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**TETRA radio equipment using non-constant envelope  
modulation operating in a channel bandwidth  
of 25 kHz, 50 kHz, 100 kHz or 150 kHz;  
Harmonised Standard for access to radio spectrum**

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## Foreword

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

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.6] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.2].

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.

Proposed national transposition dates	
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## Modal verbs terminology

In the present document "**shall**", "**shall not**", "**should**", "**should not**", "**may**", "**need not**", "**will**", "**will not**", "**can**" and "**cannot**" are to be interpreted as described in clause 3.2 of the [ETSI Drafting Rules](#) (Verbal forms for the expression of provisions).

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# 1 Scope

The present document specifies the technical requirements and methods of measurements for TETRA radio transmitters and receivers used in stations and technical requirements and methods of measurements for TMO repeater in the Private Mobile Radio (PMR) service.

It applies to use in the land mobile service, operating on radio frequencies between 137 MHz and 1 GHz, with channel separations of 25 kHz, 50 kHz, 100 kHz and 150 kHz.

**Table 1: Radiocommunications service frequency bands**

	<b>Radiocommunications service frequency bands</b>
Transmit	137 MHz to 1 000 MHz
Receive	137 MHz to 1 000 MHz

It applies to equipment for continuous and/or discontinuous transmission of data and/or digital speech.

The equipment (base station and mobile station) comprises a transmitter and associated encoder and modulator and/or a receiver and associated demodulator and decoder.

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

- base station (equipment fitted with an antenna connector, intended for use in a fixed location);
- mobile station (equipment fitted with an antenna connector, normally used in a vehicle or as a transportable);
- TMO Repeater; and
- those hand portable stations:
  - a) fitted with an antenna connector; or
  - b) without an external antenna connector (integral antenna equipment), but fitted with a permanent internal or a temporary internal 50  $\Omega$  Radio Frequency (RF) connector which allows access to the transmitter output and the receiver input.

Hand portable equipment without an external or internal RF connector and without the possibility of having a temporary internal 50  $\Omega$  RF connector is not covered by the present document.

NOTE: The relationship between the present document and essential requirements of article 3.2 of Directive 2014/53/EU [i.2] 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.

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

- [1] Recommendation ITU-T O.153 (10-1992): "Basic parameters for the measurement of error performance at bit rates below the primary rate".



- [2] IEEE/ANSI C63.5 (2017): "American National Standard for Electromagnetic Compatibility -- Radiated Emission Measurements in Electromagnetic Interference (EMI) Control -- Calibration and Qualification of Antennas (9 kHz to 40 GHz)".
- [3] ETSI EN 300 392-2 (V3.8.1) (08-2016): "Terrestrial Trunked Radio (TETRA); Voice plus Data (V+D); Part 2: Air Interface (AI)".

## 2.2 Informative references

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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] CEPT/ERC/REC 74-01 (2019): "Unwanted Emissions in the Spurious domain".
- [i.2] 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.

NOTE: Article 3.2 and article 10.8.

- [i.3] ETSI TS 101 789-1 (V1.1.2): "Terrestrial Trunked Radio (TETRA); TMO Repeaters; Part 1: Requirements, test methods and limits".
- [i.4] ETSI EN 300 394-1 (V3.3.1) (04-2015): "Terrestrial Trunked Radio (TETRA); Conformance testing specification; Part 1: Radio".
- [i.5] ETSI EN 303 035-1 (V1.2.1) (12-2001): "Terrestrial Trunked Radio (TETRA); Harmonized EN for TETRA equipment covering essential requirements under article 3.2 of the R&TTE Directive; Part 1: Voice plus Data (V+D)".
- [i.6] Commission Implementing Decision C(2015) 5376 final of 4.8.2015 on a standardisation request to the European Committee for Electrotechnical Standardisation and to the European Telecommunications Standards Institute as regards radio equipment in support of Directive 2014/53/EU of the European Parliament and of the Council.
- [i.7] ETSI EN 300 793 (V1.1.1) (02-1998): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Land mobile service; Presentation of equipment for type testing".
- [i.8] ETSI TR 102 273 (V1.2.1) (12-2001) (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Improvement on Radiated Methods of Measurement (using test site) and evaluation of the corresponding measurement uncertainties".
- [i.9] ETSI EG 203 336 (V1.2.1) (05-2020): "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".

## 3 Definition of terms, symbols and abbreviations

### 3.1 Terms

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

**base station:** equipment fitted with an antenna connector, for use with an external antenna, and intended for use in a fixed location

**bit:** binary digit

**block:** smallest quantity of information that is sent over the radio channel

NOTE: A constant number of useful bits are always sent together with the corresponding redundancy bits.

**broadband repeater:** repeater which is designed for operation on any combination of carriers (up to a specified maximum number) within the operating band of the repeater

**burst or transmission (physical):** one or several packets transmitted between power on and power off of a particular transmitter

**channelized repeater:** repeater which is designed for operation on a specified subset of carriers within the operating band of the repeater

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

**conducted measurements:** measurements which are made using direct 50  $\Omega$  connection to the equipment under test

**data transmission systems:** systems which transmit and/or receive data and/or digitized voice

**downlink:** signal path where base station transmits and mobile or hand portable station receives

**hand portable station:** equipment either fitted with an antenna connector or integral antenna, or both, normally used on a stand-alone basis, to be carried on a person or held in the hand

NOTE: Test limits specified for MS within the present document apply to mobile stations and handportable stations.

**integral antenna:** antenna designed to be connected to the equipment without the use of a 50  $\Omega$  external connector and considered to be part of the equipment

NOTE: An integral antenna may be fitted internally or externally to the equipment.

**mobile station:** mobile equipment fitted with an antenna connector, for use with an external antenna, normally used in a vehicle or as a transportable station

NOTE: Test limits specified for MS within the present document apply to mobile stations and handportable stations.

**radiated measurements:** measurements which involve the absolute measurement of a radiated field

**receive band of the equipment:** maximum frequency range in accordance with the intended operation of the equipment over which the receiver can be operated without reprogramming or realignment

**spurious emissions:** unwanted emissions in the spurious domain

**testing laboratory:** laboratory that performs tests

**TMO Repeater:** bi-directional Radio Frequency (RF) amplifier which can amplify and transmit a received Mobile Station (MS) signal in the MS transmit band, simultaneously it can amplify and transmit a received Base Station (BS) RF signal in the BS transmit band

**transmit band of the equipment:** maximum frequency range in accordance with the intended operation of the equipment over which the transmitter can be operated without reprogramming or realignment

**Trunked Mode Operation (TMO):** mode of operation where a network is used for communication

**uplink:** signal path where mobile or hand portable station transmits and base station receives

## 3.2 Symbols

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

$\alpha$	Filter roll-off factor
dB	decibel
dBm	dB relative to 1 mW
dB $\mu$ V	dB relative to 1 $\mu$ V
$f_c$	channel centre frequency
$f_{lo}$	Local Oscillator frequency
$f_{rb}$	the frequency offset corresponding to the near edge of the receive band, or 5 MHz (10 MHz for frequencies above 520 MHz), whichever is greater
T1, T2, etc.	names of test signals defined in clause 6.3
$P_A$	average power
$V_{min}$	minimum extreme test Voltage
$V_{max}$	maximum extreme test Voltage
$T_{min}$	minimum extreme test Temperature
$T_{max}$	maximum extreme test Temperature
$\lambda$	wavelength


  
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## 3.3 Abbreviations

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

AACH	Access Assignment CHannel
AACH-Q	Access Assignment CHannel, QAM
AC	Alternating Current
ACP	Adjacent Channel Power
AGC	Automatic Gain Control
BCC	Base station Colour Code
BER	Bit Error Rate
BLCH	Base station Linearization CHannel
BNCH/T	Broadcast Network CHannel, Test mode
BSCH	Broadcast Synchronization CHannel
BS	Base Station
BW	BandWidth
CA	Conventional Access
CA MS	Conventional Access Mobile Station
CEPT	European Conference of Postal and Telecommunications administrations
CLCH	Common Linearization CHannel
CW	Continuous Wave
DA	Direct Access
DA MS	Direct Access Mobile Station
dBc	decibels relative to the transmitter power
DC	Direct Current
DMO	Direct Mode Operation
DQPSK	Differential Quadrature Phase Shift Keying
DTX	Discontinuous Transmission
EC	European Community
EFTA	European Free Trade Association
EUT	Equipment Under Test
FCB	Frequency Correction downlink Burst

FER	Frame Erasure Rate
IF	Intermediate Frequency
ITU-T	International Telecommunication Union - Telecommunication standardization sector
MCC	Mobile Country Code
MNC	Mobile Network Code
MS	Mobile Station
OATS	Open Area Test Site
PDU	Protocol Data Unit
PMR	Private Mobile Radio
ppm	parts per million
PQ	Power level of QAM burst
PRBS	Pseudo Random Bit Sequence
QAM	Quadrature Amplitude Modulation
RDC	Radio Downlink Counter
RF	Radio Frequency
rms	root mean square
Rx	Receiver
SCH/F	Signalling CHannel Full
SCH/HD	Signalling CHannel, Half size Downlink
SCH/HU	Signalling CHannel, Half size Uplink
SN-Q	Symbol Number in QAM
STCH	STealing CHannel
TCH/S	Traffic CHannel, Speech
TETRA	TErrestrial Trunked RAdio
TMO	Trunked Mode Operation
Tx	Transmitter
VSWR	Voltage Standing Wave Ratio
$\pi/4$ -DQPSK	$\pi/4$ -shifted Differential Quaternary Phase Shift Keying



## 4 General

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### 4.1 Testing

#### 4.1.1 Choice of model for testing

##### 4.1.1.1 General

One or more samples of the equipment shall be provided, as appropriate for testing. Stand-alone equipment shall be complete with any ancillary equipment needed for testing.

If an equipment has several optional features, considered not to affect the RF parameters, then the tests need only be performed on the equipment configured with the combination of features considered to be the most complex. Where practicable, equipment to be tested shall provide a 50  $\Omega$  connector for conducted RF power level measurements.

In the case of integral antenna equipment, if the equipment does not have an internal permanent 50  $\Omega$  connector then it is permissible to use a second sample of the equipment with a temporary antenna connector fitted to facilitate testing. Any such modified sample shall not be used for any radiated measurements, except as noted in clause 5.5.4.

The performance of the equipment to be tested shall be representative of the performance of the corresponding production model.

##### 4.1.1.2 Auxiliary test equipment

All necessary test signal sources, setting up instructions and other product information shall be made available with the equipment to be tested.

## 4.1.2 Presentation of equipment for testing purposes

The radio tests shall be performed on one or more frequency channels selected from the lowest 5, the highest 5 and/or the middle 5 radio frequency channels of either the transmit or receive band of the equipment, whichever is appropriate, according to the test requirements of the clauses of the present document.

NOTE: Permitting a selection from a range of five channels in each case is intended to allow any interference effects at spot frequencies in the measurement arrangement to be avoided.

The frequency ranges, the range of operating conditions and power requirements as applicable, shall be in accordance with the intended use of the equipment to establish the appropriate test conditions. For BS and MS equipment information related to radio sub-system of equipment includes the transmit and receive frequency bands, first local oscillator frequency and intermediate frequencies of the receiver.

All requirements applicable to mobile stations within the present document also apply to handportable stations.

Additionally, technical documentation and operating manuals, sufficient to make the test, shall be supplied. All necessary setting up instructions and other product information shall be made available with the equipment to be tested, in accordance with article 10.8 of Directive 2014/53/EU [i.2].

For TMO Repeater Equipment the intended use of the equipment shall include:

- a) the operating band or bands of the repeater;
- b) the maximum rated output power per channel;
- c) the number of channels supported by the repeater.

Guidance on the presentation of equipment is also given in ETSI EN 300 793 [i.7].

## 4.2 Mechanical and electrical design

### 4.2.1 Transmitter shut-off facility

When a timer for an automatic shut-off facility is operative, at the moment of the time-out the transmitter shall automatically be switched off (the re-activation of the transmitter shall reset the timer).

A shut-off facility shall be inoperative for the duration of the measurements unless it has to remain operative to protect the equipment. If the shut-off facility is left operative the status of the equipment shall be indicated.

## 4.3 Measuring continuous mode equipment

In the case of measurements performed on equipment designed to operate only in continuous mode, requirements such as "equipment shall be set in continuous mode" shall be interpreted as "equipment shall be used in its normal transmission mode (in this case, the continuous mode)".

## 4.4 Measuring discontinuous mode equipment

When it is specified that the transmission shall be continuous for the duration of the measurement(s), the transmitter under test shall be set to operate in continuous mode. If this is not possible, the measurements shall be carried out in a period shorter than the duration of the transmitted burst. It may be necessary to extend the duration of the burst.

When measurements are made in discontinuous mode, the reported values can be average values. This averaging shall be made using a set of measurements, each of these measurements being made during a burst or a part of it.

## 4.5 Equipment supporting more than one channel bandwidth

In the case of equipment supporting more than one channel bandwidth, measurements shall be performed on each channel bandwidth implemented.

## 4.6 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.

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# 5 Test conditions, power sources and ambient temperatures

## 5.1 Normal and extreme test conditions

Testing shall be performed under normal test conditions, and also, where stated, under extreme test conditions.

The test conditions and procedures shall be as specified in clauses 5.2 to 5.5.

## 5.2 Test power source

During testing the power source of the equipment shall be replaced by a test power source capable of producing normal and extreme test voltages as specified in clauses 5.3.2 and 5.4.2. The internal impedance of the test power source shall be low enough for its effect on the test results to be negligible. For the purpose of tests, the voltage of the power source shall be measured at the input terminals of the equipment.

For battery operated equipment the battery shall be removed and the test power source shall be applied as close to the battery terminals as practicable.

During tests of DC powered equipment the voltage at the input terminals of the equipment shall be maintained within a tolerance of  $< \pm 1$  % relative to the voltage at the beginning of each test. The value of this tolerance is critical for power measurements. Using a smaller tolerance will provide better measurement uncertainty values.

## 5.3 Normal test conditions

### 5.3.1 Normal temperature and humidity

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

- temperature:  $+15$  °C to  $+35$  °C;
- relative humidity: 20 % to 75 %.

When it is impracticable to carry out the tests under these conditions, a note to this effect, stating the ambient temperature and relative humidity during the tests, shall be added to the test report.

### 5.3.2 Normal test power source

#### 5.3.2.1 Mains voltage

The normal test voltage for equipment to be connected to the mains 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 frequency of the test power source corresponding to the AC mains shall be between 49 Hz and 51 Hz.

### 5.3.2.2 Regulated lead-acid battery power sources used on vehicles

When the radio equipment is intended for operation from the usual types of regulated lead-acid battery power source used on vehicles the normal test voltage shall be 1,1 times the nominal voltage of the battery (for nominal voltages of 6 V and 12 V, these are 6,6 V and 13,2 V respectively).

### 5.3.2.3 Other power sources

For operation from other power sources or types of battery (primary or secondary), the normal test voltage shall be that appropriate for the intended use of the equipment.

## 5.4 Extreme test conditions

### 5.4.1 Extreme temperatures

For tests at extreme temperatures, measurements shall be made in accordance with the procedures specified in clause 5.5, at the upper and lower temperatures shall be as follows:

- the lower temperature shall be -20 °C except for BS and TMO repeater equipment where the lowest intended operational temperature of the BS/repeater shall apply if this is higher than -20 °C;
- the upper temperature shall be +55 °C except for BS and TMO repeater equipment where the highest intended operational temperature of the BS/repeater shall apply if this is lower than +55 °C.

In the case of base stations and TMO repeater equipment, the conditions for the intended installation of the equipment shall be used.

### 5.4.2 Extreme test source voltages

#### 5.4.2.1 Mains voltage

The extreme test voltage for equipment to be connected to an AC mains source shall be the nominal mains voltage  $\pm 10\%$ .

#### 5.4.2.2 Regulated lead-acid battery power sources used on vehicles

When the equipment is intended for operation from the usual types of regulated lead-acid battery power sources used on vehicles the extreme test voltages shall be 1,3 and 0,9 times the nominal voltage of the battery (for a nominal voltage of 6 V, these are 7,8 V and 5,4 V respectively and for a nominal voltage of 12 V, these are 15,6 V and 10,8 V respectively).

#### 5.4.2.3 Power sources using other types of batteries

The lower extreme test voltages for equipment with power sources using batteries shall be as follows:

- for the nickel metal-hydrate, leclanché or lithium type: 0,85 times the nominal battery voltage;
- for the mercury or nickel-cadmium type: 0,9 times the nominal battery voltage.

No upper extreme test voltages apply.

In the case where no upper extreme test voltage is applicable, the corresponding four extreme test conditions are:

- $V_{\min}/T_{\min}$ ,  $V_{\min}/T_{\max}$ ;
- $(V_{\max} = \text{nominal})/T_{\min}$ ,  $(V_{\max} = \text{nominal})/T_{\max}$ .

#### 5.4.2.4 Other power sources

For equipment using other power sources, or capable of being operated from a variety of power sources, the extreme test voltages shall be those in accordance with the intended use of the equipment.