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Digital Terrestrial TV Broadcast Receivers;
Harmonised Standard for access to radio spectrum

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Contents

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Foreword

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

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.11] 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.3].

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

The present document has a number of interference test data files that are contained in archive en_303340v010201p0.zip which accompanies the present document.

National transposition dates	
Date of adoption of this EN:	23 September 2020
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Date of latest publication of new National Standard or endorsement of this EN (dop/e):	30 June 2021
Date of withdrawal of any conflicting National Standard (dow):	30 June 2022

Modal verbs terminology

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

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

1 Scope

The present document specifies technical characteristics and methods of measurements for digital terrestrial television broadcast receivers fitted with an external antenna input (tuner port) capable of receiving DVB-T and/or DVB-T2 signals.

Receivers without external antenna connectors, receivers with diversity, and receivers intended for mobile or automotive reception are 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.3] is given in annex A.

The present document includes considerations of interference from LTE transmissions in the 700 MHz and 800 MHz bands and DTT transmissions in UHF band IV. The requirements of the installation system (antenna, feeder cable, amplifiers, etc.) are not addressed.

Table 1: Broadcast frequency bands

Broadcast frequency bands
VHF III
UHF IV and V

There are country specific variations of frequency usage for digital terrestrial television reception and other users such as mobile broadband.

The tests in the present document only apply if the DTT broadcast receiver supports the wanted signal configuration used by the test in question. The applicable tests are summarized in annex E, table E.1.

2 References

2.1 Normative references

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

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

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

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

Not applicable.

2.2 Informative references

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

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

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

[i.1] Nordig: "NorDig Unified Test Plan for Integrated Receiver Decoders v2.4".

[i.2] British Broadcasting Corporation and Arqiva, WHP288: "WSD Coexistence Testing at the Building Research Establishment: An Experimental Validation of Ofcom Regulatory Proposals".

[i.3] Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC.

[i.4] ETSI EN 300 744 (V1.6.1): "Digital Video Broadcasting (DVB); Framing structure, channel coding and modulation for digital terrestrial television".

[i.5] ETSI EN 302 755 (V1.3.1): "Digital Video Broadcasting (DVB); Frame structure channel coding and modulation for a second generation digital terrestrial television broadcasting system (DVB-T2)".

[i.6] Void.

[i.7] Void.

[i.8] Void.

[i.9] ECC Report 186 (2013): "Technical and operational requirements for the operation of white space devices under geo-location approach".

[i.10] Recommendation ITU-R BT.1729 (2005): "Common 16:9 or 4:3 aspect ratio digital television reference test pattern".

[i.11] 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.12] Recommendation ITU-R BT.419-3 (1990): "Directivity and polarization discrimination of antennas in the reception of television broadcasting".

3 Definition of terms, symbols and abbreviations

3.1 Terms

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

Adjacent Channel Leakage power Ratio (ACLR): ratio of the on-channel transmit power to the power measured in one of the adjacent channels with no active channel in the adjacent channel

NOTE: In the present document this definition also applies to an unwanted signal at a specified frequency offset in a non-adjacent channel.

Adjacent Channel Selectivity (ACS): measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted signal which differs in frequency from the wanted signal by an amount equal to the adjacent channel separation for which the equipment is intended

NOTE 1: In the present document adjacent channel selectivity is determined by the onset of picture degradation.

NOTE 2: The interference power I is equal to the licensed power of the interferer. This definition does not have the same meaning as the term "Adjacent Channel Selectivity" (ACS) used in other organizations such as ITU, CEPT, and in co-existence studies. The adjacent channel selectivity in the present document is equivalent to the measured I/C ratio.

NOTE 3: In the present document this definition also applies to an unwanted signal at a specified frequency offset in a non-adjacent channel.

blocking or desensitization: measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted signal at any frequency other than those of the spurious responses or of the adjacent channels

NOTE 1: In the present document receiver blocking is determined by the onset of picture degradation.

NOTE 2: The wanted signal level in the blocking tests of the present document is set at the specified receiver sensitivity level plus 6 dB.

broadcast receiver: digital terrestrial television broadcast receiver comprising of at least a tuner and demodulator

broadcast receiver tuner port: DTT receiver tuner RF input connector

licensed power: highest rms power of the active portions of the signal measured over a specific time period

NOTE: In the case of interference power measurements, this is the reference power used for I/C calculations in the present document. Typically for cases of LTE interference, this power is measured with a spectrum analyser in zero span with a gated power measurement function and rms detector over a period equal to an LTE symbol time. Alternatively it can be calculated by measuring the long term rms power and adding the appropriate LAPR from table 5.

long term rms power: rms power of the signal measured over a period long enough to smooth out any fluctuations in the signal power over time such as those due to transmission bursts

NOTE: This can be measured on an average power meter with an input filter time constant set high enough to average out fluctuations in the measured signal power or alternatively using a spectrum analyser with settings shown in table D.1.

onset of picture degradation: minimum time between successive errors in the displayed video is 15 seconds

radio equipment: product or relevant component thereof capable of communication by means of the emission and/or reception of radio waves utilizing the spectrum allocated to terrestrial/space radio communication

NOTE: For the purposes of the present document the radio equipment is a digital terrestrial television broadcast receiver comprising of at least a tuner and demodulator.

receiver overloading: interfering signal level expressed in dBm, above which the receiver begins to lose its ability to discriminate against interfering signals at frequencies differing from that of the wanted signal due to the onset of strong non-linear behaviour

NOTE 1: In the present document the overload level is determined by the onset of picture degradation.

NOTE 2: Above the overloading level the receiver will behave in a non-linear way, but does not necessarily fail immediately depending on the receiver and interference characteristics.

sensitivity: maximum usable sensitivity is defined as the minimum receiver Radio Frequency (RF) input signal level or field strength able to produce a specified analogue SINAD ratio or Bit Error Ratio (BER), or other specified output performance which depends on this input signal level

NOTE: In the present document receiver sensitivity is determined by the onset of picture degradation.

3.2 Symbols

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

C	Wanted signal
G_C	Coupling Gain
I	Interferer signal
I_{lic}	Licensed power
I_{rms}	Long term rms power
P_{RX_UE}	Received UE interference power
P_{UE}	UE transmitted power

3.3 Abbreviations

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

256-QAM	256-ary Quadrature Amplitude Modulation
64-QAM	64-ary Quadrature Amplitude Modulation
ACE	Active Constellation Extension
ACLR	Adjacent Channel Leakage power Ratio
ACS	Adjacent Channel Selectivity
AGC	Automatic Gain Control
AWGN	Additive White Gaussian Noise
BER	Bit Error Ratio
BS	Base Station for mobile communications
CEPT	European Conference of Postal and Telecommunications administrations
DTG	UK Digital TV Group
DTT	Digital Terrestrial Television
DVB-T	Digital Video Broadcast Terrestrial - first generation

NOTE: See ETSI EN 300 744 [i.4].

DVB-T2	Digital Video Broadcast Terrestrial - second generation

NOTE: See ETSI EN 302 755 [i.5].

EFTA	European Free Trade Association
FEC	Forward Error Correction
FEF	Future Extension Frame
FFT	Fast Fourier Transform
HEM	High Efficiency Mode
ISSY	Input Stream SYnchronizer
LAPR	Licensed to Average Power Ratio

NOTE: This is the ratio of the licensed power (described above) to the long term rms power (described above) of the signal.

LDPC	Low Density Parity Check (codes)
LTE	Long Term Evolution
PAPR	Peak to Average Power Ratio
PLP	Physical Layer Pipe
QAM	Quadrature Amplitude Modulation
RF	Radio Frequency
SINAD	(Signal + Noise + Distortion)/(Noise + Distortion) ratio
SISO	Single Input Single Output

NOTE: Meaning one transmitting and one receiving antenna.

TFS	Time-Frequency Slicing
UE	User Equipment for mobile communications

NOTE: Example handsets, dongles, etc.

UHF	Ultra High Frequency
VHF	Very High Frequency

4 Technical requirements specifications

4.1 Environmental profile

The technical requirements of the present document apply under the environmental profile for operation of the equipment, which shall be in accordance with its intended use. 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.

NOTE: The applicability of the different tests as defined in annex E may vary depending upon the selected country profile.

4.2 Conformance requirements

4.2.1 DVB-T and DVB-T2 configurations for testing

4.2.1.1 Modulation Parameters

Representative DVB-T and DVB-T2 configurations used for conformance specification and testing are shown in tables 2 and 3. These are used in the Nordig specification test plan [i.1].

Table 2: DVB-T configuration

Parameter	Value for "7 MHz" VHF tests	Value for "8 MHz" UHF tests
Bandwidth	6,66 MHz	7,61 MHz
FFT size	8K	8K
Modulation	64-QAM	64-QAM
Hierarchy	Non-Hierarchical	Non-Hierarchical
Guard interval	1/4	1/4
Code rate	2/3	2/3
Channel Bandwidth	7 MHz	8 MHz

Table 3: DVB-T2 configuration

Parameter	Value for "7 MHz" VHF tests	Value for "8 MHz" UHF tests
Bandwidth	6,66 MHz	7,77 MHz
FFT	32K	32K
Carrier mode	Normal	Extended
SISO/MISO	SISO	SISO
Guard Interval	1/16	1/16
Version	1.2.1	1.2.1
Number of symbols/frame (L_f)	42	62
Pilot pattern	PP4	PP4
TFS	No	No
FEF	Not used	Not used
Auxiliary streams	Not used	Not used
Subslices/T2 frame	1	1
Frames/Superframe	2	2
L1 post FEC type	16k LDPC (see note 1)	16k LDPC (see note 1)
L1 repetition	0	0
L1 post extension	No	No
L1 post modulation	64-QAM	64-QAM
L1 post scrambling	None	None
L1_ACE_MAX	0 (see note 2)	0 (see note 2)
L1 bias balancing cells	No	No
PAPR	L1-ACE & TR (see note 3)	L1-ACE & TR (see note 3)
PAPR: V_{clip}	3,1 V (see note 1)	3,1 V (see note 1)
PAPR: Number of iterations	10 (see note 1)	10 (see note 1)
TS bit rate (Mbit/s)	31,146	36,552

Parameter	Value for "7 MHz" VHF tests	Value for "8 MHz" UHF tests
Input mode	Mode A (single PLP mode)	Mode A (single PLP mode)
Number of PLPs	1	1
PLP type	Data type 1	Data type 1
Constellation rotation	Yes	Yes
PLP FEC type	64k LDPC	64k LDPC
FEC Frame length	64 800 (see note 4)	64 800 (see note 4)
Baseband Mode	High Efficiency Mode (HEM)	High Efficiency Mode (HEM)
ISSY	None	None
In band signalling	Disabled	Disabled
Null packet deletion	Disabled	Disabled
Time interleaver length	3	3
Frame interval	1	1
Time interleaver type	0	0
T2 frames/Interleaver frame	1 (see note 5)	1 (see note 5)
FEC Blocks/Interleaving Frame	132	200
Code rate	2/3	2/3
Modulation	256-QAM	256-QAM
NOTE 1: This parameter is preset on some modulators. NOTE 2: This value disables L1 ACE operation. NOTE 3: This parameter is referred to as "TR" on some modulators. NOTE 4: This parameter is referred to as "Normal" on some modulators. NOTE 5: Derived value shown for information only. Forced to 1 when time interleaver type = 0.		

4.2.1.2 Receiver Configuration

Some DTT receiver products may include an optional internal preamplifier between the antenna connector and the tuner. All tests in the present document shall be conducted with the optional preamplifier in the default shipping condition (ON or OFF).

4.2.2 Interference and wanted test signals

Three LTE waveforms with 10 MHz bandwidth are used in the present document as interference sources for the receiver conformance specification and tests. These waveforms are based on recordings from LTE BS and UE equipment which have been converted into a suitable format for replay on laboratory vector signal generators. Two of these waveforms have been selected because they are known to exercise the operation of DTT receiver Automatic Gain Control (AGC) systems which is a key area for receiver performance optimization. In particular tests using the UE waveform may require receiver optimization. These waveforms are contained in archive en_303340v010201p0.zip which accompanies the present document. More waveform details are given in annex B.

The wanted DVB-T and DVB-T2 test signals shall carry a video stream containing moving images and an audio signal. Recommendation ITU-R BT.1729 test signal [i.10] may be used.

4.2.3 Sensitivity

4.2.3.1 Definition

The maximum usable sensitivity is defined as the minimum receiver Radio Frequency (RF) input signal level or field strength able to produce a specified analogue SINAD ratio or Bit Error Ratio (BER), or other specified output performance which depends on this input signal level. In the present document receiver sensitivity is determined by the onset of picture degradation.

4.2.3.2 Method of Measurement

4.2.3.2.1 Test arrangement description

The test arrangement is shown in figure 1.

4.2.3.2.2 Test procedure

The steps of the test procedure are given below:

a) The wanted signal, provided by signal generator C, shall be set to the wanted signal frequency as shown in table 4 and configured with the appropriate DTT mode parameters (tables 2 and 3).

b) Determine the attenuation of the cables, splitters, 50/75 ohm matching pad.

c) Set the level of the wanted signal C at the broadcast receiver tuner port to -50 dBm and note the value of the "attenuator C" (= A_{C1}).

d) Tune the DTT receiver to the wanted channel.

e) Increase the "attenuator C" sufficiently to cause complete picture failure.

f) Adjust "attenuator C" gradually until the onset of picture degradation occurs. Force the receiver under test to re-acquire and re-adjust "attenuator C" until the onset of picture degradation occurs. Note the attenuator setting (= A_{C2}).

g) The receiver sensitivity shall be recorded in the measurement record (table C.1) as:

$$-50 - (A_{C2} - A_{C1}) \text{ dBm} \quad (1)$$

h) Repeat steps a) to g) for the remaining frequencies in table 4.

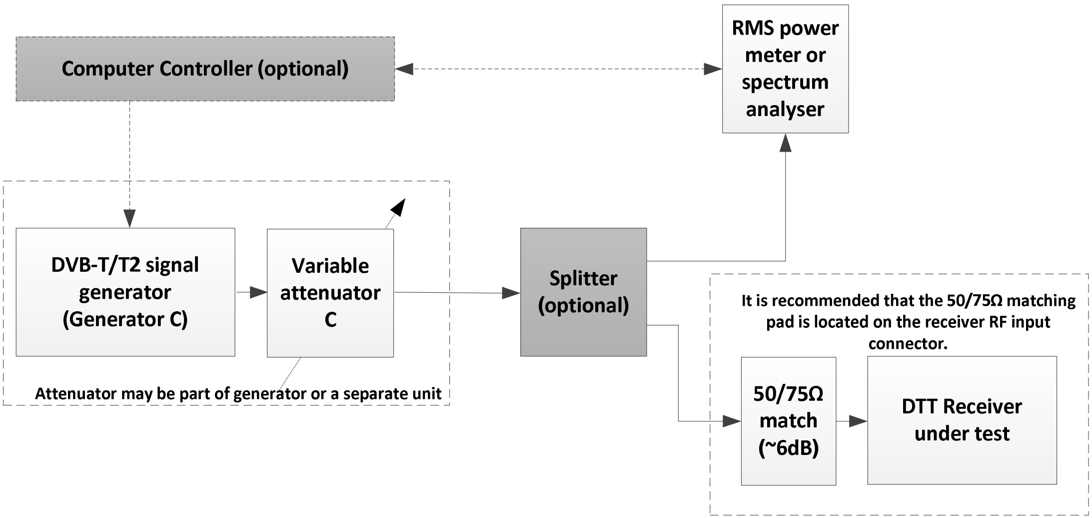

Figure 1: Measurement arrangement for sensitivity tests

4.2.3.3 Limits

The sensitivity limits which shall be met are shown in table 4. The equipment shall be tested in its normal operating mode.

Table 4: Receiver sensitivity

Test number	Test description	C wanted signal centre frequency (MHz)	Required sensitivity limit for DTT configurations in tables 2 and 3 (dBm)	
			DVB-T	DVB-T2
1	Sensitivity VHF	198,5	-77	-75
2	Sensitivity UHF	666	-77	-75
NOTE: For applicability of tests see annex E.				

4.2.4 Adjacent channel selectivity

4.2.4.1 Definition

In the present document, adjacent channel selectivity (I/C) is defined as the measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted signal which differs in frequency from the wanted signal by an amount equal to the adjacent channel separation for which the equipment is intended. In the present document adjacent channel selectivity is determined by the onset of picture degradation.

NOTE 1: The interference power I is equal to the licensed power of the interferer. This definition does not have the same meaning as the term "Adjacent Channel Selectivity" (ACS) used in other organizations such as ITU, CEPT, and in co-existence studies. The adjacent channel selectivity in the present document is equivalent to the measured I/C ratio.

NOTE 2: In the present document this definition also applies to an unwanted signal at a specified frequency offset in a non-adjacent channel.

4.2.4.2 Method of Measurement

4.2.4.2.1 Test arrangement description

The basic measurement arrangement is shown in the top half of figure 2. Other arrangements may also be used - for example a widely deployed test configuration shown at the bottom of figure 2 uses a single item of test equipment that combines generator C and generator I. Some signal generators include precision RF attenuators which can be used in place of "attenuator I" and "attenuator C". Some generators have an optimum output power level where the ACLR is at a maximum and in these circumstances it may be preferable to use external attenuators to maintain the optimum ACLR over the interference power level used for the test.

Additional information on the optional elements of the test arrangement, measurement techniques, recommended instrument settings are given in annex D.

4.2.4.2.2 Requirements for the ACLR of the interfering signal

See annex F.

4.2.4.2.3 Test procedure

a) Two signal generators, I and C, shall be connected to the receiver via a combining network.

b) Determine the attenuation of the cables, combiner, splitter and 50/75 ohm matching pad.

c) The wanted signal, provided by signal generator C, shall be set to the wanted signal frequency C as shown in table 5 and configured with the appropriate DTT mode parameters (tables 2 and 3). Turn this generator off (or to at least 30 dBc below the interferer signal) maintaining output impedance.

d) The unwanted signal I, provided by signal generator I, shall be configured with the required interferer waveform and interferer signal frequency as shown in table 5.

e) The unwanted signal power at the broadcast receiver tuner port shall be set to the rms interferer power I_{rms} in table 5. This power shall be verified with the power meter or spectrum analyser. Recommended instrument settings are described in clause D.2.

f) Turn on signal generator C and adjust "attenuator C" so that the rms powers of the interferer I and wanted signal C are equal. Note this attenuator setting (= A_{C1}).

g) Tune the DTT receiver to the wanted channel.

h) Increase "attenuator C" in 1 dB steps or less until the onset of picture degradation occurs (see clause 3.1 for definition). Force the receiver under test to re-acquire and re-adjust "attenuator C" until the onset of picture degradation occurs. Note the attenuator setting (= A_{C2}).

i) The adjacent channel selectivity (I/C) shall be recorded in the measurement record (table C.2) as A_{C2}-A_{C1} + LAPR dB, where LAPR is the licensed to average power ratio shown in table 5. Alternatively the measured wanted signal power C shall be recorded in the measurement record (table C.2) as I_{rms} - (A_{C2} - A_{C1}) dBm.

j) Repeat steps b) to i) for the remaining tests in table 5.

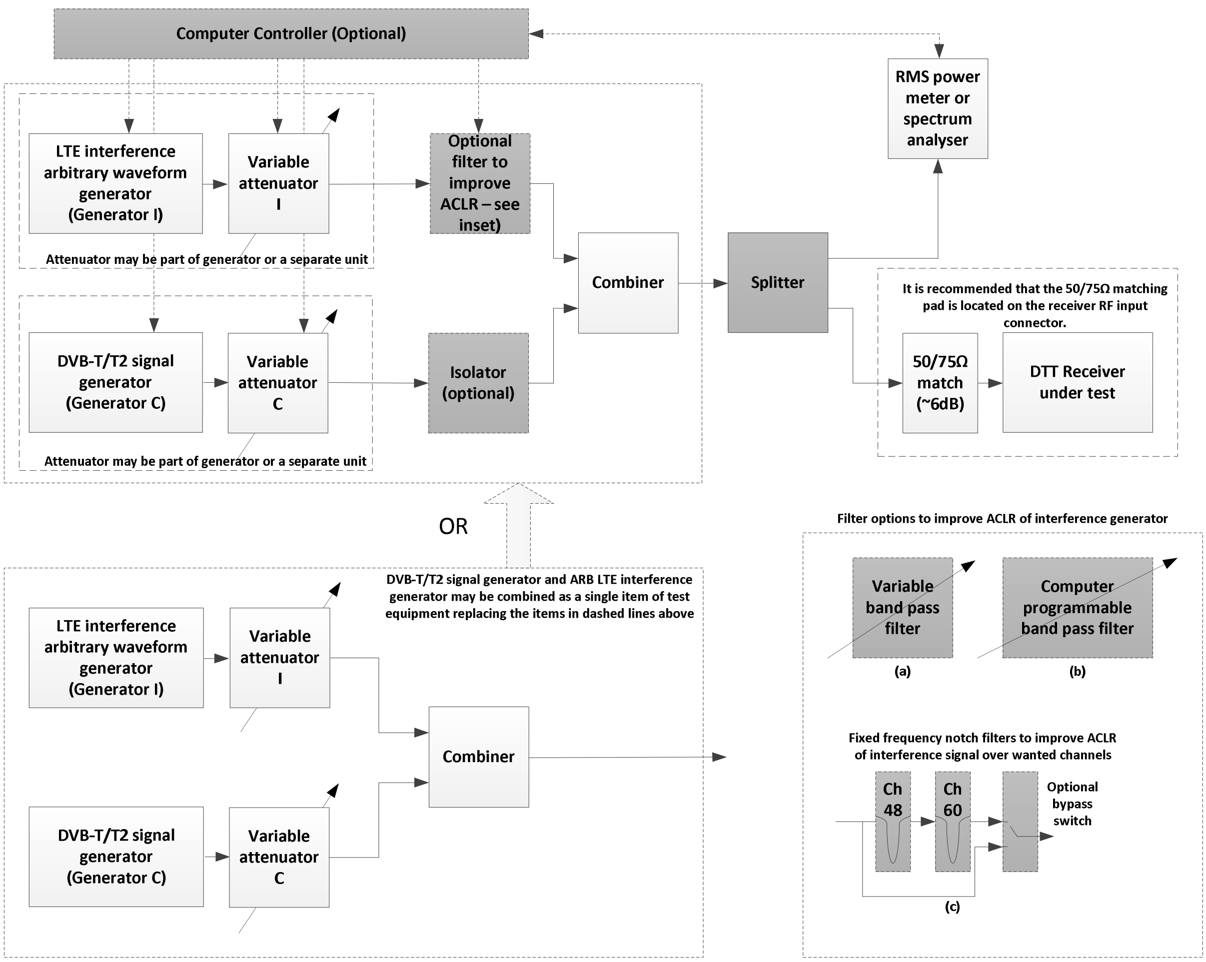

Figure 2: Generic measurement arrangement for adjacent channel selectivity, blocking and overloading tests

4.2.4.3 Limits

The I/C limits which shall be met are shown in table 5. The equipment shall be tested in its normal operating mode.

Table 5: Adjacent channel selectivity requirements

Test	Interferer (I) type	I interference test signal waveform name	C wanted signal centre frequency (MHz)	I interferer centre frequency (MHz)	I_{lic} (licensed) (dBm)	I_{rms} (rms) (dBm)	I LAPR (dB)	Minimum required I/C limit (where I = I_{lic}) for DTT configurations in tables 2 and 3 (dB)		Equivalent wanted level C_{rms} for DTT configurations in tables 2 and 3 (dBm)	
								DVB-T	DVB-T2	DVB-T	DVB-T2
1 (see notes 1 and 2)	10 MHz LTE 800 BS light load (near idle)	LTE_BS-idle_synth	786	796	-15	-23,3	8,3	35	36	-50	-51
2 (see note 2)	10 MHz LTE 700 BS light load (near idle)	LTE_BS-idle_synth	690	763 (see note 3)	-15	-23,3	8,3	43	43	-58	-58
3 (see note 2)	10 MHz LTE 700 UE Video-Stream	Short_UE-Video-Stream	690	708	-25	-42,7	17,7	33	38	-58	-63
4 (see note 2)	N-1 UHF	8 MHz DVB-T	482	474	-30	-30	0	25	25	-55	-55
5 (see note 2)	N+1 UHF	8 MHz DVB-T	482	490	-30	-30	0	25	25	-55	-55

NOTE 1: For broadcast receivers that do not receive DVB-T/T2 signals above 698 MHz, test 1 is not applicable.
NOTE 2: For applicability of tests see annex E.
NOTE 3: It is acceptable to use an alternative lower interference frequency such as 761 MHz. This may be necessary due to test equipment limitations.

4.2.5 Blocking

4.2.5.1 Definition

The measure of the capability of the receiver to receive a wanted modulated signal without exceeding a given degradation due to the presence of an unwanted signal at any frequency other than those of the spurious responses or of the adjacent channels. In the present document receiver blocking is determined by the onset of picture degradation.

NOTE: The wanted signal level in the blocking tests of the present document is fixed at the specified receiver sensitivity level plus 6 dB.

4.2.5.2 Method of Measurement

4.2.5.2.1 Test arrangement description

See clause 4.2.4.2.1.

4.2.5.2.2 Requirements for the ACLR of the interfering signal

See annex F.

The interference signal I is a fully loaded LTE-BS signal with 10 MHz channel bandwidth.

4.2.5.2.3 Test procedure

a) Two signal generators, I and C, shall be connected to the receiver via a combining network.

b) Determine the attenuation of the cables, combiner, splitter and 50/75 ohm matching pad.

c) The wanted signal, provided by signal generator C, shall be set to the wanted signal frequency as shown in table 6 and configured with the appropriate DTT mode parameters (tables 2 and 3).

d) The unwanted signal I, provided by signal generator I, shall be configured with the required interferer waveform, interferer signal frequency as shown in table 6.

e) Adjust "attenuator C" to set the wanted level to -40 dBm at the broadcast receiver tuner port. This power shall be verified with the power meter or spectrum analyser. Then reduce the wanted signal power to the value of C_{rms} in table 6 by increasing "attenuator C" by 31 dB for test 1 or by 29 dB for test 2.

f) Adjust "attenuator I" to set the interferer level to -40 dBm at the broadcast receiver tuner port. This power shall be verified with the power meter or spectrum analyser. Then reduce the interferer signal power to that of the wanted signal (C_{rms} in table 6) by increasing "attenuator I" by 31 dB for test 1 or by 29 dB for test 2. Note the value of "attenuator I" (= A_{I1}).

g) Tune the DTT receiver to the wanted channel.

h) Reduce "attenuator I" until the onset of picture degradation occurs (see clause 3.1 for terms). Force the receiver under test to re-acquire and re-adjust "attenuator I" until the onset of picture degradation occurs. Note the attenuator setting (= A_{I2}).

i) The blocking level shall be recorded in the measurement record (table C.3) as $C_{rms} + A_{I1} - A_{I2}$ dBm where C_{rms} is the value given in table 6.

4.2.5.3 Limits

The blocking limits which shall be met are shown in table 6. The equipment shall be tested in its normal operating mode.

Table 6: Blocking requirements

Test	Interferer (I) type	I interference test signal waveform name	C wanted signal centre frequency (MHz)	I centre frequency (MHz)	C_{rms} (rms) (dBm)	Required blocking level I_{rms} for DTT configurations in tables 2 and 3 (dBm)	
						DVB-T	DVB-T2
1 (see note 3)	10 MHz LTE 700 BS fully loaded	LTE_BS-100PC_synth	690	763 (see note 1)	-71 (see note 2)	-25	
2 (see note 3)	10 MHz LTE 700 BS fully loaded	LTE_BS-100PC_synth	690	763 (see note 1)	-69 (see note 2)		-25
NOTE 1: It is acceptable to use an alternative lower interference frequency such as 761 MHz subject to the limitations in the definition of blocking in the present document. This may be necessary due to test equipment limitations. NOTE 2: The values of C_{rms} are equal to the defined sensitivity specification + 6 dB. NOTE 3: For applicability of tests see annex E.							

4.2.6 Overloading

4.2.6.1 Definition

Overloading is the interfering signal level expressed in dBm, above which the receiver begins to lose its ability to discriminate against interfering signals at frequencies differing from that of the wanted signal due to the onset of strong non-linear behaviour. In the present document the overload level is determined by the onset of picture degradation.

NOTE: Above the overloading level the receiver will behave in a non-linear way, but does not necessarily fail immediately depending on the receiver and interference characteristics.

4.2.6.2 Method of Measurement

4.2.6.2.1 Test arrangement description

See clause 4.2.4.2.1.

4.2.6.2.2 Requirements for the ACLR of the interfering signal

See annex F.

The interference signal I is a fully loaded LTE-BS signal with 10 MHz channel bandwidth.

4.2.6.2.3 Test procedure

a) Two signal generators, I and C, shall be connected to the receiver via a combining network.

b) Determine the attenuation of the cables, combiner, splitter and 50/75 ohm matching pad.

c) The wanted signal, provided by signal generator C, shall be set to the wanted signal frequency as shown in table 7 and configured with the appropriate DTT mode parameters (tables 2 and 3).

d) The unwanted signal I, provided by signal generator I, shall be configured with the required interferer waveform, interferer signal frequency as shown in table 7.

e) Adjust "attenuator C" to set the wanted level to C_{rms} at the broadcast receiver tuner port. This power shall be verified with the power meter or spectrum analyser.

f) Adjust "attenuator I" to set the interferer level to same level as C_{rms} at the broadcast receiver tuner port. This power shall be verified with the power meter or spectrum analyser. Note the value of "attenuator I" (= A_{I1}).

g) Tune the DTT receiver to the wanted channel.

h) Reduce "attenuator I" until the onset of picture degradation occurs (see clause 3.1 for definition). Force the receiver under test to re-acquire and re-adjust "attenuator I" until the onset of picture degradation occurs. Note the attenuator setting (= A_{I2}).

i) The overload level shall be recorded in the measurement record (table C.4) as $C_{rms} + A_{I1} - A_{I2}$ dBm where C_{rms} is the value shown in table 7.

4.2.6.3 Limits

The required overloading limits which shall be met are shown in table 7.

Table 7: Overloading requirements

Test	Interferer (I) type	I interference test signal waveform name	C wanted signal centre frequency (MHz)	I centre frequency (MHz)	C_{rms} (rms) (dBm)	Required overload level I_{rms} for DTT configurations in tables 2 and 3 (dBm)	
						DVB-T	DVB-T2
1 Broadcast receivers with optional preamplifier (see notes 1, 2 and 4)	10 MHz LTE 700 BS fully loaded	LTE_BS-100PC_synth	690	763 (see note 1)	-35	-8	-8
2 Void							
3 Broadcast receivers without optional preamplifier (see notes 1, 2 and 4)	10 MHz LTE 700 BS fully loaded	LTE_BS-100PC_synth	690	763 (see note 1)	-35	-4	-4

NOTE 1: It is acceptable to test compliance at an alternative lower interference frequency (e.g. 761 MHz). This may be necessary due to test equipment limitations.
NOTE 2: For applicability of tests see annex E.
NOTE 3: Void.
NOTE 4: For the tests in the present table, "optional preamplifier" means an additional user controllable amplifier before the actual tuner IC device in the broadcast receiver, which may be available to the user and documented in the user documentation. The manufacturer shall declare the presence of an optional preamplifier in the declaration of conformity.

5 Testing for compliance with technical requirements

5.1 Environmental conditions for testing

The equipment shall be tested under normal test conditions according to the relevant product and basic standards or to the information accompanying the equipment, which are within the manufacturers declared range of humidity, temperature and supply voltage. The test conditions shall be recorded in the test report.

5.2 Void

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

The present document has been prepared under the Commission's standardisation request C(2015) 5376 final [i.11] 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.3].

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

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

Harmonised Standard ETSI EN 303 340					
Requirement				Requirement Conditionality	
No	Description	Essential requirements of Directive	Clause(s) of the present document	U/C	Condition
1	Receiver sensitivity	3.2	4.2.3	U	
2	Receiver adjacent channel selectivity	3.2	4.2.4	U	
3	Receiver blocking	3.2	4.2.5	U	
4	Receiver overloading	3.2	4.2.6	U	

Key to columns:

Requirement:

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

Description A textual reference to the requirement.

Essential requirements of Directive

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

Clause(s) of the present document

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

Requirement Conditionality:

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

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

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

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

Annex B (informative): Summary of study work

B.1 Overview

The present document focuses on the requirements to handle the most likely sources of interference to Digital Terrestrial Television (DTT) receivers following the first and second digital dividends. In particular the working group study has concentrated on stimulating good receiver behaviour in the presence of bursty interference signals, such as from LTE User Equipment (UE) which is important for the deployment of LTE 700 MHz services because the UE transmissions starting at 703 MHz (channel edge) are only 9 MHz away from the top edge of DTT channel 48 (694 MHz) (figure B.1). This can be compared to the LTE 800 MHz situation where the UE transmissions are separated from DTT channel 60 by 42 MHz (figure B.2).

The study has focused on fixed rooftop reception of DTT using standard antennas without amplification. Interference immunity specifications for external amplifiers such as mast head amplifiers, booster amplifiers, distribution amplifiers and amplified antennas used with portable receivers are outside the scope of the present document.

The result of the study is a specification including tests for receiver performance against interference from LTE 800 MHz BS, LTE 700 MHz BS, and LTE 700 MHz UE, using as interfering sources, representative bursty LTE waveforms based on recordings from LTE BS and UE equipment. These specifications were based on statistical analysis of 26 DTT receiver tests for LTE 700 MHz and 37 DTT receiver tests for LTE 800 MHz interference made on recent DVB-T/T2 receiver designs and tuner silicon. The receivers tested were dated between 2012 and 2015 and a high proportion of these receivers already conformed to existing DTG and Nordig specifications.

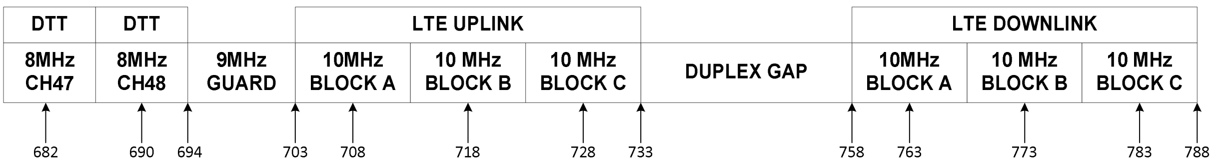

Figure B.1: Example spectrum plan for LTE 700 MHz

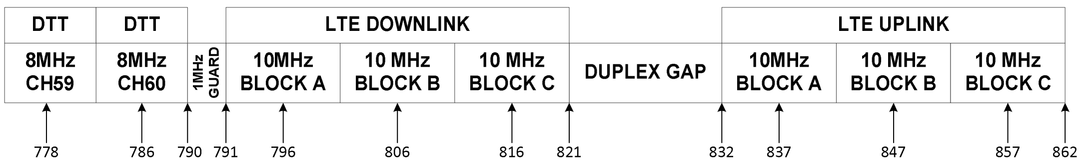

Figure B.2: Example spectrum plan for LTE 800 MHz

B.2 Selection of interferer waveforms

B.2.1 UE waveform

The LTE UE signal is typically more bursty than Base Station (BS) signals due to the likelihood of occasional transmitted bursts from a single user separated by long gaps, rather than frequent bursts (including regular pilot reference symbols) to multiple users from a BS. It is this bursty characteristic of the UE signal that can be particularly challenging to DTT receiver Automatic Gain Control (AGC) operation and this was identified as a potential area of receiver improvement that could be stimulated by setting appropriate conformance tests in the present document using a suitable UE interference signal.

Several different 10 MHz LTE UE signals with different traffic loads were recorded whilst connected to a live LTE 800 MHz network. These signals were replayed in laboratory tests at the most critical co-existence frequency of 708 MHz to measure the performance of a range of modern DTT receivers (up to 3 years old) operating on channel 48 (690 MHz) (9 MHz guard band). From those early tests the "short_UE-Video-Stream" waveform was selected as the most appropriate interferer signal for more extensive receiver testing for the following reasons:

- It was a signal representative of terminal traffic from a real video streaming application.
- It was a signal carried by a real mobile network LTE-800.
- It was a signal representative of that from modern 4G smart phones.
- It was a repetitive signal that could be truncated in a valid way to facilitate rapid testing (truncated to 1 second approximately).
- It was an LTE signal with particularly challenging characteristics for measured DTT receivers whose testing would lead to significant improvement in the presence of LTE interference.

The time domain plot of this waveform is shown in figure B.3. The regular bursts of activity are separated by one second gaps with some low level background traffic from the UE operating system.

The "short_UE-Video-Stream" waveform has been converted into a popular signal generator format for receiver testing purposes. The file header has been adjusted to display the licensed power rather than the rms power on the signal generator for convenience in testing.

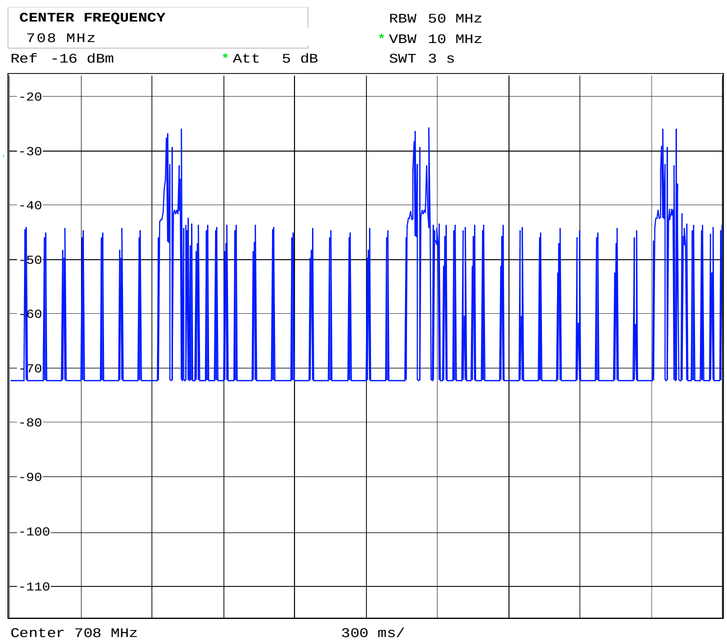

Figure B.3: Zero span plot of "short_UE-Video-Stream" waveform (1 second loop)

B.2.2 BS waveforms

For the base station tests, the "LTE_BS_idle_synth" waveform specified in the present document was synthesized from the existing so called "LTE_BS_idle" recorded waveform which is widely known to challenge the AGCs of DTT receivers. The synthesized version has similar time and frequency domain characteristics to the existing "LTE_BS_idle" waveform and gives similar receiver adjacent channel selectivity results, but has the advantage of being available to ETSI for use with the present document. Other improvements in the synthesized waveform include the removal of an artefact, the file length trimmed to a whole number of LTE symbols and the file header adjusted to display the licensed power on the signal generator rather than the rms power for convenience in testing. Figure B.4 shows a 50 ms section of this waveform which largely consists of pilot reference symbols plus some occasional short data bursts. Figure B.5 shows a swept frequency plot of this waveform. More correctly this waveform could be termed "near idle" rather than true idle where no data is sent.

For the blocking and overloading tests, the "LTE_BS-100PC_synth" waveform specified in the present document was synthesized from the existing so called "LTE_BS-100PC recorded" waveform. This is a fully loaded LTE base station signal with a 10 MHz bandwidth. Figure B.6 shows a 50 ms section of this waveform and figure B.7 shows a swept frequency plot of this waveform.

Both these waveforms have been converted into popular signal generator formats for receiver testing purposes.

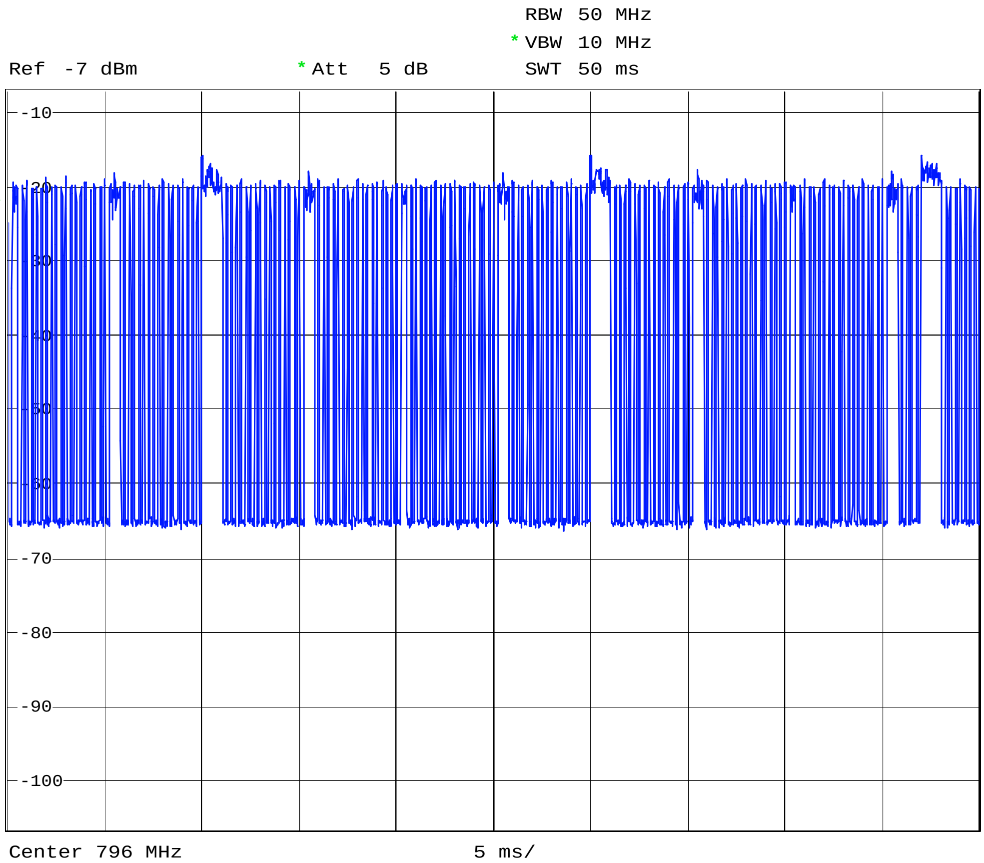

Figure B.4: Zero span plot of a 50 ms section of "LTE_BS-idle_synth" waveform

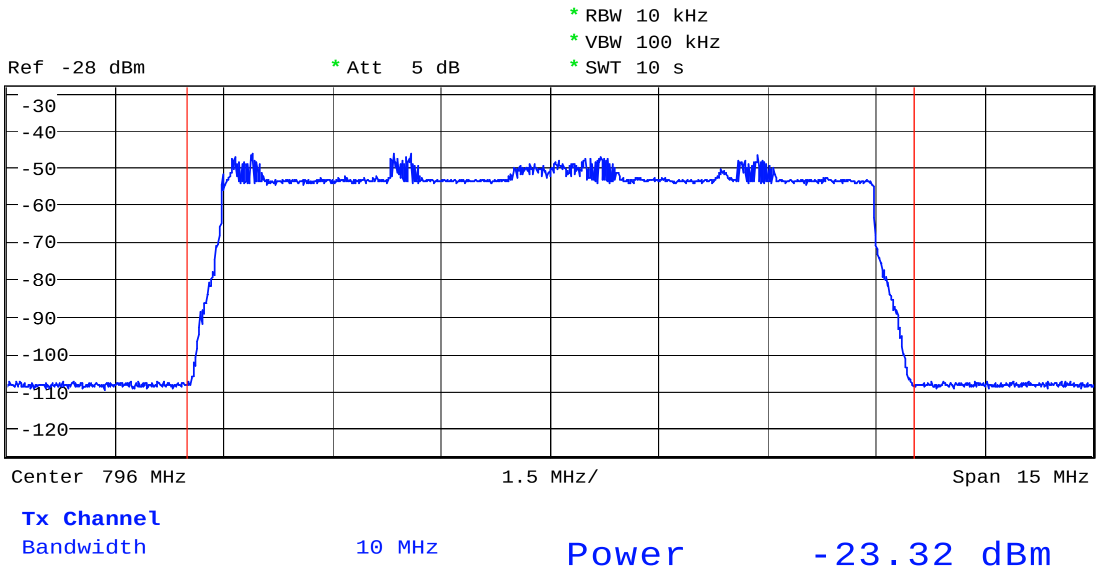

Figure B.5: Swept frequency plot of "LTE_BS-idle_synth" waveform

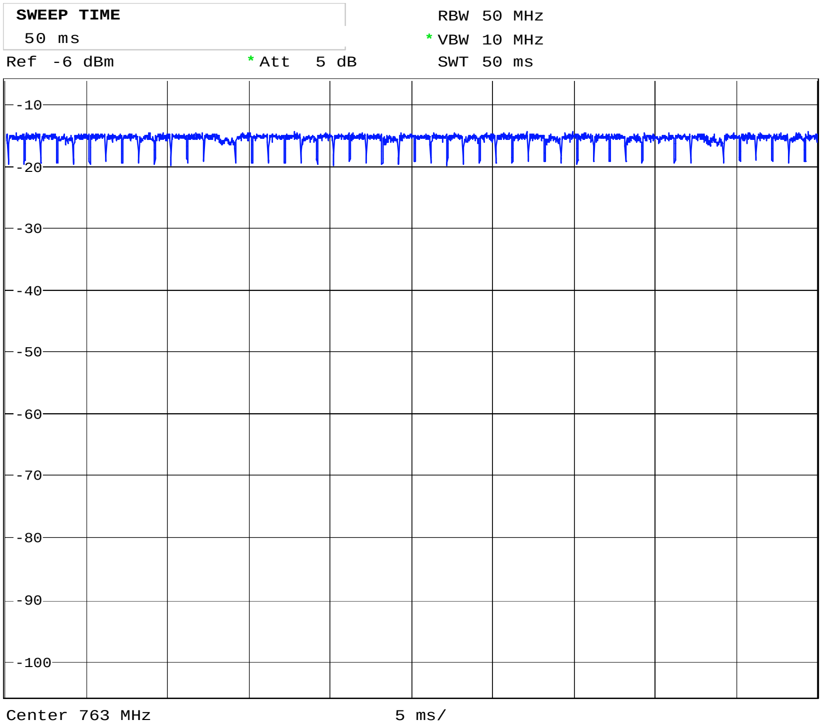

Figure B.6: Zero span plot of a 50 ms section of "LTE_BS-100PC_synth" waveform

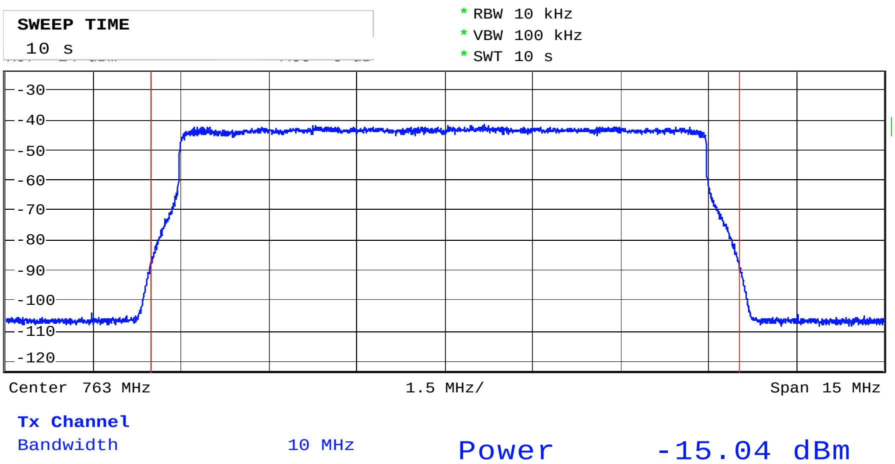

Figure B.7: Swept frequency plot of "LTE_BS-100PC_synth" waveform

B.3 Reception conditions for LTE UE 700 MHz interference

B.3.1 Calculation of maximum coupling gain

Figure B.8 shows the standard reference geometry model used to derive the received UE interference level at the DTT receiver input using a fixed rooftop antenna, taken from clause A.2.1.1 of ECC Report 186 [i.9] using a frequency of 650 MHz. This model uses Recommendation ITU-R BT.419-3 [i.12] template antenna with a 9,15 dBi gain (including feeder cable loss).

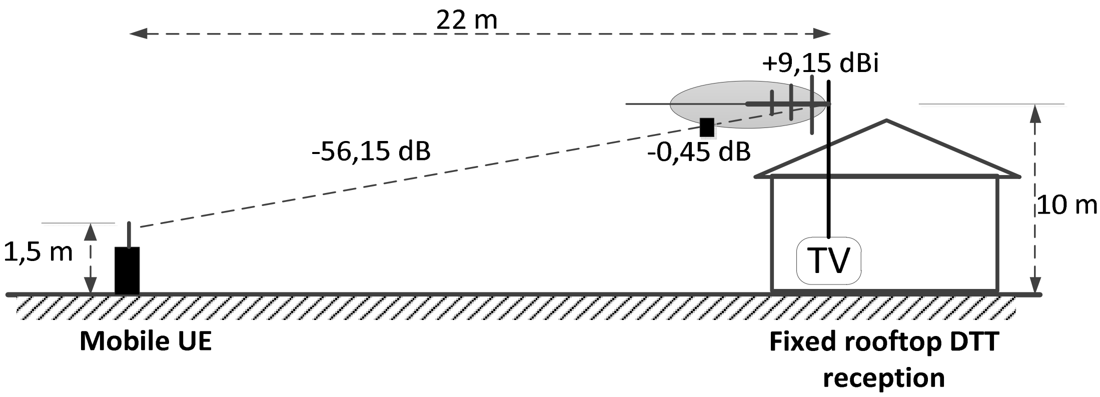

Figure B.8: Reference model for coupling gain

The maximum theoretical coupling gain G_C between the UE at 1,5 m height and the broadcast receiver tuner port taking account of the vertical DTT receive antenna pattern, the maximum loss and receive antenna discrimination from the UE to the DTT antenna is -56,15 - 0,45 dB + 9,15 = -47,45 dB at 650 MHz, or -48,24 dB at 708 MHz. This maximum gain was achieved at a horizontal separation of 22 m. Higher horizontal separations result in a higher propagation losses and lower separations take the UE out of the antenna bore sight, both resulting in lower coupling gains. Similar theoretical coupling gains were calculated in [i.2] along with field measurements of coupling gains using different antenna types.

B.3.2 Calculation of maximum received UE interference power

The LTE UE transmitted power was taken to be P_{UE} = 23 dBm E.I.R.P.

Therefore the maximum received UE interference power (P_{RX_UE}) at the broadcast receiver tuner port was estimated to be:

P_{RX_UE} $= P_{UE} - G_C$

= 23 dBm - 48,24 dB

= -25,24 dBm at 708 MHz

Thus a received UE interference power of -25 dBm was used for conformance tests in the present document as the worst case UE interference power level likely to be received on the broadcast receiver tuner port via a rooftop antenna. Typical received UE interference levels are likely to be lower than this figure.

B.4 Choice of BS interference power in receiver tests

The interference test levels were a pragmatic choice, based on the highest signal level that can be tolerated by current DTT receiver designs (including some safety margin). This is particularly relevant for some DTT receiver products where a high gain preamplifier and signal splitter is needed to achieve a low noise figure in each tuner, but this high gain preamplifier is naturally more sensitive to high level interference.

Annex C (informative): Measurement records

Table C.1: Measurement record for sensitivity tests

Test	Required sensitivity limit for DTT configurations in tables 2 and 3 (dBm)		Measured sensitivity for DTT configurations in tables 2 and 3 (dBm)		Test temperature °C	Test humidity %	Measurement uncertainty ± dB
	DVB-T	DVB-T2	DVB-T	DVB-T2			
1 VHF	-77	-75					
2 UHF	-77	-75					

Table C.2: Measurement record for adjacent channel selectivity tests

Test (see note 2)	Minimum required I/C limit for DTT configurations in tables 2 and 3 (dB)		Measured I/C for DTT configurations in tables 2 and 3 (see note 2) (dB)		Test temperature °C	Test humidity %	Measurement uncertainty ± dB
	DVB-T	DVB-T2	DVB-T	DVB-T2			
1 (see note 1)	35	36					
2	43	43					
3	33	38					
4	25	25					
5	25	25					
Test (see note 2)	**Equivalent wanted signal level C_{rms} for DTT configurations in tables 2 and 3 (dBm)**		**Measured wanted signal level C_{rms} for DTT configurations in tables 2 and 3 (see note 2) (dBm)**		**Test temperature °C**	**Test humidity %**	**Measurement uncertainty ± dB**
	DVB-T	**DVB-T2**	**DVB-T**	**DVB-T2**			
1 (see note 1)	-50	-51					
2	-58	-58					
3	-58	-63					
4	-55	-55					
5	-55	-55					
NOTE 1: For devices that do not receive DVB-T/T2 signals above 698 MHz, test 1 is not applicable. NOTE 2: It is only necessary to record either I/C or wanted signal level.							

Table C.3: Measurement record for blocking test

Test	Required blocking level I_{rms} for DTT configurations in tables 2 and 3 (dBm)		Measured blocking level I_{rms} for DTT configurations in tables 2 and 3 (dBm)		Test temperature °C	Test humidity %	Measurement uncertainty ± dB
	DVB-T	DVB-T2	DVB-T	DVB-T2			
1	-25			N/A			
2		-25	N/A				

Table C.4: Measurement record for overloading test

Test	Required overload level I_{rms} for DTT configurations in tables 2 and 3 (dBm)		Measured overload level I_{rms} for DTT configurations in tables 2 and 3 (dBm)		Test temperature °C	Test humidity %	Measurement uncertainty ± dB
	DVB-T	DVB-T2	DVB-T	DVB-T2			
1	-8	-8					
2	Void	Void					
3	-4	-4					

Annex D (informative):
Additional information to assist measurements

D.1 Optional elements of the test arrangement

Optional elements of the test arrangement described in figure 2 are greyed out such as a computer controller to partially automate the control of test equipment. Other optional elements include an RF isolator to avoid the strong interferer signal affecting the wanted signal generator, and various filter options (see inset of figure 2) to improve the ACLR of the interference generator so as to obtain the best performance from the receiver under test. It is not necessary to permanently connect the power meter/spectrum analyser whilst the receiver measurement is being made, thus eliminating the need for the splitter. It is possible to use a 75 ohm power meter to avoid the splitter shown in figure 2.

D.2 Instrument settings for measuring the power of bursty interference signals

The selectivity tests in clause 4.2.4 require measuring the long term rms power of bursty signals. Long term rms power measurements can be made using an average power sensor plus power meter with an input filter time constant set high enough to smooth out the fluctuations in the bursty interferer signal. Alternatively the power may be measured using a spectrum analyser in zero span or swept frequency mode. Recommended settings for measuring the long term rms power of the interference signal are shown in table D.1.

Table D.1: Recommended spectrum analyser settings for interferer power measurements

Setting	Clause 4.2.4.3, table 5, Tests 1 & 2	Clause 4.2.4.3, table 5 Test 3	Clause 4.2.4.3, table 5 Test 3 (alternative)
Span	10 MHz to 15 MHz	0 Hz	15 MHz
Resolution bandwidth	10 kHz	≥ 8 MHz	10 kHz
Video bandwidth	100 kHz	≥ 8 MHz	100 kHz
Sweep time	5 s to 10 s	2 s	≥ 30 s
No of points	≥ 401	≥ 401	≥ 1 250
Detector/trace mode	RMS/clear write	RMS/clear write	RMS/clear write
Power measurement	Channel power in 10 MHz bandwidth	Gated power cursors 1,042 seconds apart	Channel power in 10 MHz bandwidth

D.3 Improving ACLR

In the present document the term ACLR applies to the measurements of an unwanted signal in an adjacent or non-adjacent channel according to the specified frequencies of the wanted and unwanted signals of the test.

Achieving adequate ACLR on wideband interference test signals is important to reduce the impact on I/C measurements. The ideal configuration uses separate signal generators for the wanted and interferer signals which also allow a band pass filter to be added to the interference path to improve the ACLR further as shown in figure 2 of the present document.

The ACLR improvement filter may be a manually variable band pass filter (a) in figure 2 , or a computer programmable band pass filter (b) in figure 2. Best performance can be achieved by offsetting the filter slightly over the interferer signal to maximize the attenuation of out of band components falling into the wanted channel. A typical band pass filter suitable for improving ACLR is a 5-section variable band pass filter which is commercially available in both manually tuneable and computer controlled variants. This has a 5 % 3 dB bandwidth and a shape factor of 2,2:1 for 30 dB to 3 dB, and 3,5:1 for 50 dB to 3 dB. An example filter response is shown in figure D.1 where the filter can improve the ACLR of the signal generator by 65,57 dB for test 2 (clause 4.2.4.3, table 5).

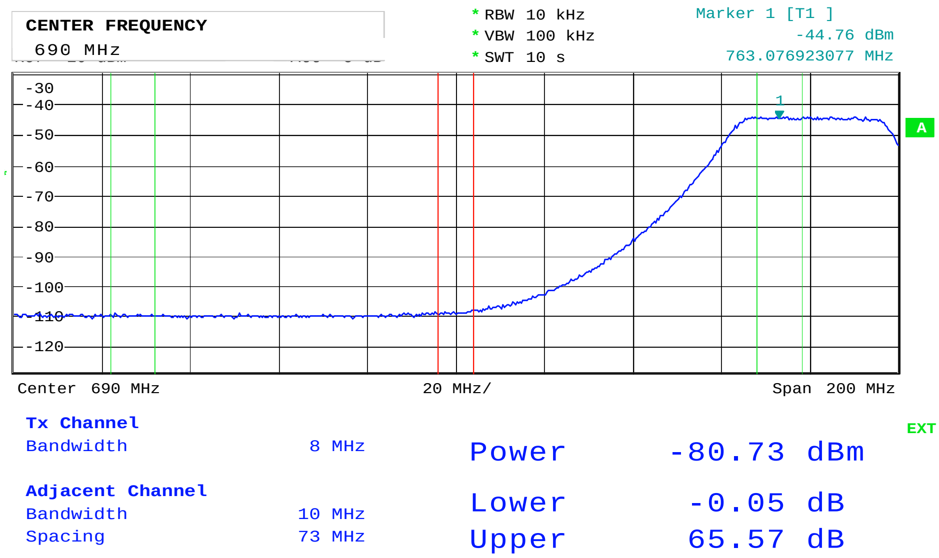

Figure D.1: Frequency response of band pass filter used for ACLR improvement

Another option (c) in figure 2 uses fixed frequency notch filters centred on the wanted channels to reduce the out of band components of the interferer. A filter bypass may be needed for adjacent channel selectivity test 1 where the interferer and wanted signals are close together in frequency (see clause 4.2.4.3, table 5) if the Ch60 notch filter attenuates the lower edge of the BS interferer spectrum at 791 MHz.

Signal generators often include precision RF attenuators which can be used in place of "attenuator I" and "attenuator C" in figure 2. However some generators have an optimum output power level where the ACLR is maximized and in these circumstances it may be preferable to set the interferer to this optimum power level and then use external attenuators to maintain the optimum ACLR over all interference power levels of the test.

D.4 Measuring ACLR

The ACLR measurement can be limited by the spectrum analyser dynamic range, particularly if the ACLR is being improved by the use of a band pass filter. ACLR measurements can be degraded by overloading the spectrum analyser input or by using low signal levels where the spectrum analyser noise floor will limit measurements. The noise correlation function in some spectrum analysers can reduce the effects of analyser noise and improve the ACLR measurement. Optimizing the input attenuator setting, using long sweep times and using an adequate number of points can also be beneficial.

The combined generator plus filter ACLR can easily exceed the dynamic range of the spectrum analyser. In this case the total ACLR can be determined in two steps:

1) The filter's ACLR contribution can be measured over the band of interest using a wide band noise generator as the input source.

2) The measured filter ACLR can then be added to the measured ACLR of the generator itself.

Annex E (normative): Applicable tests

E.1 Applicable tests for different receiver variants

The tests in the present document only apply if the DTT broadcast receiver supports the wanted signal configuration used by the test in question. This is summarized in table E.1. The type of receivers covered by the present document are:

- Capable of DVB-T only, or DVB-T and DVB-T2 reception in the VHF and UHF bands.
- Capable of DVB-T only, or DVB-T and DVB-T2 reception in the UHF band.
- Capable only of DVB-T2 reception in the VHF and UHF bands.
- Capable only of DVB-T2 reception in the UHF band.

Table E.1: Applicable tests for different receiver variants

<table>
<tr><th></th><th colspan="4">Applicable tests</th></tr>
<tr><th>Wanted signal configuration supported by receiver</th><th>Sensitivity tests clause 4.2.3</th><th>Adjacent channel selectivity tests clause 4.2.4 (see note 1 and note 3)</th><th>Blocking tests clause 4.2.5 (see note 4)</th><th>Overloading tests clause 4.2.6 (see note 5)</th></tr>
<tr><td>DVB-T only,

VHF & UHF</td><td>Test-1 (DVB-T)
Test-2 (DVB-T)</td><td rowspan="4">Test-1 (DVB-T) & (DVB-T2)
Test-2 (DVB-T) & (DVB-T2)
Test-3 (DVB-T) & (DVB-T2)
Test-4 (DVB-T)
Test-5 (DVB-T)</td><td rowspan="4">Test-1 (DVB-T)</td><td rowspan="4">Test-1 (DVB-T)
(for broadcast receivers with optional preamplifier)

Or

Test-3 DVB-T
(for broadcast receivers without optional preamplifier)</td></tr>
<tr><td>DVB-T & T2,

VHF & UHF</td><td>Test-1 (DVB-T)
Test-2 (DVB-T)
Test-1 (DVB-T2)
Test-2 (DVB-T2)</td></tr>
<tr><td>DVB-T only,

UHF only</td><td>Test-2 (DVB-T)</td></tr>
<tr><td>DVB-T & T2,

UHF only</td><td>Test-2 (DVB-T)
Test-2 (DVB-T2)</td></tr>
<tr><td>DVB-T2 only,

VHF & UHF</td><td>Test-1 (DVB-T2)
Test-2 (DVB-T2)</td><td rowspan="2">Test-1 (DVB-T2)
Test-2 (DVB-T2)
Test-3 (DVB-T2)
Test-4 (DVB-T2)
Test-5 (DVB-T2)</td><td rowspan="2">Test-2 (DVB-T2)</td><td rowspan="2">Test-1 (DVB-T2)
(for broadcast receivers with optional preamplifier)

Or

Test-3 (DVB-T2)
(for broadcast receivers without optional preamplifier)</td></tr>
<tr><td>DVB-T2 only,

UHF only</td><td>Test-2 (DVB-T2)</td></tr>
<tr><td colspan="5">NOTE 1: For broadcast receivers that do not receive DVB-T/T2 signals above 698 MHz, Adjacent channel selectivity test 1 is not applicable.
NOTE 2: Void.
NOTE 3: Test-4 (DVB-T) and Test-5 (DVB-T) are UHF tests which apply to broadcast receivers capable of either DVB-T only, or DVB-T&T2 reception in UHF/VHF because DVB-T and DVB-T2 adjacent channel selectivities are correlated and also UHF/VHF selectivities are correlated.
NOTE 4: Test-1 (DVB-T) is a UHF test which applies to broadcast receivers capable of either DVB-T only, or DVB-T&T2 reception in UHF/VHF because DVB-T and DVB-T2 blocking levels are correlated and UHF/VHF blocking levels are correlated.
Test-2 (DVB-T2) is a UHF DVB-T2 test which applies to broadcast receivers only capable of DVB-T2 reception in UHF/VHF because UHF/VHF blocking levels are correlated.
NOTE 5: Test-1 (DVB-T) and Test-3 (DVB-T) are UHF tests which apply to broadcast receivers capable of either DVB-T only, or DVB-T&T2 reception in UHF/VHF because DVB-T and DVB-T2 overload levels are correlated and UHF/VHF overload levels are correlated.
Test-1 (DVB-T2) and Test-3 (DVB-T2) are UHF tests which apply to broadcast receivers only capable of DVB-T2 reception in UHF/VHF because UHF/VHF overload levels are correlated.</td></tr>
</table>

Annex F (normative): Requirements for the interfering signal minimum ACLR

The required minimum ACLR level depends on the magnitude of I/C values to be measured. Minimum ACLR values to just pass the tests in the present document are provided in table F.1. These values assume a 3 dB ACLR degradation contributing to on the measured performance.

Table F.1: Required interference signal ACLR

Test description	Assumed AWGN C/N	I/C requirement	Recommended minimum ACLR (dB)
Adjacent channel selectivity test 1	DVB-T C/N = 15 dB	35	53
Adjacent channel selectivity test 2		43	61
Adjacent channel selectivity test 3		33	51
Adjacent channel selectivity tests 4 & 5		25	43
Blocking test 1		N/A	64
Overloading test 1		N/A	49
Adjacent channel selectivity test 1	DVB-T2 C/N = 19 dB	36	58
Adjacent channel selectivity test 2		43	65
Adjacent channel selectivity test 3		38	60
Adjacent channel selectivity tests 4 & 5		25	47
Blocking test 2		N/A	66
Overloading test 1		N/A	53

Annex G (informative): Justification of omitted receiver parameters

G.1 Receiver parameters omitted

G.1.1 Co-channel rejection

Receiver co-channel rejection is a measure of the capability of a receiver to receive a wanted signal, without exceeding a given degradation, due to the presence of an unwanted signal, both signals being at the nominal frequency of the receiver.

A specific test for co-channel rejection is not included because in the TV bands, co-channel interference is other DTT signals, possibly from neighbouring countries or distant MFN transmitters (at low level). Since DTT signals are Gaussian in nature, the co-channel performance is strongly correlated to AWGN performance. See measured data in table G.1. Therefore, weaknesses in receiver co-channel rejection will result in degraded sensitivity test results (table 4 of the present document).

Table G.1: Example measurements of correlation between AWGN and co-channel C/I

Test setup	Two signal generators with power combiner			
DVB-T	**Signal: 482 MHz, -55 dBm, 8k GI 1/4 64-QAM CR 2/3 8 MHz**			
	Desired signal	**Criteria**	**C/N or D/U (dB)**	**Test item**
	Undesired Case1	No uncorrected errors	14,56	AWGN C/N
	Undesired Case2	No uncorrected errors	14,3	DVB-T Co-channel
DVB-T2	**Signal: 482 MHz, -55 dBm, 32k_ext GI 1/16 256-QAM rot PP4 CR 2_3 PAPR TR 8 MHz**			
	Desired signal	**Criteria**	**C/N or D/U (dB)**	**Test item**
	Undesired Case1	No uncorrected errors	18,82	AWGN C/N
	Undesired Case2	No uncorrected errors	18,6	DVB-T2 Co-channel

G.1.2 Spurious response rejection

The spurious response rejection is a measure of the capability of the receiver to receive a wanted signal without exceeding a given degradation due to the presence of an unwanted signal at any frequency at which a response is obtained. The frequencies of the adjacent signals (channels) are excluded. A specific test for spurious response rejection is not included in the present document because the design architecture of the receiver would need to be known in order to determine the critical test parameters to provide an economically proportionate testing regime. Modern DTT receivers have not historically suffered specifically from this issue.

For example, modern TV tuners implement a low IF architecture (4 to 5 MHz IF frequency) and have an image channel centred 8 to 10 MHz above or below the centre of the wanted channel. Therefore, the spurious response is already tested by adjacent channel selectivity tests 1, 4 and 5 (table 5 of the present document).

G.1.3 Intermodulation

G.1.3.0 General

The receiver radio-frequency intermodulation response rejection is a measure of the capability of the receiver to receive a wanted signal, without exceeding a given degradation due to the presence of at least two unwanted signals at frequencies F1 and F2 with a specific frequency relationship to the wanted signal frequency.

Second and third order intermodulation products are analysed as follows.

G.1.3.1 Second order intermodulation

a) $F_{if} = F_1 + F_2$

b) $F_{if} = F_1 - F_2$

c) $F_{rx} = F_1 + F_2$

d) $F_{rx} = F_1 - F_2$

Most modern DTT silicon tuners typically have IF frequencies in the range 4 to 5 MHz.

a) does not occur in practice due to the low IF architecture of modern TV receivers.

b) this occurs, for example 765 - 760 = 5 MHz, but this is covered by table 7 (overloading) in the present document. In this test the interference signal used is a very high power multicarrier LTE signal with a 10 MHz BW, where a large number of intermodulation products fall in-band.

c) could occur if for example two FM radio signals at F1 = 90 MHz and F2 = 100 MHz produce an intermodulation product at 190 MHz which falls into VHF band III TV (174 - 230 MHz). However field experience indicates this is not a widespread problem in the EU market area, probably because the tracking RF filters in TV tuner front end help to attenuate out of band signals such as FM radio. Tracking filters are required to achieve selectivity over the wide range of frequencies that TV tuners (somewhat uniquely) need to cover. Also in the case of two LTE interferers, F1+F1 does not fall inside the DTT wanted band as all LTE frequencies are above DTT frequencies.

d) could occur if F1 = 763 MHz (LTE BS signal) and F2 = 90 MHz (FM radio signal), producing an intermodulation product in the DTT band at 673 MHz. As in c) above, field experience indicates this is not a widespread problem in the EU market area probably due to the RF tracking filters in TV tuners. Also in the case of two LTE interferers, this intermodulation product does not fall in the wanted DTT band, since even taking extreme ends of the LTE bands at 700 and 800 MHz, F1 = 862 MHz and F2 = 703 MHz, then F1 - F2 = 159 MHz, which is lower than the VHF band III starting frequency of 174 MHz.

G.1.3.2 Third order intermodulation

In the case of LTE interferers, third order intermodulation occurs. For example, LTE subcarriers at 792 MHz and 800 MHz gives rise to a 3rd order intermodulation products at $2 \times 792 - 800 = 784$ MHz, which is in DTT channel 60. Additionally, cross modulation products arise due to the amplitude modulation of each LTE subcarrier. These 3rd order intermodulation and cross modulation effects are tested by tests 1, 4 and 5 of table 5 of the present document.

G.1.4 Dynamic range

Receiver "dynamic range" is a generic term broadly defined as the range of input signal levels over which a receiver functions at a specified performance level. A specific test for receiver dynamic range is not included in the present document because the sensitivity, ACS, and blocking tests provide testing of both low and high-level signal situations.

G.1.5 Reciprocal mixing

Reciprocal mixing is where noise sidebands of the Local Oscillator (LO) mix with unwanted signals producing unwanted noise at the frequency of the receiver which may result in degraded receiver sensitivity.

With multicarrier desired and undesired signals, the LO phase noise is tested in the present document through the adjacent channel measurements (tests 1, 3, 4, 5 in table 5). Due to the low IF frequency of modern silicon tuners being close to the wanted signal, reciprocal mixing in a poor quality receiver would cause a degradation in these tests which use a strong multicarrier adjacent channel interferer.

G.1.6 Desensitisation

Desensitization is a degradation of receiver sensitivity caused by the presence of a large unwanted signal. The term is most commonly applied when an unwanted signal is present in the receiver which is above a receiver's linear "dynamic range" resulting in desensitization for example by the process of gain compression.

Desensitisation is tested in the present document by the blocking test (table 6), where a relatively high power interferer is applied with the wanted signal at +6 dB above the stated sensitivity specification.

Annex H (informative): Change History

Version	Information about changes
1.1.1	First published version.
1.1.2	Version containing editorial changes only: • Clause 4.2.7.2: reference to EN 55032 improved • Clause 4.2.7.3: reference to EN 55032 improved • Table 8: reference to EN 55032 improved • Clause 4.2.7.2: item b) removed because the scope does not include equipment with integral antennas
1.2.0	Second published version: • Table 7: updated test 1 limit from -12 dBm to -8 dBm for DVB-T and DVB-T2 • Table C.4: updated test 1 limit from -12 dBm to -8 dBm for DVB-T and DVB-T2 • Table 7: voided note 3 • Clause B.2.2: removed note referencing future plans for other signal generator formats • Resampled existing test waveforms to remove an unwanted sampling artifact • Added new test waveforms for additional signal generators • Renamed all instances of Short_UE-Video-Stream_V2 to Short_UE-Video-Stream • Renamed all instances of LTE_BS-idle_V3_synth to LTE_BS-idle_synth

History

Document history		
V1.1.1	May 2016	Publication (withdrawn)
V1.1.2	September 2016	Publication
V1.2.0	June 2020	EN Approval Procedure AP 20200923: 2020-06-25 to 2020-09-23
V1.2.1	September 2020	Publication