



**Transmitting equipment for the  
Digital Audio Broadcasting (DAB) service;  
Harmonised Standard for access to radio spectrum**

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**Reference**

REN/ERM-TG17-015

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**Keywords**

audio, broadcasting, DAB, digital, harmonised  
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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.4] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.1].

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

National transposition dates	
Date of adoption of this EN:	4 June 2018
Date of latest announcement of this EN (doa):	30 September 2018
Date of latest publication of new National Standard or endorsement of this EN (dop/e):	31 March 2019
Date of withdrawal of any conflicting National Standard (dow):	31 March 2020

# 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 technical characteristics and methods of measurements for transmitter equipment for broadcast sound services using the Digital Audio Broadcast (DAB) modulation system operating in VHF band III (174 MHz to 240 MHz).

The present document covers the essential requirements of article 3.2 of Directive 2014/53/EU [i.1] under the conditions identified in annex A.

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

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# 2 References

## 2.1 Normative references

References are specific, identified by date of publication and/or edition number or version number. Only the cited version applies.

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

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

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

- [1] ETSI EN 300 401 (V2.1.1) (01-2017): "Radio broadcasting systems; Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers".
- [2] ETSI ETS 300 799 (Edition 1) (09-1997): "Digital Audio Broadcasting (DAB); Distribution interfaces; Ensemble Transport Interface (ETI)".

## 2.2 Informative references

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

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

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

- [i.1] Directive 2014/53/EU of the European Parliament and of the Council of 16 April 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC.
- [i.2] ETSI TR 100 028 (all parts): "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics".
- [i.3] ETSI TR 100 028-2: "Electromagnetic compatibility and Radio spectrum Matters (ERM); Uncertainties in the measurement of mobile radio equipment characteristics; Part 2".
- [i.4] 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.

## 3 Definitions, symbols and abbreviations

### 3.1 Definitions

For the purposes of the present document, the terms and definitions given in Directive 2014/53/EU [i.1] and the following apply:

**Adjacent Channel Leakage Ratio (ACLR):** ratio of the mean power of the DAB signal in the OFDM block at  $f_L$  to the mean power of the unoccupied OFDM block within the MCOFDM group

**antenna port:** port of an apparatus which is designed, in normal operation, to be connected to an antenna using coaxial cable

**broadcasting service:** radiocommunication service in which the transmissions are intended for direct reception by the general public

NOTE: This service may include sound transmissions, television transmissions or other types of transmission.

**class of emission:** set of characteristics of an emission, designated by standard symbols, e.g. type of modulation of the main carrier, modulating signal, type of information to be transmitted, and also, if appropriate, any additional signal characteristics

**DAB transmitter:** device comprising a DAB exciter, RF amplifier and RF system filter

**dBc:** decibels relative to the unmodulated carrier power of the emission

NOTE: In the cases which do not have a carrier, for example in some digital modulation schemes where the carrier is not accessible for measurement, the reference level equivalent to dBc is decibels relative to the mean power  $P$ .

**enclosure port:** physical boundary of the apparatus through which electromagnetic fields may radiate or impinge

NOTE: In the case of integral antenna equipment, this port is inseparable from the antenna port.

**exclusion band:** band of radio frequencies where no measurements are made

**harmonic:** component of order greater than 1 of the Fourier series of a periodic quantity

**high power transmitter:** transmitter whose conducted output power is greater than 1 000 W per OFDM block

**intermodulation products:** unwanted frequencies resulting from intermodulation between carriers or harmonics of emission, or between any oscillations generated to produce the carrier

**low power transmitter:** transmitter whose conducted output power is less than or equal to 25 W per OFDM block

**MCOFDM group:** group of OFDM blocks generated by a MCOFDM system

**MCOFDM system:** low power transmitter system that generates more than one OFDM block with an overall RF system filter spanning all blocks

**mean power:** average power supplied to the antenna port by a transmitter during an interval of time sufficiently long compared with the lowest frequency encountered in the modulation envelope taken under normal operating conditions

**medium power transmitter:** transmitter whose conducted output power is greater than 25 W and less than or equal to 1 000 W per OFDM block

**necessary bandwidth:** for a given class of emission, the width of the frequency band which is sufficient to ensure the transmission of information at the rate and with the quality required under specified conditions

**OFDM block:** group of digitally modulated carriers comprising a complete DAB ensemble

**out-of-band emissions:** emission on a frequency or frequencies immediately outside the necessary bandwidth which results from the modulation process, but excluding spurious emissions



**rated output power:** conducted power that the transmitter delivers at its output under specified conditions of operation

**reference bandwidth:** bandwidth in which the emission level is specified

**RF system filter:** filter connected to the output of the RF amplifier to control output spectrum

NOTE: The RF system filter may be internal or external to the transmitter casing.

**RMS power:** apparent power of an AC power that is calculated by multiplying root-mean-square (rms) current by the root mean square voltage

NOTE 1: In a purely resistive circuit this is held to be the equivalent heating effect of a DC power and can be deemed to be true power. In a circuit that consists of reactance as well as resistance the apparent power is greater than the true power (the vector difference between true power and apparent power is called reactive power).

$$\text{True Power} = V_{\text{rms}} \times (I_{\text{rms}} \Delta \cos \phi)$$

Where  $\Delta \cos \phi$  is the phase difference between voltage and current introduced by the reactance of the load.

NOTE 2: From note 1 it becomes clear that unless any measuring system can be completely devoid of reactance then the measured power cannot be considered to be RMS power. It therefore becomes apparent that this parameter would be difficult to measure with any degree of accuracy at RF frequencies.

**spurious emissions:** emissions on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information.

NOTE: Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products but exclude out of band emissions.

**unwanted emissions:** consist of spurious emissions and out-of-band emissions

## 3.2 Symbols

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

"	inch
C/N	Carrier power to Noise power density
Hz	Hertz (cycles per second)
m	metre
$\mu$	micro, $10^{-6}$
V	Volt
W	Watt

## 3.3 Abbreviations

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

ACLR	Adjacent Channel Leakage Ratio
BER	Bit Error Ratio
COFDM	Coded Orthogonal Frequency Division Multiplex
CRC	Cyclic Redundancy Check
CW	Continuous Wave
DAB	Digital Audio Broadcasting
EDI	Encapsulation of DAB Interfaces
EMC	ElectroMagnetic Compatibility
ETI	Ensemble Transport Interface
EUT	Equipment Under Test
MCOFDM	Multiple Coded Orthogonal Frequency Division Multiplex
MER	Modulation Error Ratio
N	Noise power

OFDM	Orthogonal Frequency Division Multiplex
PRBS	Pseudo Random Binary Sequence
RF	Radio Frequency
rms	root mean square
SFN	Single Frequency Network
TII	Transmitter Identification Information
Tx	Transmitter
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 declared by the manufacturer. The equipment shall comply with all the technical requirements of the present document which are identified as applicable in annex A at all times when operating within the boundary limits of the declared operational environmental profile.

### 4.2 Conformance requirements

#### 4.2.1 Rated output power accuracy

##### 4.2.1.1 Definition

The rated output power is the conducted power that the transmitter shall deliver at its antenna port under the manufacturers specified conditions of operation. It is, however, recommended that this parameter is not quoted as RMS power.

For MCOFDM systems, the rated output power is the conducted power of the highest powered OFDM block within the MCOFDM group.

Transmitters shall be categorized into one of three power classes, as follows:

- low power;
- medium power;
- high power.

##### 4.2.1.2 Limit

The output power shall be within -0,5 dB of the rated output power under normal operating conditions as defined by the manufacturer.

##### 4.2.1.3 Conformance

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

### 4.2.2 Frequency stability

#### 4.2.2.1 Definition

The frequency stability of an emission is the variation of frequency against a predetermined time scale.

#### 4.2.2.2 Limit

The centre frequency of the RF signal shall not deviate more than 10 % of the relevant carrier spacing from its nominal value. In transmission mode I, the limit is 100 Hz.

The stability of the centre frequency shall not deviate more than 1 % of the relevant carrier spacing from its nominal value within a three month period when measured under identical operating conditions at the start and at the end of the period. In transmission mode I, the limit is 10 Hz.

#### 4.2.2.3 Conformance

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

### 4.2.3 Crest factor

#### 4.2.3.1 Definition

Maximum ratio of peak power to mean power levels.

#### 4.2.3.2 Limit

The peak level of the output RF power signal shall not exceed the mean power level by more than 13 dB.

#### 4.2.3.3 Conformance

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

### 4.2.4 Spurious emissions

#### 4.2.4.1 Definition

Emission on a frequency or frequencies which are outside the necessary bandwidth and the level of which may be reduced without affecting the corresponding transmission of information. Spurious emissions include harmonic emissions, parasitic emissions, intermodulation products and frequency conversion products but exclude out-of-band emissions.

For the purposes of the present document spurious emissions are emissions at frequencies below  $f_L - 3$  MHz, where  $f_L$  is the centre frequency of the lowest frequency OFDM block, and above  $f_H + 3$  MHz, where  $f_H$  is the centre frequency of the highest frequency OFDM block of the transmission, irrespective of the number of blocks employed. In the case of a single block transmitter,  $f_L = f_H$ .

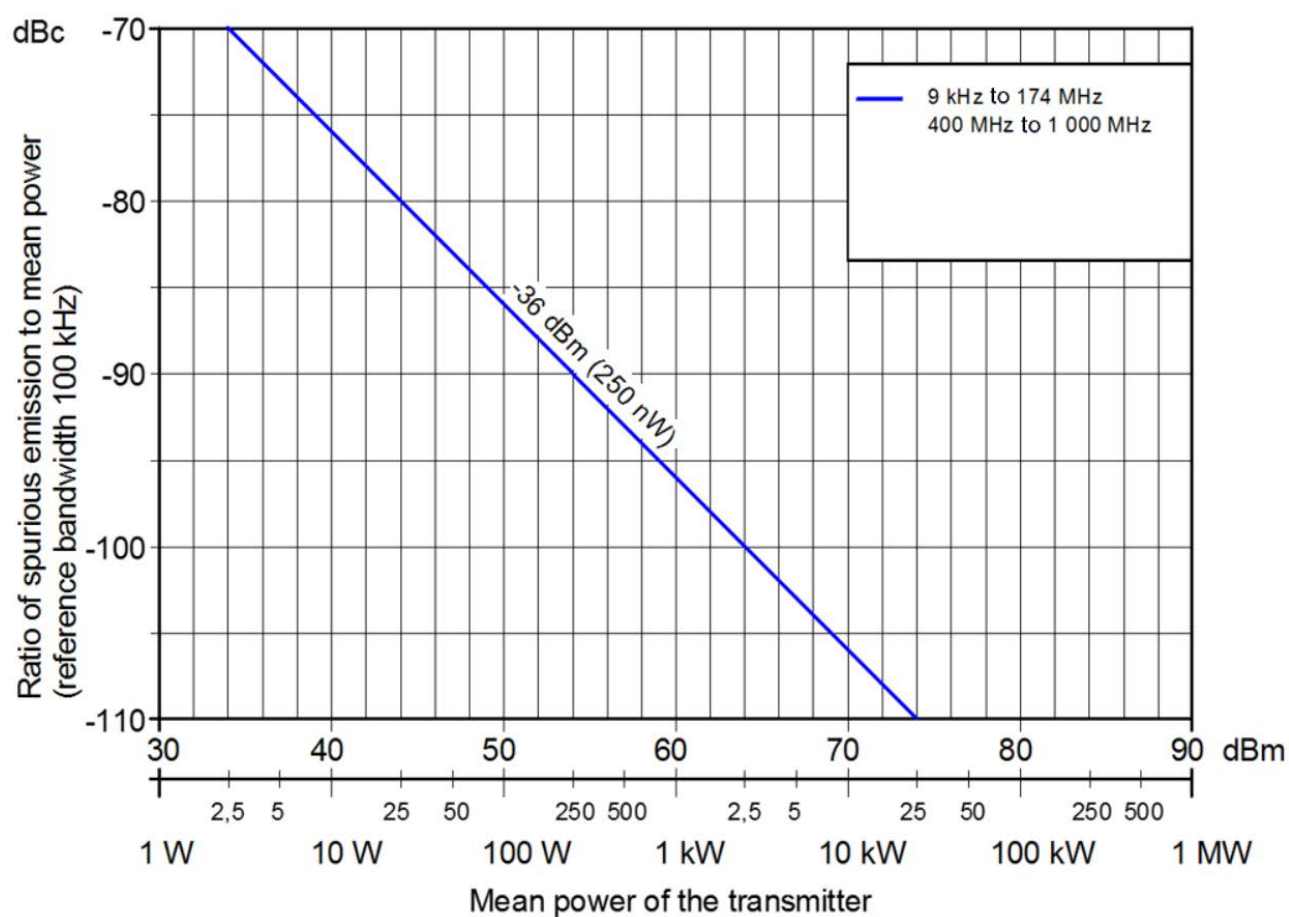
#### 4.2.4.2 Limits

Spurious emissions shall not exceed the values set out in table 1, shown additionally in figure 1 and figure 2, for the frequency range 9 kHz to 1 GHz at the output of the RF system filter.

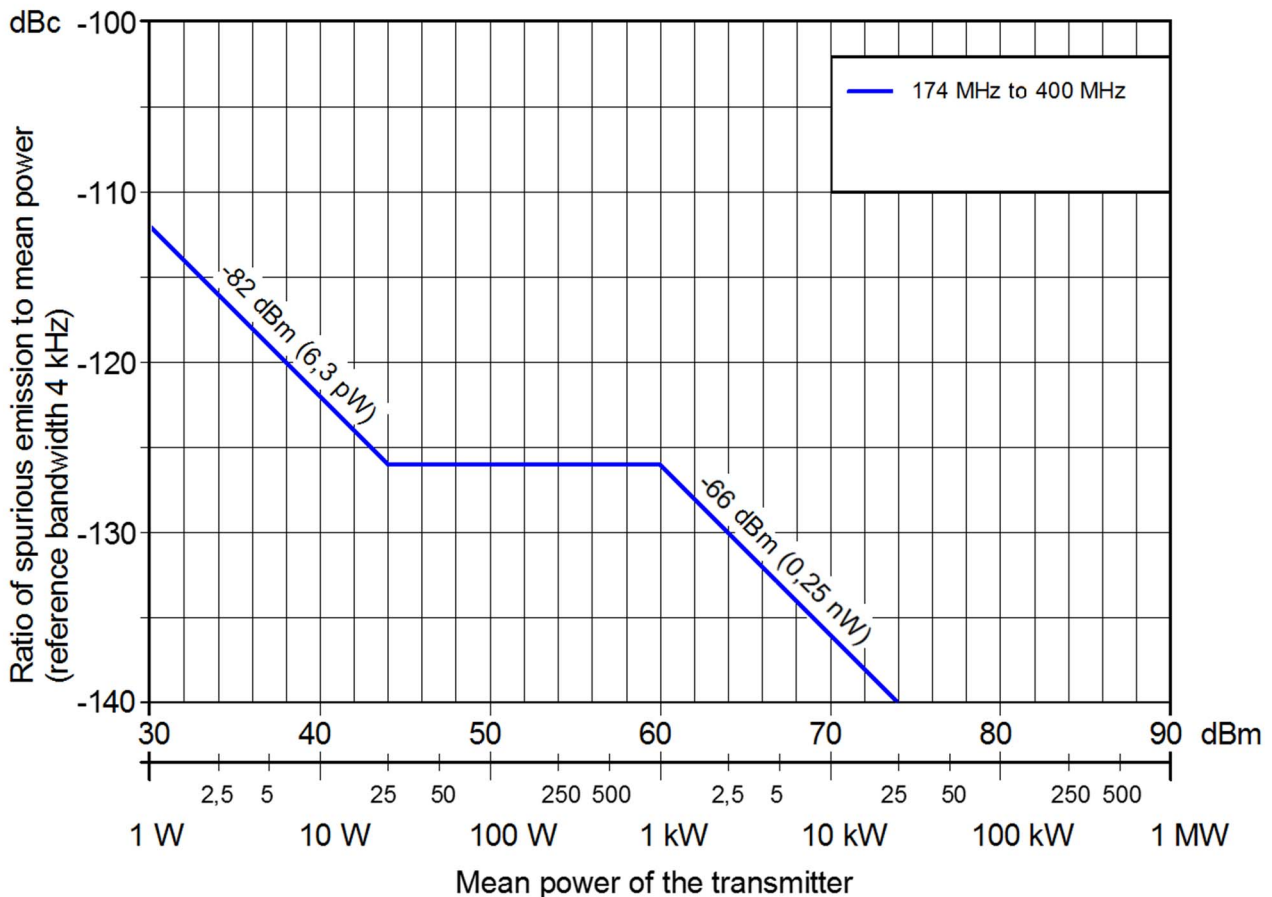
**Table 1: Spurious emissions limits**

Frequency range of the spurious emission	Limits of the spurious emission	Reference bandwidth (kHz)	Figure
9 kHz to 174 MHz	-36 dBm (250 nW).	100	1
> 174 MHz to 400 MHz	-82 dBm for low power transmitters; -126 dBc for medium power transmitters; -66 dBm for high power transmitters.	4	2
> 400 MHz to 1 000 MHz	-36 dBm (250 nW).	100	1

NOTE: The power category of the transmitter is defined in clause 4.2.1.



**Figure 1: Spurious emissions limits for DAB transmitters  
(100 kHz reference bandwidth)**



**Figure 2: Spurious emissions limits for DAB transmitters  
(4 kHz reference bandwidth)**

#### 4.2.4.3 Conformance

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

### 4.2.5 Out-of-band emissions

#### 4.2.5.1 Definition

Emission on a frequency or frequencies immediately outside the necessary bandwidth which results from the modulation process, but excludes spurious emissions.

For the purposes of the present document out-of-band emissions are emissions at frequencies outside the necessary bandwidth and within the frequency ranges  $f_L - 3$  MHz to  $f_L$ , where  $f_L$  is the centre frequency of the lowest frequency OFDM block, and  $f_H$  to  $f_H + 3$  MHz, where  $f_H$  is the centre frequency of the highest frequency OFDM block of the transmission, irrespective of the number of blocks employed. In the case of a single block transmitter,  $f_L = f_H$ .

#### 4.2.5.2 Limit

Out-of-band emissions shall not exceed the limits specified in tables 2 to 5, additionally shown in figure 3 and figure 4.

Out-of-band emissions limits are given as mean power level measured in a 4 kHz bandwidth, where 0 dB corresponds to the mean output power.

Unless otherwise stated by licence condition it shall be assumed that the EUT conforms to the non-critical case (case 2).

- Case 1: The solid line mask (see figure 3) shall apply to DAB transmitters operating in areas critical for adjacent channel DAB to DAB interference, and in any case when it is necessary to protect other services operating on adjacent frequencies on a primary basis.
- Case 2: The dashed line mask (see figure 3) shall apply to DAB transmitters in other cases.
- Case 3: The solid line mask (see figure 4) shall apply to DAB transmitters in exceptional circumstances to protect safety services.
- Case 4: The chain dotted line mask (see figure 4) shall apply to DAB transmitters operating on a case by case basis in certain areas.

**Table 2: Case 1: Transmitters operating in critical cases**

1,54 MHz block, frequency difference from the centre frequency (MHz)	Low power Absolute level (dBm)	Medium power Relative level (dBc)	High Power Absolute level (dBm)
$\pm 0,77$	18	-26	34
$\pm 0,97$	-27	-71	-11
$\pm 1,75$	-62	-106	-46
$\pm 3,0$	-62	-106	-46

**Table 3: Case 2: Transmitters operating in uncritical cases**

1,54 MHz block, frequency difference from the centre frequency (MHz)	Low power Absolute level (dBm)	Medium power Relative level (dBc)	High Power Absolute level (dBm)
$\pm 0,97$	18	-26	34
$\pm 0,97$	-12	-56	4
$\pm 3,0$	-62	-106	-46

**Table 4: Case 3: Transmitters operating in exceptional circumstances to protect safety services**

1,54 MHz block, frequency difference from the centre frequency (MHz)	Low power Absolute level (dBm)	Medium power Relative level (dBc)	High Power Absolute level (dBm)
$\pm 0,77$	18	-26	34
$\pm 0,97$	-27	-71	-11
$\pm 2,2$	-82	-126	-66
$\pm 3,0$	-82	-126	-66

**Table 5: Case 4: Transmitters operating on a case by case basis in certain areas**

1,54 MHz block, frequency difference from the centre frequency (MHz)	Low power Absolute level (dBm)	Medium power Relative level (dBc)	High Power Absolute level (dBm)
$\pm 0,77$	18	-26	34
$\pm 0,97$	-34	-78	-18
$\pm 2,2$	-82	-126	-66
$\pm 3,0$	-82	-126	-66

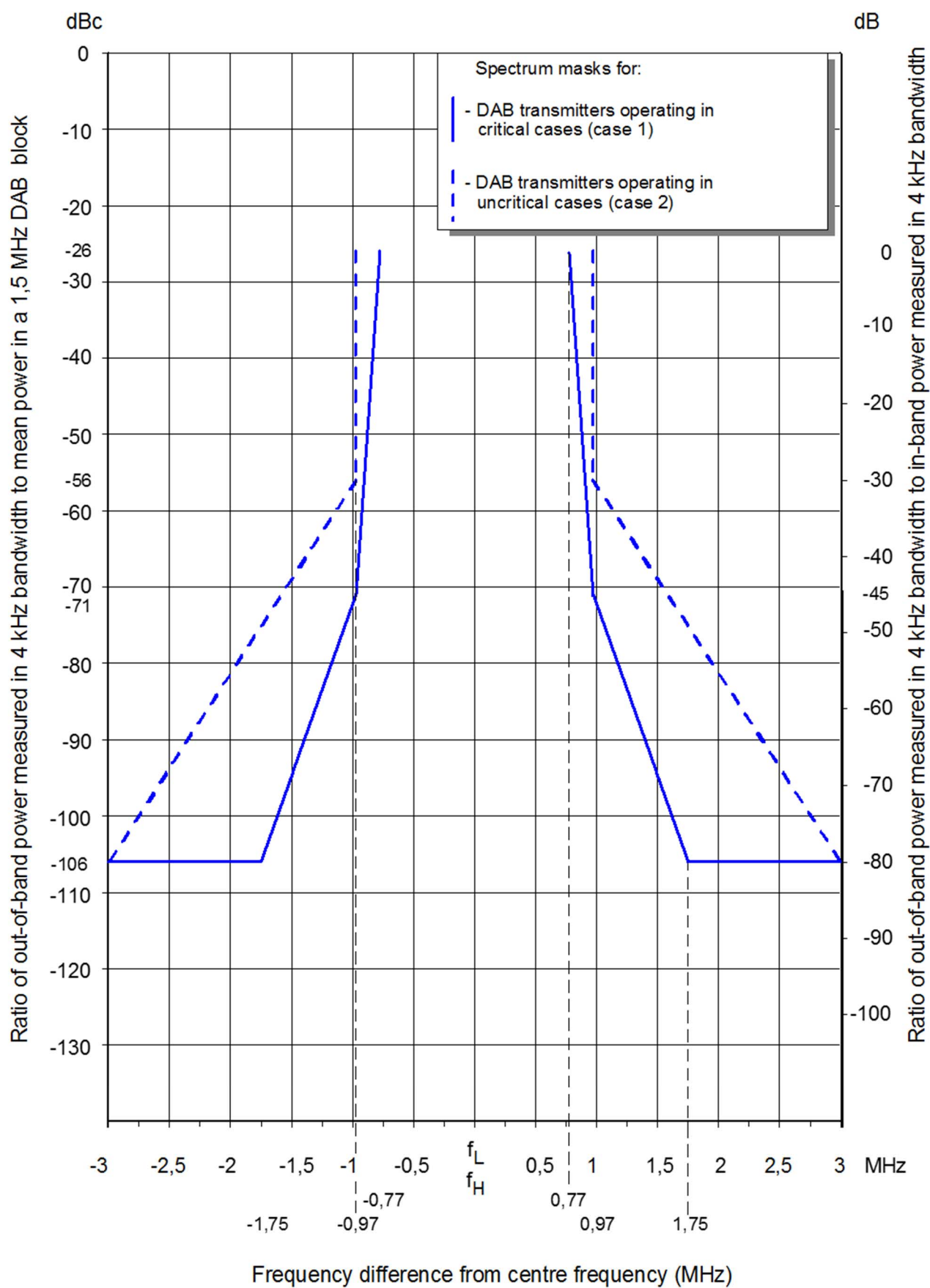


Figure 3: Spectrum masks for DAB out-of-band emissions (case 1 and case 2)

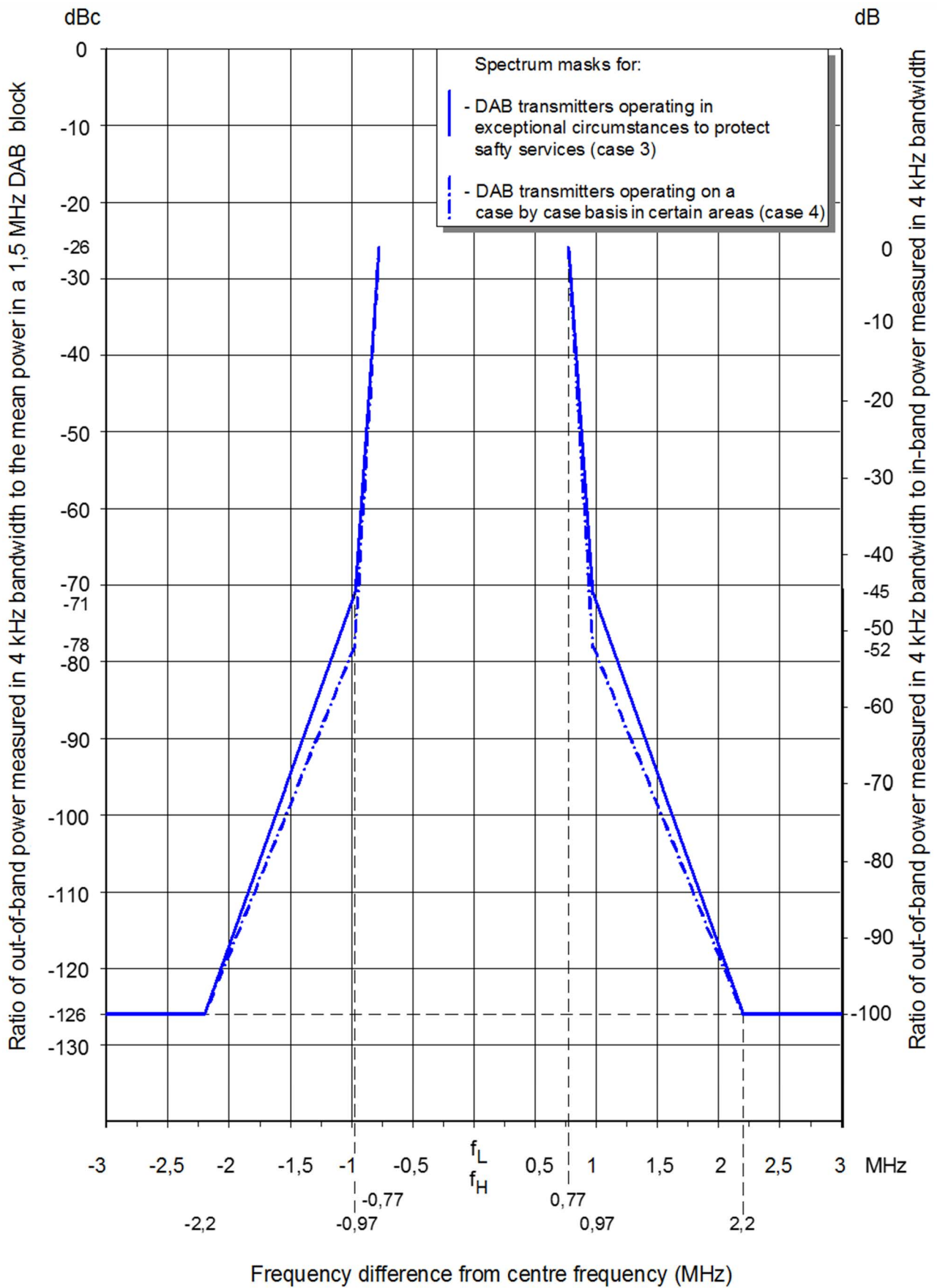


Figure 4: Spectrum masks for DAB out-of-band emissions (case 3 and case 4)



### 4.2.5.3 Conformance

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

## 4.2.6 MCOFDM systems: ACLR performance

### 4.2.6.1 Definition

Adjacent channel performance required for unoccupied OFDM blocks within the MCOFDM group.

The ACLR is defined as the ratio of the mean power of the DAB signal in the OFDM block at  $f_L$  to the mean power of the unoccupied OFDM block within the MCOFDM group.

Out-of-band emissions which fall between  $f_L$  and  $f_H$  within the MCOFDM group are not influenced by the RF system filter. Every unoccupied OFDM block within the MCOFDM group shall be subject to an ACLR limit.

### 4.2.6.2 Limit

For each unoccupied OFDM block within the MCOFDM group, the ACLR shall be less than 55 dB.

### 4.2.6.3 Conformance

Conformance tests as defined in clause 5.3.6 shall be carried out.

## 4.2.7 MCOFDM systems: MER performance

### 4.2.7.1 Definition

MER performance required for every occupied OFDM block within the MCOFDM group.

### 4.2.7.2 Limit

For every occupied OFDM block within the MCOFDM group, the MER shall be  $\geq 20$  dB.

### 4.2.7.3 Conformance

Conformance tests as defined in clause 5.3.7 shall be carried out.

## 4.2.8 Behaviour in case of erroneous ETI signal

### 4.2.8.1 Definition

Operational status of transmitter during ETI signal error (see ETSI ETS 300 799 [2], clauses 4 to 8).

### 4.2.8.2 Limit

The minimum requirements for DAB transmitters shall be:

- $P = 4$ ;
- $Q = 40$ ;
- $M = 80$ .

If the input signal is absent, or if frame synchronization is not achieved, the transmitter RF signal shall be muted in line with spurious emission limits, clause 4.2.4.2.

If frame synchronization is achieved, but CRC violations are detected, the transmitter shall offer two alternative responses:

- a) The output RF signal is not affected by sporadic single CRC violations. The output RF signal is switched off after P CRC violations in Q frames, and switched on after M consecutive frames free from CRC violations.
- b) The output RF signal is transmitted irrespective of CRC violations.

After the warming-up time of the transmitter the output RF signal shall be stable within two seconds following the application of an error-free input signal.

### 4.2.8.3 Conformance

Conformance tests as defined in clause 5.3.8 shall be carried out.

## 4.2.9 BER-Performance degradation

### 4.2.9.1 Definition

Difference between theoretical and actual BER degradation.

### 4.2.9.2 Limit

An operational transmitter shall not degrade the theoretical system BER (with channel coding and decoding) by more than 1 dB, under the conditions set out in table 6 and table 7.

**Table 6: BER Performance degradation limits**

Code Rate R for equal convolutional coding	0,5
Theoretical performance	according to table 7

**Table 7: BER Performance degradation limits**

BER	C/N
$1 \times 10^{-2}$	5,0 dB
$3 \times 10^{-3}$	5,4 dB
$1 \times 10^{-3}$	5,8 dB
$3 \times 10^{-4}$	6,2 dB
$1 \times 10^{-4}$	6,6 dB
$3 \times 10^{-5}$	6,9 dB
$1 \times 10^{-5}$	7,2 dB
$3 \times 10^{-6}$	7,5 dB
$1 \times 10^{-6}$	7,8 dB

### 4.2.9.3 Conformance

Conformance tests as defined in clause 5.3.9 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 for the affected technical requirements.

### 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 related to the corresponding limit will 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 recorded value of the measurement uncertainty shall be, for each measurement, equal to or less than the figures in table 8.

For the test methods, according to the present document, the measurement uncertainty figures shall be calculated and shall correspond to an expansion factor (coverage factor)  $k = 1,96$  or  $k = 2$  (which provide confidence levels of respectively 95 % and 95,45 % in the case where the distributions characterizing the actual measurement uncertainties are normal (Gaussian)). Principles for the calculation of measurement uncertainty are contained in ETSI TR 100 028 [i.2], in particular in annex D of the ETSI TR 100 028-2 [i.3].

Table 8 is based on such expansion factors.

**Table 8: Maximum measurement uncertainty**

Parameter	Uncertainty
Spurious emissions (conducted emissions)	3,0 dB
Out-of-band emissions (conducted emissions)	3,0 dB

### 5.3 Methods of measurement

#### 5.3.1 Rated output power accuracy

##### 5.3.1.1 Method of measurement

###### 5.3.1.1.1 Initial conditions

Test environment:

The normal operating environment, as declared by the equipment manufacturer.

Test frequencies:

- the lowest operating frequency of the EUT;
- the highest operating frequency of the EUT;

- c) a frequency mid-way between a) and b) above.

Test arrangement (see figure B.1):

- 1) all ports unused at the time of testing shall be correctly terminated;
- 2) connect the EUT to the Test Load, via the Coupling Device or via the attenuator;
- 3) connect the measuring device to the Coupling Device or attenuator.

#### 5.3.1.1.2 Procedure

The power of the signal of a DAB transmitter is defined as the long-term average of the time-varying short-term signal power. An appropriate instrument for DAB power measurements is a thermal power meter. The signal power is constant symbol by symbol. A certain short-term variation is especially given by the Null symbol.

#### 5.3.1.1.3 Test requirements

The results obtained shall be compared to the limits in clause 4.2.1.2 in order to demonstrate compliance.

### 5.3.2 Frequency stability

#### 5.3.2.1 Method of measurement

##### 5.3.2.1.1 Initial conditions

Test environment:

The normal operating environment, as declared by the equipment manufacturer.

Test frequencies:

Any one frequency within the tuning range of the EUT.

Test arrangement (see figure B.1):

- 1) all ports unused at the time of testing shall be correctly terminated;
- 2) connect the EUT to the Test Load, via the Coupling Device or via the attenuator;
- 3) connect the measuring device to the Coupling Device or attenuator.

Alternatively, the transmitter local oscillator may be measured in order to calculate the frequency stability of the EUT RF output signal.

##### 5.3.2.1.2 Procedure

The characteristic frequency may be measured with any suitable measuring device, provided that the accuracy attained during the measurement is better than approximately 10 % of the frequency tolerance or the frequency stability given in the relevant equipment specification of the transmitter.

For a tight frequency tolerance or a high degree of frequency stability, the measuring accuracy stated above puts higher demands on the accuracy of the measuring equipment.

In this case, the measurements shall preferably be made with a recording instrument.

The accuracy of the measuring method, if known, shall be stated with the results of the measurements. If not known, an estimate should be given.

The conditions of operation shall also be given together with the assigned frequency of the emission, which has been used as the characteristic frequency.

### 5.3.2.1.3 Test requirements

The results obtained shall be compared to the limits in clause 4.2.2.2 in order to demonstrate compliance.

## 5.3.3 Crest factor

### 5.3.3.1 Method of measurement

#### 5.3.3.1.1 Initial conditions

Test environment:

The normal operating environment, as declared by the equipment manufacturer.

Test frequencies:

- a) the lowest operating frequency of the EUT;
- b) the highest operating frequency of the EUT;
- c) a frequency mid-way between a) and b) above.

Test arrangement (see figure B.1):

- 1) all ports unused at the time of testing shall be correctly terminated;
- 2) connect the EUT to the Test Load, via the Coupling Device or attenuator;
- 3) connect the measuring device to the Coupling Device or attenuator.

#### 5.3.3.1.2 Procedure

Using a suitable measuring device first record the peak power then record the mean power.

#### 5.3.3.1.3 Test requirements

The results obtained shall be compared to the limits in clause 4.2.3.2 in order to demonstrate compliance.

## 5.3.4 Spurious emissions

### 5.3.4.1 Method of measurement

#### 5.3.4.1.1 Initial conditions

Test environment:

The normal operating environment, as declared by the equipment manufacturer.

Test frequencies:

- a) the lowest operating frequency of the EUT;
- b) the highest operating frequency of the EUT;
- c) a frequency mid-way between a) and b) above.

Test arrangement (see figure B.1):

- 1) all ports unused at the time of testing shall be correctly terminated;
- 2) connect the EUT to the Test Load, via the Coupling Device or via the attenuator;

- 3) connect the measuring device to the Coupling Device or attenuator.

#### 5.3.4.1.2 Procedure

- 1) operate the EUT at each of the test frequencies as defined in clause 5.3.4.1.1;
- 2) measure the results on the Spectrum Analyser.

#### 5.3.4.1.3 Test requirements

The results obtained shall be compared to the limits in clause 4.2.4.2 in order to demonstrate compliance.

### 5.3.5 Out-of-band emissions

#### 5.3.5.1 Method of measurement

##### 5.3.5.1.1 Initial conditions

Test environment:

The normal operating environment, as declared by the equipment manufacturer.

Test frequencies:

- a) the lowest operating frequency of the EUT;
- b) the highest operating frequency of the EUT;
- c) a frequency mid-way between a) and b) above.

Test arrangement (see figure B.2).

##### 5.3.5.1.2 Procedure

- 1) all ports unused at the time of testing shall be correctly terminated;
- 2) operate the EUT at each of the test frequencies as defined in clause 5.3.5.1.1;
- 3) measure the results on the Spectrum Analyser.

##### 5.3.5.1.3 Test requirements

The results obtained shall be compared to the limits in clause 4.2.5.2 in order to demonstrate compliance.

### 5.3.6 MCOFDM systems: ACLR

#### 5.3.6.1 Method of measurement

##### 5.3.6.1.1 Initial conditions

Test environment:

The normal operating environment, as declared by the equipment manufacturer.

Test frequencies:

- a) the operating frequency of each unoccupied OFDM block between the lowest and highest used frequencies of the EUT.

Test arrangement (see figure B.3):

The manufacturer shall ensure that the lowest and highest OFDM blocks are operated at the full rated output power of the transmitter during this test.

#### 5.3.6.1.2 Procedure

- 1) connect the EUT to the Test Load, via the Coupling Device;
- 2) measure the mean power of the OFDM block centred at  $f_L$ ;
- 3) measure the mean power of the OFDM block centred at the test frequency;
- 4) calculate the ACLR as the ratio of the two powers.

The ACLR can be measured directly on some spectrum analysers, but off-line calculation by a numerical linear power sum of the trace data may be required in other cases.

#### 5.3.6.1.3 Test requirements

The results obtained shall be compared to the limits in clause 4.2.6.2 in order to demonstrate compliance.

### 5.3.7 MCOFDM systems: MER

#### 5.3.7.1 Method of measurement

##### 5.3.7.1.1 Initial conditions

Test environment:

The normal operating environment, as declared by the equipment manufacturer.

Test frequencies:

- a) the operating frequency of each occupied OFDM block of the EUT.

Test arrangement (see figure B.3):

The manufacturer shall ensure that the lowest and highest OFDM blocks are operated at the full rated output power of the transmitter during this test.

##### 5.3.7.1.2 Procedure

- 1) connect the EUT to the Test Load, via the Coupling Device;
- 2) MER can be measured directly with a suitable DAB enabled RF analyser or decoder. The analyser should be connected to a suitable low level RF coupling device on the antenna or test load port after the EUT RF system filter.

##### 5.3.7.1.3 Test requirements

The results obtained shall be compared to the limits in clause 4.2.7.2 in order to demonstrate compliance.

### 5.3.8 Behaviour in case of erroneous ETI signal

#### 5.3.8.1 Method of measurement

##### 5.3.8.1.1 Initial conditions

Test environment:

The normal operating environment, as declared by the equipment manufacturer.

Test arrangement (see clause B.1).

##### 5.3.8.1.2 Procedure

See annex C.

##### 5.3.8.1.3 Test requirements

The results obtained shall be compared to the limits in clause 4.2.8.2 in order to demonstrate compliance.

### 5.3.9 BER-Performance degradation

#### 5.3.9.1 Method of measurement

##### 5.3.9.1.1 Initial conditions

Test environment:

The normal operating environment, as declared by the equipment manufacturer.

Test arrangement (see clause C.2).

##### 5.3.9.1.2 Procedure

For this measurement a test receiver should be used. In principle, only the degradation of the whole chain (transmitter and receiver) can be assessed, but this can provide a useful indication of transmitter degradation.

The receiver is connected to the output of the transmitter (without insertion of a channel simulator). Error correction shall be enabled in both the EUT and the receiver. Band limited noise is added to the DAB signal at the receiver input in order to achieve a given value of BER. Adjustable attenuators are used to set both the input power (C) and the noise power (N) to appropriate values at the input of the receiver. BER is the ratio of erroneous bits of the received data to the total bits of the received data during the measurement interval. The power of the added noise, N, is measured within the nominal DAB bandwidth of 1,536 MHz.

##### 5.3.9.1.3 Test requirements

The results obtained shall be compared to the limits in clause 4.2.9.2 in order to demonstrate compliance.



## 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.4] to provide one voluntary means of conforming to the essential requirements of Directive 2014/53/EU on the harmonisation of the laws of the Member States relating to the making available on the market of radio equipment and repealing Directive 1999/5/EC [i.1].

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

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

Harmonised Standard ETSI EN 302 077					
Requirement				Requirement Conditionality	
No	Description	Essential requirements of Directive	Clause(s) of the present document	U/C	Condition
1	Rated output power accuracy	3.2	4.2.1	U	
2	Frequency stability	3.2	4.2.2	U	
3	Crest factor	3.2	4.2.3	U	
4	Spurious emissions	3.2	4.2.4	U	
5	Out-of-band emissions	3.2	4.2.5	U	
6	MCOFDM ACLR	3.2	4.2.6	C	MCOFDM transmitter
7	MCOFDM MER	3.2	4.2.7	C	MCOFDM transmitter
8	Behaviour in case of erroneous ETI signal	3.2	4.2.8	U	
9	BER-Performance degradation	3.2	4.2.9	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".

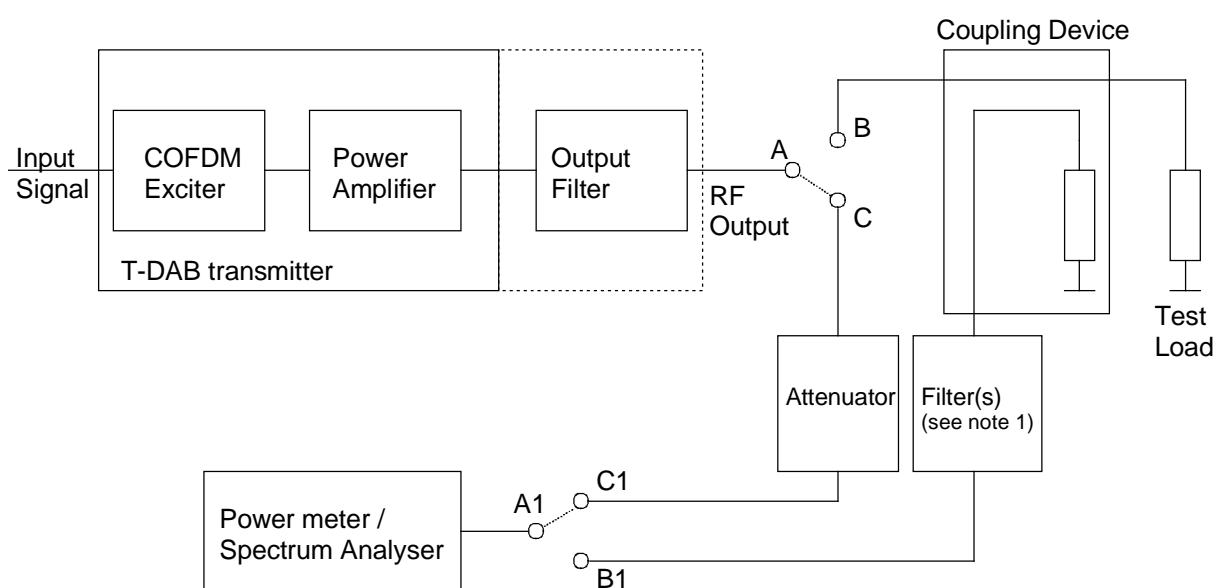
Presumption of conformity stays valid only as long as a reference to the present document is maintained in the list published in the Official Journal of the European Union. Users of the present document should consult frequently the latest list published in the Official Journal of the European Union.

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

## Annex B (normative): General measuring arrangements

### B.1 Testing arrangements for antenna port measurements

#### B.1.1 Spurious emissions



NOTE 1: The optional filter should suppress the output signal so that no intermodulation products are generated by the spectrum analyser. The insertion loss throughout the measuring range should be known.

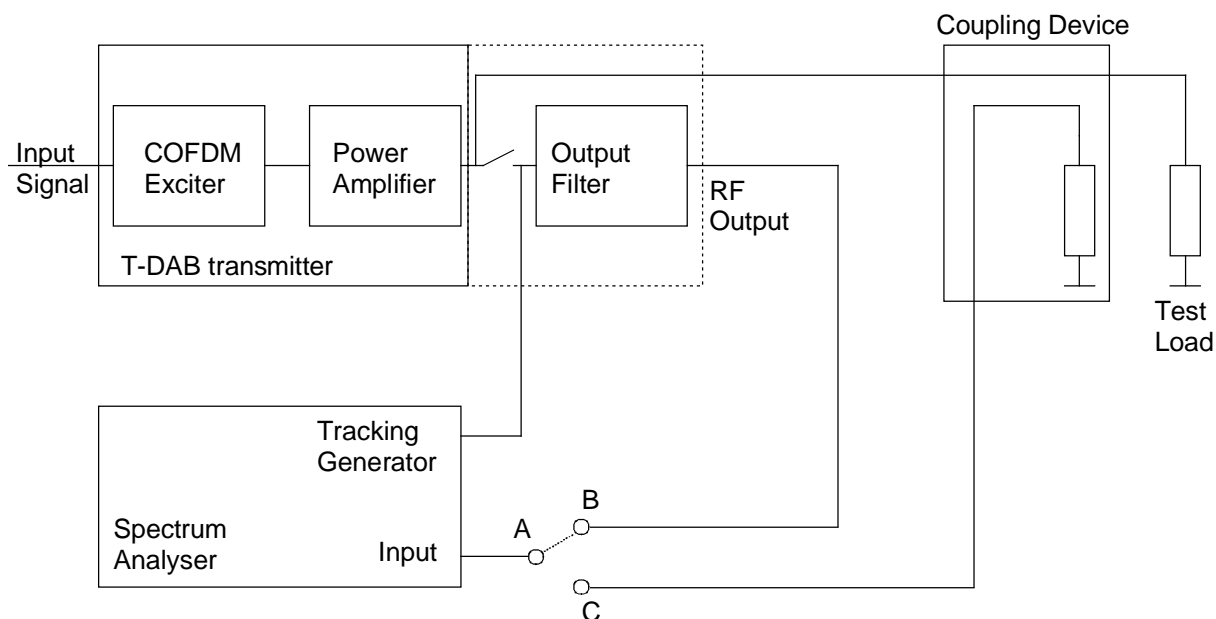
NOTE 2: For high power transmitters the preferred set up would require A to be connected to B and A1 to be connected to B1.

NOTE 3: For low power transmitters the preferred set up would require A to be connected to C and A1 to be connected to C1.

NOTE 4: If the transmitter does not include any output filter, an external filter shall be added after the transmitter for the testing arrangement. This filter shall be representative of the multiplexer or filter existing in operational conditions and viewed by the transmitted output when installed. In this case, the antenna port measurements shall be performed at the output of this extra filter.

**Figure B.1: Testing arrangement for spurious emissions**

## B.1.2 Out-of-band emissions

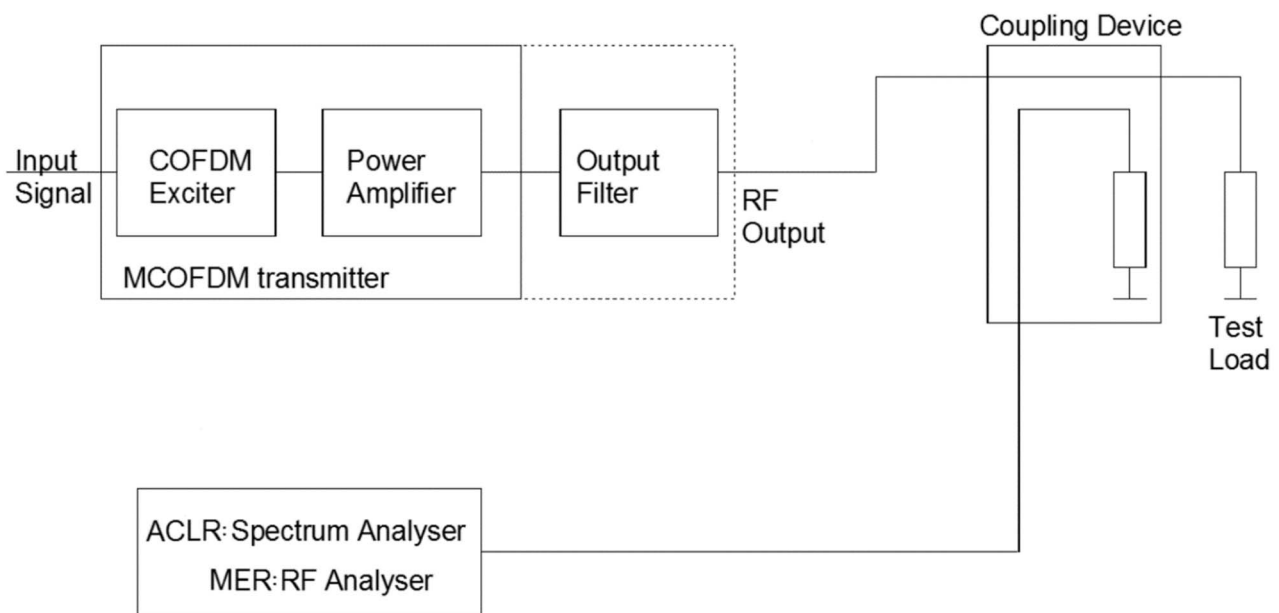


To overcome dynamic range limitations of typical spectrum analysers a composite measurement approach is proposed as follows:

- NOTE 1: Disconnect the power amplifier from the output filter.
- NOTE 2: The frequency response of the output filter shall be measured and recorded (connection A to B).
- NOTE 3: The spectrum of the DAB signal at the output of the power amplifier shall be measured and recorded (connection A to C).
- NOTE 4: The out-of-band spectrum of the DAB signal shall be calculated by applying the recorded frequency response of the output filter to the recorded spectrum of the DAB signal.
- NOTE 5: If the transmitter does not include any output filter, an external filter shall be added after the transmitter for the testing arrangement. This filter shall be representative of the RF combiner or filter existing in operational conditions and viewed by the transmitted output when installed. In this case, the antenna port measurements shall be performed at the output of this extra filter.

**Figure B.2: Testing arrangement for out-of-band emissions**

### B.1.3 MCOFDM: ACLR and MER performance



NOTE: If the transmitter does not include any output filter, an external filter shall be added after the transmitter for the testing arrangement. This filter shall be representative of the multiplexer or filter existing in operational conditions and viewed by the transmitted output when installed. In this case, the antenna port measurements shall be performed at the output of this extra filter.

**Figure B.3: Testing arrangement for MCOFDM ACLR and MER performance**

### B.1.4 Test frequency range

Limits on unwanted emissions for radio equipment are considered to be applicable to the range 9 kHz to 300 GHz. However, for practical measurement purposes, the frequency range of spurious emissions may be restricted. As guidance for practical purposes, the following measurement parameters in table B.1 are recommended.

**Table B.1: Test frequency range**

Unwanted emission frequency measurement range	
lower frequency	upper frequency
9 kHz	1 GHz

The following reference bandwidths shall be used:

For Spurious Emissions:

- 100 kHz between 9 kHz and 174 MHz;
- 4 kHz between 174 MHz and 400 MHz;
- 100 kHz between 400 MHz and 1 GHz.

For Out-of- band Emissions:

- 4 kHz.

## B.1.5 Test modulating signal

No special test signal is required; however, an input signal or PRBS should be provided, according to the specification of the transmitter, to obtain a valid DAB output signal as defined in ETSI EN 300 401 [1], clause 15.

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## Annex C (normative): Typical COFDM measuring arrangements

### C.1 ETI errors

The test arrangement is shown in figure C.1.



**Figure C.1: ETI Test arrangement**

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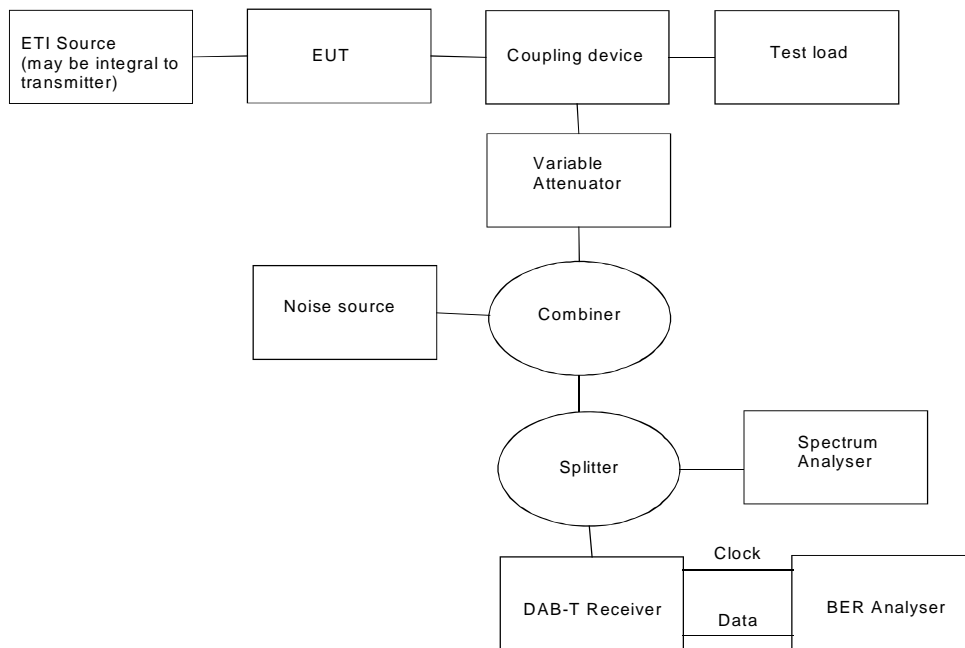
### C.2 Bit Error performance measurement

#### C.2.1 Test procedure

- Run the EUT for at least 30 min at its nominal power.
- Set the spectrum analyser centre frequency to the Tx frequency, Span to 5 MHz, Reference Band Width to 30 kHz, Video Band Width to 100 Hz.
- Make sure that the internal noise of the analyser is less than 25 dB below the noise source output. Make sure that the analyser is not overloaded.
- Adjust the variable attenuator and/or the noise source output until the spectrum analyser shows the desired  $(C + N_0)/N_0$ . Use the marker to read the results from the analyser.

EXAMPLE: For 5 dB  $C/N_0$ , the DAB signal on the analyser display is 6,2 dB above the noise level.

- Set the EUT and the DAB Receiver according to figure C.2.
- The Bit Error Ratio is displayed on the BER analyser.



**Figure C.2: Bit error performance measurement**



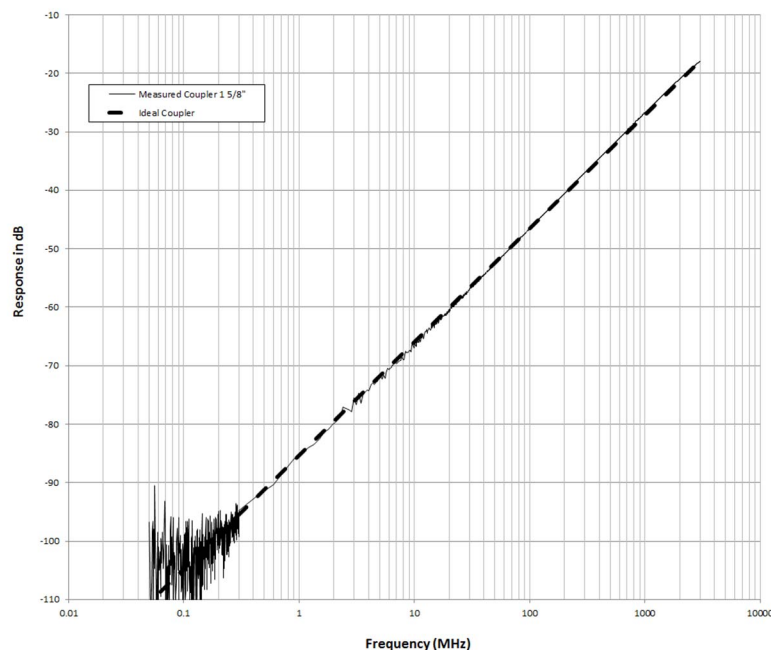
## Annex D (informative): Practical measurement of spurious domain emissions

### D.1 Introduction

The accurate measurement of spurious domain emissions is typically limited by the dynamic range of the spectrum analyser. It is usually necessary to use additional band-reject, low pass or high pass filters to remove the fundamental signal in order to reveal the unwanted spurious domain emissions.

### D.2 Directional coupler issues

Measurements on live equipment connected to broadcast antennas are further complicated by practical issues relating to the couplers used to probe the transmitter output signal. These typically exhibit a frequency dependent response which is expected to be accounted for in the measurement. Directional couplers usually exhibit a response whereby the coupling factor increases 6 dB per octave as shown in figure D.1 for a device for use with a 1 5/8 " feeder.



**Figure D.1: Typical Measured Directional Coupler Frequency Response (1 5/8 " feeder)**

At low frequencies, the decreasing coupling factor results in a low signal level and the spurious domain measurement will typically be limited by the noise floor of the spectrum analyser.

The RF transmission response seen in figure D.1 shows very low coupling factors at low frequencies and higher coupling factors at frequencies above the operating channel. In order to overcome this effect a composite measurement approach can be adopted as follows:

The levels of the spurious emissions at the output of the channel filter / RF combiner may be calculated by weighting the measured result with the frequency response of the coupler. This calculation can be carried out off-line.

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## Annex E (informative): Spectrum measurements

The spectrum mask is defined in relation to spectrum density measured in 4 kHz bandwidth.

The spectral density of a DAB signal is defined as the long-term average of the time-varying signal power per unity bandwidth (i.e. 1 Hz). Values for other bandwidths can be achieved by proportional increase of the values for unity bandwidth.

The spectral density of a DAB signal can in principle be determined by the following procedure: The DAB signal is applied to a band filter with rectangular passband characteristics and a known bandwidth (typically 10 kHz) and with an adjustable centre frequency. The output of the filter is measured by a power meter that delivers real mean values and integrates as long as necessary (typically 2 transmission frames) to get constant readings. These readings can be interpreted as the average spectral density for the measurement bandwidth used. By moving the centre frequency step by step across the DAB signal and adjacent frequency regions the frequency dependent average of the spectral density can be found. The derivation of the average spectrum density for the unity bandwidth is straightforward. In practice, such measurements are often performed by using a spectrum analyser. It has to be analysed to what extent the device follows the principles given above. In particular, equivalent noise bandwidth and RMS measurement need to be carefully checked.

Due to the prolongation of the COFDM symbol by the guard interval the spectral density inside the nominal bandwidth varies by about 3 dB with a periodicity of the carrier distance. This variation can only be observed in its entirety if the bandwidth of the spectral density measurement filter is low compared to the carrier distance (the carrier distance is mode-dependent). Low measurement bandwidth allows detection of small CW components within the COFDM spectrum. Those components that fall outside the nominal DAB frequency block should be treated separately from the COFDM signal as their impairment effect may be different.

To avoid regular structures in the modulated signal a non-regular, e.g. a PRBS like or a programme type digital transmitter-input signal, is necessary.

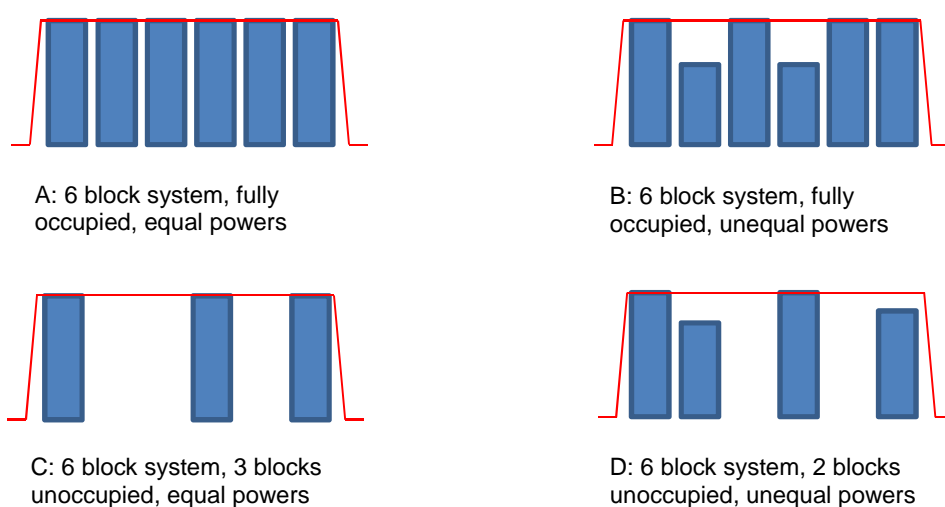
Care has to be taken that the input stage of the selective measurement equipment is not overloaded by the main lobe of the signal while assessing the spectral density of the side lobes, i.e. the out-of-band range. Especially in cases with very strong attenuation of the side lobes non-linear distortion in the measurement equipment can produce side lobe signals that mask the original ones. Selective attenuation of the main lobe has proven to be in principal a way to avoid this masking effect. However, as the frequency response of the band-stop filter has to be included in the evaluation the whole measurement procedure may become somewhat complex.

## Annex F (informative): MCOFDM systems

### F.1 Introduction

A traditional DAB transmitter generates and amplifies a single OFDM block. However, with the further development of DAB networks, lower cost filler transmitters are desirable, and the ability to generate and amplify multiple OFDM blocks within the same transmitter becomes attractive. An MCOFDM system fulfils this need.

An MCOFDM system allows a number of adjacent OFDM blocks to be generated and amplified. The power of each OFDM block within the MCOFDM group may be different, and some OFDM blocks may not be occupied. Some example arrangements are shown in figure F.1.



**Figure F.1: Example MCOFDM systems**

The requirements for spurious and OOB emissions from an MCOFDM system are the same as for traditional DAB transmitters, based on the block edge characteristics, as shown in figure F.2.

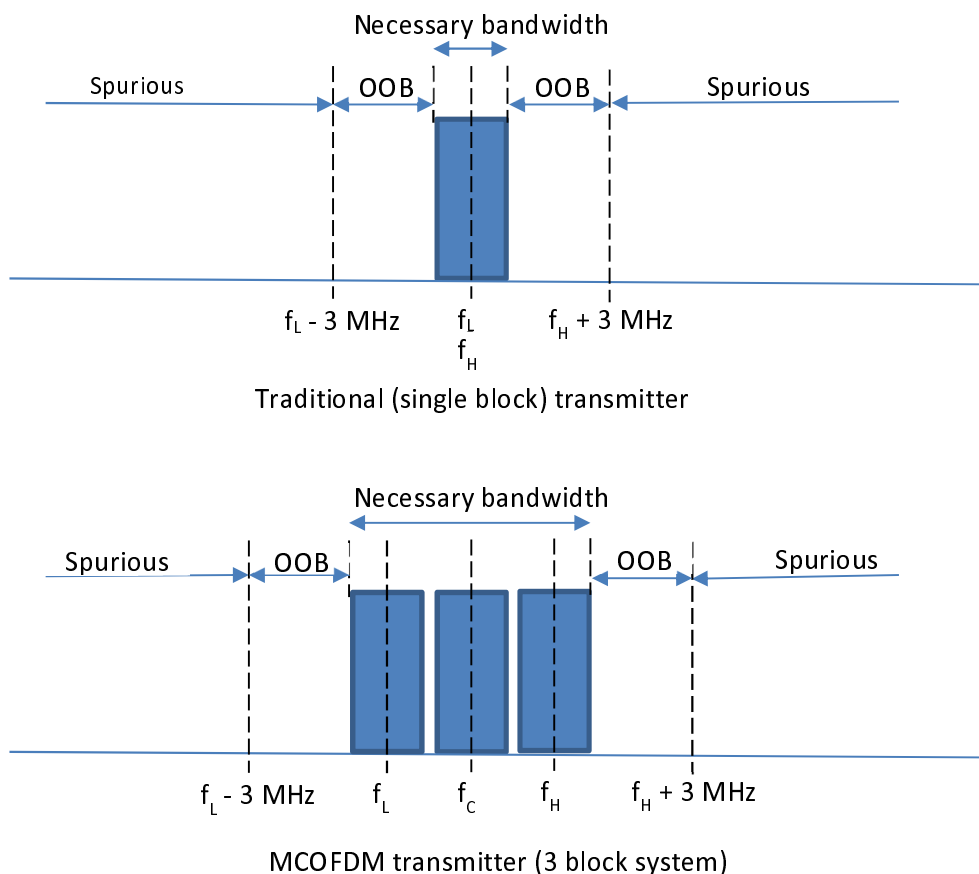


Figure F.2: Frequency bands of spurious and OOB emissions and necessary bandwidth

## F.2 Architecture

The MCOFDM signal chain consists of the same three elements as a traditional single OFDM block transmission system, that is an exciter, RF amplifier and RF system filter.

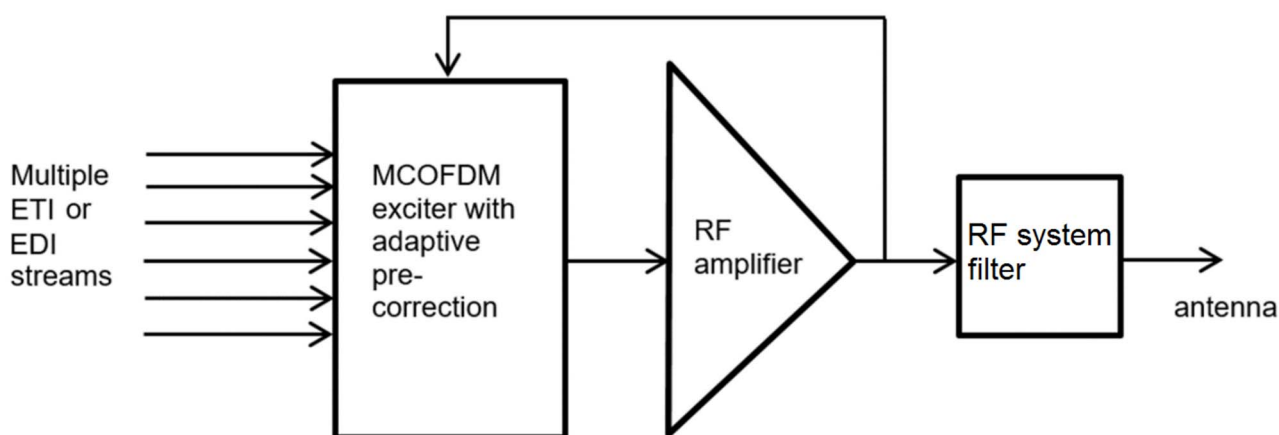


Figure F.3: Typical MCOFDM architecture

The MCOFDM exciter is fed with multiple ETI or EDI feeds and generates a group of DAB OFDM blocks. Each block can be individually configured, allowing parameters such as SFN timing, TII, etc. to be set.

The composite group of OFDM blocks is then passed through a single amplifier chain (with suitable digital adaptive non-linear and linear pre-correction).

The MCOFDM output from the RF amplifier is then passed through a RF band-pass system filter. The filter amplitude response is set to provide sufficient bandwidth in order to pass the group of OFDM blocks with low loss. Stop band attenuation provides suppression beyond the upper and lower edges of the group of blocks. Since the RF system filter passes the entire MCOFDM group, the attenuation of unoccupied OFDM blocks within the group is performed in the exciter.

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## Annex G (informative): Change history

Version	Information about changes
2.1.1	First published version covering Directive 2014/53/EU. Major changes are: <ul style="list-style-type: none"><li>• Introduction of MCOFDM systems</li><li>• Removal of cabinet radiation testing (transferred to EMC testing)</li></ul>

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## History

Document history		
V1.1.1	January 2005	Publication as ETSI EN 302 077 parts 1 and 2
V2.1.0	March 2018	EN Approval Procedure AP 20180603: 2018-03-05 to 2018-06-04
V2.1.1	June 2018	Publication