions and Wideband noise

The purpose of this test is to establish the level of conducted spurious emissions and wideband noise at the antenna ports and the effective power of spurious emissions radiated by the cabinet and structure.

This requirement applies to all types of repeaters.

The measurements specified in TS 101 789-1 [3], clause 5.5.1 shall be carried out under normal test conditions. Measurement bandwidths shall be as indicated in table 1 and 2:

Table 1: Reference bandwidths to be used for the measurement of spurious radiations

Frequency range	RBW
9 kHz to 150 kHz	1 kHz
150 kHz to 30 MHz	10 kHz
30 MHz to 1 GHz	100 kHz
1 GHz to 12,75 GHz	1 MHz

Table 2: Reference bandwidth to be used for the measurement of wideband noise

Frequency range	RBW
all frequencies	25 kHz (30 kHz)

5.3.5 Out of band gain

To test the net gain of the repeater outside the declared transmit frequency band. This test shall also be used to check the net gain at harmonic frequencies.

This requirement applies to all types of repeaters.

The measurements specified in TS 101 789-1 [3], clause 5.5.3 shall be carried out, under normal test conditions.

6 Repealed documents

NT-3002 V1.0.0
NT-3002 V1.1.0
NT-3002 V1.2.0

Biel/Bienne, 30.08.2016

Federal Office of Communications

Philipp Metzger
Director

Annex A (normative): Requirements and conformance test specifications table

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

- it provides a statement of 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 provides a statement of all the test procedures corresponding to those essential requirements 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;

Table A.1: Requirements and conformance Test specifications Table

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

Requirement			**Requirement Conditionality**		**Test Specification**
No	**Description**	**Reference: Clause No**	**U/C**	**Condition**	**Reference: Clause No**
1	Frequency error.	4.3.2	C	Applies only to frequency changing repeaters.	5.3.1
2	Adjacent and alternate channels power.	4.3.4	C	Applies only to channel selective repeaters.	5.3.2
3	TX intermodulation products.	4.3.4	U		5.3.3
4	Spurious emissions and Wideband noise.	4.3.5	U		5.3.4
5	Out of band gain.	4.3.6	U		5.3.6

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 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 to be *unconditionally* applicable (U) or is *conditional* upon the manufacturers 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 "conditional".

Test Specification:

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.