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Digital Audio Broadcasting (DAB); Domestic and in-vehicle digital radio receivers; Minimum requirements and Test specifications for technologies and products

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Foreword

This Technical Specification (TS) has been produced by Joint Technical Committee (JTC) Broadcast of the European Broadcasting Union (EBU), Comité Européen de Normalisation ELECtrotechnique (CENELEC) and the European Telecommunications Standards Institute (ETSI).

NOTE 1: The EBU/ETSI JTC Broadcast was established in 1990 to co-ordinate the drafting of standards in the specific field of broadcasting and related fields. Since 1995 the JTC Broadcast became a tripartite body by including in the Memorandum of Understanding also CENELEC, which is responsible for the standardization of radio and television receivers. The EBU is a professional association of broadcasting organizations whose work includes the co-ordination of its members' activities in the technical, legal, programme-making and programme-exchange domains. The EBU has active members in about 60 countries in the European broadcasting area; its headquarters is in Geneva.

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The Eureka Project 147 was established in 1987, with funding from the European Commission, to develop a system for the broadcasting of audio and data to fixed, portable or mobile receivers. Their work resulted in the publication of European Standard, ETSI EN 300 401 [1], for DAB (see note 2) which now has worldwide acceptance.

NOTE 2: DAB is a registered trademark owned by one of the Eureka Project 147 partners.

The DAB family of standards is supported by WorldDAB, an organization with members drawn from broadcasting organizations and telecommunication providers together with companies from the professional and consumer electronics industry.

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 describes the minimum requirements for digital radios, both domestic and in-vehicle, and the necessary test methods that lead to compliance with the requirements. It may be used as the technical basis for a Digital Radio Certification Mark scheme. A Digital Radio Certification Mark is designed to be used on product packaging and provides an easily recognized mark to correspond to public information campaigns on the necessary requirements for consumers to make a switch to digital radio. Manufacturers are, of course, free to include additional features or increased performance compared to the minimum requirements specified in the present document.

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.

[1] ETSI EN 300 401 (V2.1.1): "Radio Broadcasting Systems; Digital Audio Broadcasting (DAB) to mobile, portable and fixed receivers".

[2] ETSI TS 101 756: "Digital Audio Broadcasting (DAB); Registered Tables".

[3] ETSI TS 103 176: "Digital Audio Broadcasting (DAB); Rules of implementation; Service information features".

[4] ETSI ETS 300 799: "Digital Audio Broadcasting (DAB); Distribution interfaces; Ensemble Transport Interface (ETI)".

[5] ETSI ETS 300 384: "Radio broadcasting systems; Very High Frequency (VHF), frequency modulated, sound broadcasting transmitters".

[6] IEC 62106:2015: "Specification of the radio data system (RDS) for VHF/FM sound broadcasting in the frequency range from 87,5 MHz to 108,0 MHz".

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.

Not applicable.

3 Definitions and abbreviations

3.1 Definitions

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

adapter: product that provides a DAB and DAB+ capability to another device

adequate audio reception: error rate of the output data stream of the Viterbi decoder is equal to or better than 10^{-4} when decoding a 128 kbit/s DAB audio service transmitted with error protection level EEP-3A

band scan: user function to scan the whole of the tuning range to update the stored service list when required

receiver: any device designed to receive digital radio signals

3.2 Abbreviations

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

AAC	Advanced Audio Coding
AUX	AUXilliary
BER	Bit Error Rate
CD	Compact Disc
CU	Capacity Unit
DAB	Digital Audio Broadcasting
DC	Direct Current
DL	Dynamic Label
DUT	Device Under Test
EEP	Equal Error Protection
EId	Ensemble Identifier
EOH	End Of Header
ETI	Ensemble Transport Interface
EU	European Union
FAR	Fully Anechoic Room
FIC	Fast Information Channel
FIG	Fast Information Group
FM	Frequency Modulation
FM-RDS	Frequency Modulation-Radio Data System
MCI	Multiplex Configuration Information
MFN	Multiple Frequency Network
MPEG	Moving Pictures Expert Group
NI	Network Independent
OE	Other Ensemble
OEM	Original Equipment Manufacturer
OOI	Occurrence Of Impairments
PAD	Programme Associated Data
PC	Personal Computer
PI	Programme Identification code (RDS)
PLB	Preferred Line Break
PS	Parametric Stereo
PSU	Power Supply Unit
PWB	Preferred Word Break
RA	Rual Area
RDS	Radio Data System
RF	Radio Frequency
RMS	Root Mean Squared
SAR	Semi Anachois Room
SBR	Spectral Band Replication
SFN	Single Frequency Network
SId	Service Identifier

SPI	Service and Programme Information
SPL	Sound Pressure Level
TEM	Transverse ElectroMagnetic
TU	Typical Urban
UCS	Universal Character Set
UEP	Unequal Error Protection
UI	User Interface
USB	Universal Serial Bus
UTF	Unicode Transformation Format

4 Digital Radio Certification Mark

The present document comprises the requirements and test specifications by which radio receivers can qualify to carry a Digital Radio Certification Mark ("the Mark"). The purpose of the Mark is to ensure that consumers can readily identify products which are suitable for reception of digital radio services and which provide features at a sufficiently high level of performance to ensure that the product meets the criteria set out for a switchover process and beyond. The requirements are based on the design of DAB transmission networks, which are the result of internationally agreed coverage planning, and essential user features that present digital radio as a desirable yet affordable product.

In order to qualify for use of the Mark, products shall meet the minimum requirements set out for the type of product, either:

- Minimum requirements for domestic digital radio receivers (see clause 5); or
- Minimum requirements for in-vehicle digital radio receivers (see clause 6).

Products are considered to consist of a core technology - that is a chip or module that may be common to many products - and displays, antennas, power supplies, casework, etc., which in combination are specific to a particular product model.

In order to prove compliance against the minimum requirements, products shall pass both of the test specifications, below:

- Test specification for core technology (see clause 7).
- Test specification for products (see clause 8).

The test specification for core technology is designed to explore all aspects of the minimum requirements, whereas the test specification for products is designed to explore how the core technology performs when integrated into the product.

This is shown diagrammatically in figure 1.

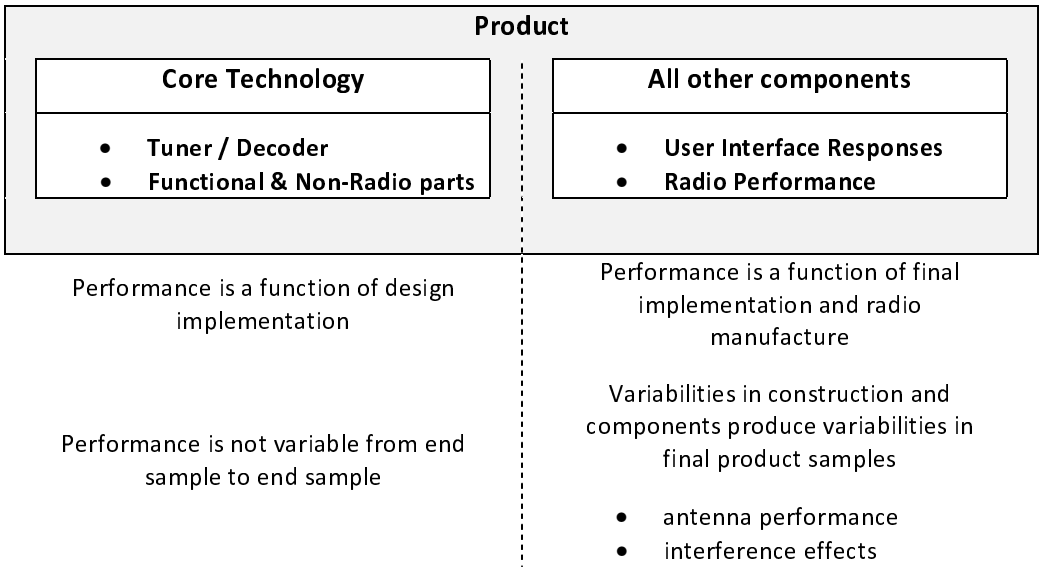


Figure 1: Product testing scheme

For certain product architectures, some aspects of the required functions may be performed by a combination of the core technology and the other components. In this case, some aspects of the core technology testing cannot be performed with the core technology alone: these specific tests shall be recorded in the core technology test report and shall be carried out on the final product in addition to the product testing.

The process for applying for certification to use the Mark is beyond the scope of the present document, but national and international schemes are expected to be in place.

5 Minimum requirements for domestic digital radio receivers

5.1 Introduction

The minimum requirements for domestic digital radio receivers are set out in this clause 5. In-vehicle digital radio receivers are the subject of clause 6.

Domestic products comprise many types of receiver, including portable and larger devices, and receivers incorporated in equipment such as mobile phones and computers. This includes adapters, whose main function is to add a digital radio capability to another device. Domestic products may be mains or battery powered, or both. They may have a telescopic antenna, a flexible wire antenna, an earphone antenna, an antenna integrated into the receiver, or they may be supplied without an antenna.

Products may include additional features beyond the minimum requirement, including reception of digital radio services via other delivery platforms, such as the internet or digital television, or capabilities beyond the minimum requirement.

5.2 Frequency range

Products shall be capable of receiving DAB digital radio broadcasts in the frequency range 174 MHz to 240 MHz. The required centre frequencies of the transmitted signals are specified in annex E.

5.3 Antenna connection

An antenna connection is not required. Products sold with an antenna connection shall have an antenna input impedance of 75 Ohms.

5.4 Gaussian sensitivity

Products sold with a packaged antenna shall provide adequate audio reception of a DAB signal with Gaussian transmission channel characteristics with field strengths at or above the frequency dependent threshold shown in the following formula:

$$FSG_{min} = [\ 34{,}4 + 20\log(F/220)\ ]\ dB\mu V/m,\ \text{where F is the frequency in MHz.}$$

Products sold without an antenna shall provide adequate audio reception with an input power level of -97,7 dBm when fed by a DAB signal with Gaussian transmission channel characteristics.

NOTE: It is assumed that the external antenna has a gain of -8,1 dBi or greater thus producing this power level at the required minimum field strength. The performance of the antenna and the quality of the connectors and cabling will determine the actual sensitivity experienced by the user.

5.5 Rayleigh sensitivity

Products sold with a packaged antenna shall provide adequate audio reception of a DAB signal with Rayleigh transmission channel characteristics with field strengths at or above the frequency dependent threshold shown in the following formula:

$$FSR_{min} = [\ 39{,}9 + 20\log(F/220)\ ]\ dB\mu V/m,\ \text{where F is the frequency in MHz}$$

The Rayleigh fading channel characteristics are as specified in annex D.

Products sold without an antenna shall provide adequate audio reception with an input power level of -92,2 dBm when fed by a DAB signal with Rayleigh transmission channel characteristics.

NOTE: It is assumed that the external antenna has a gain of -8,1 dBi or greater thus producing this power level at the required minimum field strength. The performance of the antenna and the quality of the connectors and cabling will determine the actual sensitivity experienced by the user.

5.6 Receiver selectivity (adjacent channel interference)

Products shall provide adequate audio reception in the presence of interfering DAB signals at specified levels on other frequencies.

The wanted signal shall be a DAB signal at a level of -70 dBm. The interfering signal shall be a DAB signal with a frequency offset and amplitude as described in table 1.

Products shall achieve the required selectivity for an interfering signal in all adjacent channels.

Table 1: Receiver selectivity requirements

Frequency of interfering DAB signal	Level of interfering signal, relative to wanted signal
±1,712 MHz relative to wanted signal	+35 dB
±3,428 MHz relative to wanted signal	+40 dB
±5,136 MHz relative to wanted signal	+45 dB
All DAB centre frequencies (see annex E) with more than 6 MHz offset from wanted signal	+45 dB

5.7 DAB and DAB+ channel decoding

Products shall be able to decode one audio sub-channel.

NOTE: Products may decode additional audio sub-channels.

Products shall be able to decode a DAB audio component contained in a sub-channel of a size up to and including 208 Capacity Units.

Products shall be able to decode a DAB+ audio component contained in a sub-channel of a size up to and including 144 Capacity Units.

All protection levels shall be supported.

5.8 Analogue radio requirements

Products, except adapters, shall be able to receive FM analogue radio broadcasts, as described in ETSI ETS 300 384 [5], in the frequency range 87,5 MHz to 107,9 MHz.

5.9 Retuning

Products which store a list of services/service components shall provide a "band scan" user function which scans the whole of the tuning range and updates the stored list when required. This feature shall be initiated by the press of a single button on the device, or, if it is a feature in a menu structure, it shall be in the top level of the menu, or one level down.

The band scan feature shall ensure that all services and service components currently on-air that the receiver is able to decode are added to the service list. Multiple instances of the same service (i.e. same SId) on different ensembles, or on the same ensemble but at different frequencies, shall produce only a single entry in the service list which shall contain at least the source of the service at the best signal quality at the time of scanning. Additional sources may also be stored.

The band scan feature may clear the service list of all entries before performing the scan. Alternatively, the band scan feature shall ensure that previously stored service list entries that are not found during the band scan are suitably marked or removed.

NOTE 1: Since the available services may change after performing a band scan, the effect on preset buttons should be carefully considered.

NOTE 2: DAB ensembles change their configuration from time to time. It is recommended that products update their stored service list by constantly checking the FIC of the ensemble to which they are currently tuned. Background scanning (for example, immediately after switch-off) to maintain an up-to-date service list is recommended.

5.10 Text display

Products shall have a means of displaying text to the user.

The text display shall display the name of the audio components available for selection. Products shall display the **complete** label whenever possible. The label shall only be reduced in length by applying the character selection provided in the flag field of the label. It is not permissible for the product to reduce the length of the label in any other manner.

Products shall display the service label when a primary audio component is selected. Products shall display the service component label when a secondary audio component is selected.

Products shall decode the dynamic label from the X-PAD (short X-PAD, variable length X-PAD, whether the dynamic label is the only PAD application or if it is one of a number of PAD applications) of the currently selected service and display it to the user legibly. Products shall treat the special characters 0x0A, 0x0B, and 0x1F as specified in ETSI EN 300 401 [1] and apply such formatting as is possible on the display. Products shall act upon the command to remove the label from the display by **immediately** removing the label, even if it has only been partially displayed.

It is accepted that different displays will have different text rendering capabilities. Receivers shall have a display capable of rendering all the characters from the Complete EBU Latin based repertoire character set, as defined in ETSI TS 101 756 [2], annex C, correctly mapped, visually well-formed and clear.

6 Minimum requirements for in-vehicle digital radio receivers

6.1 Introduction

The minimum requirements for in-vehicle digital radio receivers are set out in this clause 6. Domestic digital radio receivers are the subject of clause 5.

In-vehicle products are those products designed specifically for use within a vehicle.

In-vehicle products comprise many types of receiver, including those integrated into the dashboard, and aftermarket products mounted in the dashboard, behind the dashboard, to the vehicle windscreen or elsewhere. Aftermarket products designed to be self-installed by the consumer should ensure that proper consideration is given to ensuring that power adapters, etc., do not cause interference in the FM and DAB broadcast bands.

In-vehicle products may supplied with or without an antenna.

Products may include additional features beyond the minimum requirement, or capabilities beyond the minimum requirement.

6.2 Frequency range

Products shall be capable of receiving DAB and DAB+ digital radio broadcasts in the frequency range 174 MHz to 240 MHz. The required centre frequencies of the transmitted signals are specified in annex E.

6.3 Antenna connection

An antenna connection with input impedance of 50 Ohms is required.

6.4 Gaussian sensitivity

Products shall provide adequate audio reception with an input power level of -97,7 dBm when fed by a DAB signal with Gaussian transmission channel characteristics.

Products sold with a packaged antenna shall provide adequate audio reception of a DAB signal with Gaussian transmission channel characteristics with field strengths at or above the frequency dependent threshold shown in the following formula:

$$FSG_{min} = [\ 29{,}2 + 20\log(F/220)\ ]\ dB\mu V/m,\ \text{where F is the frequency in MHz.}$$

NOTE: The performance of the antenna and the quality of the connectors and cabling will determine the actual sensitivity experienced by the user. Assuming glass mount antennas are properly fitted in the vehicle, the experienced sensitivity will still depend on several factors, like the type of vehicle, direction of driving, interaction with the body and other components present, etc.

6.5 Rayleigh sensitivity

Receivers shall provide adequate audio reception with an input power level of -92,2 dBm when fed by a DAB signal with Rayleigh transmission channel characteristics.

Products sold with a packaged antenna shall provide adequate audio reception of a DAB signal with Rayleigh transmission channel characteristics with field strengths at or above the frequency dependent threshold shown in the following formula:

$$FSR_{min} = [\ 34{,}7 + 20\log(F/220)\ ]\ dB\mu V/m,\ \text{where F is the frequency in MHz}$$

The Rayleigh fading channel characteristics are as specified in annex D.

NOTE: The performance of the antenna and the quality of the connectors and cabling will determine the actual sensitivity experienced by the user. Assuming glass mount antennas are properly fitted in the vehicle, the experienced sensitivity will still depend on several factors, like the type of vehicle, direction of driving, interaction with the body and other components present, etc.

6.6 Receiver selectivity (adjacent channel interference)

Products shall provide adequate audio reception in the presence of interfering DAB signals at specified levels on other frequencies.

The wanted signal shall be a DAB signal at a level of -70 dBm. The interfering signal shall be a DAB signal with a frequency offset and amplitude as described in table 2.

Products shall achieve the required selectivity for an interfering signal in all adjacent channels.

Table 2: Receiver selectivity requirements

Frequency of interfering DAB signal	Level of interfering signal, relative to wanted signal
±1,712 MHz relative to wanted signal	+35 dB
±3,428 MHz relative to wanted signal	+40 dB
±5,136 MHz relative to wanted signal	+45 dB
All DAB centre frequencies (see annex E) with more than 6 MHz offset from wanted signal	+45 dB

6.7 DAB and DAB+ channel decoding

Products shall be able to decode one audio sub-channel.

NOTE: Products may decode additional audio sub-channels.

Products shall be able to decode a DAB audio component contained in a sub-channel of a size up to and including 208 Capacity Units.

Products shall be able to decode a DAB+ audio component contained in a sub-channel of a size up to and including 144 Capacity Units.

All protection levels shall be supported.

6.8 Analogue radio requirements

Products, except adapters, shall be able to receive FM analogue radio broadcasts, as described in ETSI ETS 300 384 [5], in the frequency range 87,5 MHz to 107,9 MHz.

6.9 Retuning

Products which store a list of services/service components shall provide a "band scan" user function which scans the whole of the tuning range and updates the stored list when required. This feature shall be initiated by the press of a single button on the device, or, if it is a feature in a menu structure, it shall be in the top level of the menu, or one level down.

The band scan feature shall ensure that all services and service components currently on-air that the receiver is able to decode are added to the service list. Multiple instances of the same service (i.e. same SId) on different ensembles, or on the same ensemble but at different frequencies, shall produce only a single entry in the service list which shall contain at least the source of the service at the best signal quality at the time of scanning. Additional sources should also be stored to assist with service following.

The band scan feature may clear the service list of all entries before performing the scan. Alternatively, the band scan feature shall ensure that previously stored service list entries that are not found during the band scan are suitably marked or removed.

NOTE 1: Since the available services may change after performing a band scan, the effect on preset buttons should be carefully considered.

NOTE 2: DAB ensembles change their configuration from time to time. It is recommended that products update their stored service list by constantly checking the FIC of the ensemble to which they are currently tuned. Background scanning (for example, immediately after switch-off or with another tuner) to maintain an up-to-date service list is recommended.

6.10 Text display

Products shall have a means of displaying text to the user.

The text display shall display the name of the audio components available for selection. Products shall display the **complete** label whenever possible. The label shall only be reduced in length by applying the character selection provided in the flag field of the label. It is not permissible for the product to reduce the length of the label in any other manner.

Products shall display the service label when a primary audio component is selected. Products shall display the service component label when a secondary audio component is selected.

It is accepted that different displays will have different text rendering capabilities. Receivers shall have a display capable of rendering all the characters from the Complete EBU Latin based repertoire character set, as defined in ETSI TS 101 756 [2], annex C, correctly mapped, visually well-formed and clear. Adapters that use an in-vehicle FM-RDS receiver display shall provide mapping according to table B.1 to ensure that all the characters from the Complete EBU Latin based repertoire character set, as defined in ETSI TS 101 756 [2], annex C, are mapped to the best equivalent RDS character.

NOTE: In-vehicle receivers are not required to implement dynamic label.

6.11 Announcement signalling and switching

Products shall support announcement switching as defined in ETSI EN 300 401 [1], clause 8.1.6.2 (i.e. same ensemble only). This feature instructs the receiver to select an alternative audio source only for the duration of an audio announcement, before returning to the original source.

NOTE: Manufacturers may provide the user with an option to enable and disable this feature.

Products shall switch from the selected service component (even if the user is listening to the CD, AUX, etc.) to a traffic announcement if all the following conditions are met:

- The announcement feature is enabled.
- The selected service is signalled as supporting announcements by means of FIG 0/18 with ASu flag bit 1 set to indicate "Road Traffic Flash" and is provided with a Cluster Id.
- In the same ensemble, an announcement is signalled by means of FIG 0/19 with ASw flag bit 1 set to indicate "Road Traffic Flash" and with the same Cluster Id as the selected service.

Products may support Other Ensembles announcement switching, but this is not required. If provided, it shall conform to all the requirements for OE announcement support: i.e. no interruption shall be made to any service that does not provide OE announcement support.

If the selected service has correct ASu signalling and the product provides support for FM-RDS traffic announcements, then it shall not switch to FM for a traffic announcement of a hard-linked service or implicitly linked service (i.e. PI code = SId) since these services carry the same audio which may not be co-timed.

6.12 Service following

Products shall support service following to ensure that the user is always provided with the best audio experience. Ensembles on different frequencies (MFNs), services on multiple ensembles, hard linking to DAB and FM-RDS alternatives, including implicit linking and the "dead link" mechanism, and soft linking shall be supported, as specified in ETSI TS 103 176 [3]. Products shall also decode the relevant parts of the RDS data (as defined by IEC 62106:2015 [6]) transmitted as part of an FM broadcast signal to achieve DAB to FM linking. Service following algorithms shall be designed so as to provide the best possible user experience. If no alternative signal is available, undisturbed reception shall be maintained at the minimum sensitivity level.

7 Test specification for core technology

7.1 Introduction

Clause 7 provides descriptions for the testing that provides evidence that the core technology meets the Minimum Requirements set out in clauses 5 and 6.

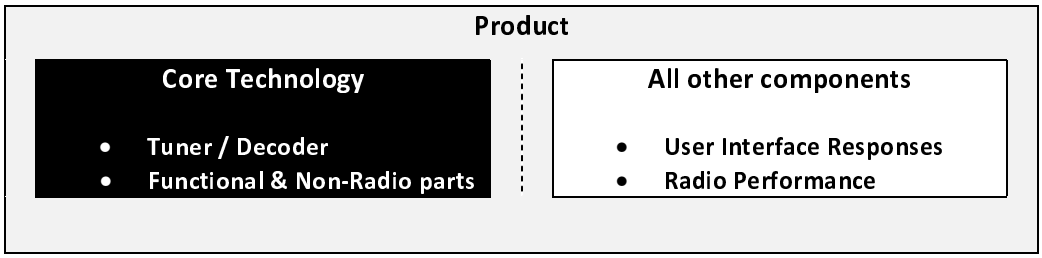


Figure 2: Place of core technology testing in overall scheme

The core technology may exist in different forms - integrated circuit or module - and the functions implemented may vary according to different architectural models. The same integrated circuit may be capable of operation in different architectural modes (for example with or without an external host controller) and so some product functions may be provided directly by the integrated circuit or by the integrated circuit in combination with other circuitry. Therefore, core technology testing requires that the functions provided by the test harness, supplied by the core technology manufacturer in order to perform the testing, are fully documented. The test report shall record which tests were passed by the core technology alone and which tests were passed by the core technology when in combination with the test harness.

For certain product architectures, some aspects of the minimum requirements may be performed by a combination of the core technology and the other components. In this case, some of the core technology testing cannot be performed on the core technology and test harness: these specific tests shall be recorded in the core technology test report and shall be carried out on the final product in addition to the product testing.

Some of the minimum requirements differ between domestic and in-vehicle receivers and core technology may be designed exclusively for one or other application. Therefore, not all of the core technology testing is required for all core technologies, see clauses 7.8 and 7.9.

The DUT consists of the core technology and the test harness. The DUT may be a standalone evaluation board, incorporating the core technology, power supply, user controls, audio device and display device; or it may be an evaluation board which provides power to the core technology and an interface to a PC which provides the user controls, audio device and display device via a developer UI; or it may be some other appropriate arrangement.

NOTE: The requirements for FM testing may require the test harness to provide a controllable FM receiver.

The specified testing requires the use of suitable ETI files. The content of the ETI files shall be coded according to ETSI EN 300 401 [1] and the structure according to ETSI ETS 300 799 [4].

7.2 Basic checks

In order to perform the technology core testing, the basic interfaces of the DUT shall be checked first. The testing in this clause ensures that the controls, display device and audio device are working, and that the selection mechanism delivers the right audio stream to the audio output.

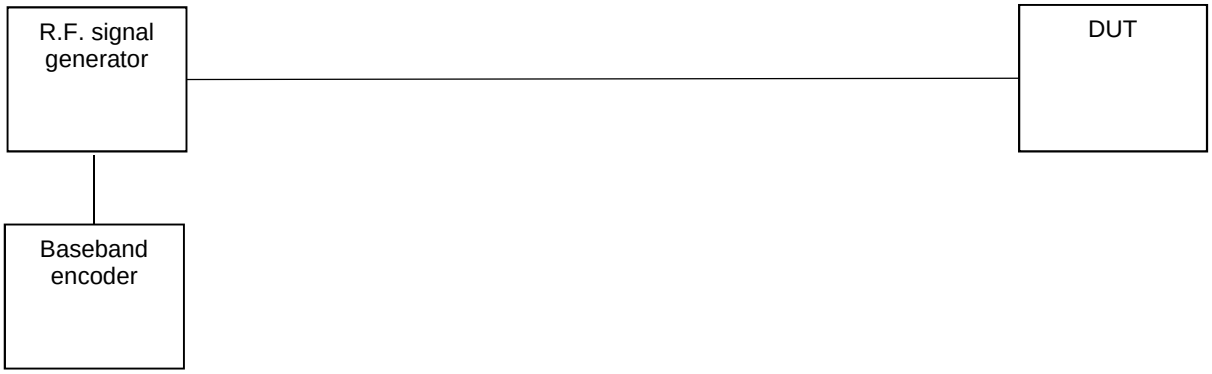


Figure 3: Test set up with one signal generator

The tests are performed in transmission mode I using a conducted method. The test setup is shown in figure 3. Any band III channel may be used. The signal level shall be set to -70 dBm. The tests specified in table 3 and table 4 shall be performed.

Table 3: Basic checks

Test number	Test description	Valid result
2.1.1	An ETI file describing an ensemble with four programme services each with two audio service components (DAB, DAB; DAB, DAB+; DAB+, DAB; DAB+, DAB+) is played on the baseband encoder. The audio of each component shall be different and easily identifiable. Perform the necessary steps on the DUT to clear the service list and perform a band scan.	The DUT lists all 8 components in the service list (the four service labels of the programme services and the four service component labels of the audio secondary service components).
2.1.2	Select each service component in turn.	The correct audio is played within 5 seconds for all 8 service components.

If the tests in table 3 are unsuccessful, the causes shall be found and rectified before proceeding.

Table 4: Multiple sub-channels

Test number	Test description	Valid result
2.2.1	An ETI file describing an ensemble with 32 programme services, each with a primary service component only, carried in a separate sub-channel (i.e. the ensemble contains 32 sub-channels), 16 coded as DAB audio and 16 coded as DAB+ audio, is played on the baseband encoder. The audio of each component shall be different and easily identifiable. Perform the necessary steps on the DUT to clear the service list and perform a band scan.	The DUT lists all 32 services in the service list.
2.2.2	Select each service in turn.	The correct audio is played within 5 seconds for all 32 services.

7.3 Audio testing

The testing in this clause ensures that the DUT is able to decode DAB audio and DAB+ audio with various channel coding and audio coding parameters. Not all possible permutations are tested, but the DUT needs to be able to handle all situations that may occur.

The tests are performed in transmission mode I using a conducted method. The test setup is shown in figure 3. Any band III channel may be used. The signal level shall be set to -70 dBm. ETI files containing services corresponding to the parameters specified in tables 5 to 7 shall be played on the baseband encoder. A band scan shall be performed for each ETI file. Each service shall be selected in turn, each corresponding to a particular parameter set. For each service, the audio output of the device under test shall be monitored.

Table 5: DAB audio (MPEG Audio Layer II) parameters with protection level

Test number	Protection level	Sampling rate	Audio mode	Sub-channel size (kbps)	Valid result
3.1.1	UEP-3	24 kHz	mono	32	Audio plays for 15 seconds without any interruptions or audio artefacts
3.1.2		24 kHz	mono	48	
3.1.3		24 kHz	mono	64	
3.1.4		48 kHz	mono	80	
3.1.5		48 kHz	mono	96	
3.1.6		48 kHz	joint stereo	96	
3.1.7		48 kHz	joint stereo	112	
3.1.8		48 kHz	joint stereo	128	
3.1.9		48 kHz	joint stereo	160	
3.1.10		48 kHz	stereo	160	
3.1.11		48 kHz	stereo	192	
3.1.12	UEP-1	24 kHz	mono	48	
3.1.13		48 kHz	joint stereo	128	
3.1.14		48 kHz	stereo	192	
3.1.15	UEP-2	24 kHz	mono	48	
3.1.16		48 kHz	joint stereo	128	
3.1.17		48 kHz	stereo	192	
3.1.18	UEP-4	24 kHz	mono	48	
3.1.19		48 kHz	joint stereo	128	
3.1.20		48 kHz	stereo	192	
3.1.21	UEP-5	24 kHz	mono	48	
3.1.22		48 kHz	joint stereo	128	
3.1.23		48 kHz	stereo	192	

Table 6: DAB+ audio (HE-AACv2) parameters with protection level EEP-3A

Test number	Protection level	Sampling rate	Audio mode	Sub-channel size (kbps)	SBR	PS	Valid result
3.2.1	EEP-3A	32 kHz	Mono	16	SBR		Audio plays for 15 seconds without any interruptions or audio artefacts
3.2.2		32 kHz	Mono	32	SBR		
3.2.3		32 kHz	Mono	40	SBR		
3.2.4		32 kHz	Mono	48	SBR		
3.2.5		32 kHz	Stereo	32	SBR	PS	
3.2.6		32 kHz	Stereo	40	SBR		
3.2.7		32 kHz	Stereo	48	SBR		
3.2.8		48 kHz	Mono	32	SBR		
3.2.9		48 kHz	Mono	40	SBR		
3.2.10		48 kHz	Mono	48	SBR		
3.2.11		48 kHz	Mono	56	SBR		
3.2.12		48 kHz	Stereo	32	SBR	PS	
3.2.13		48 kHz	Stereo	40	SBR	PS	
3.2.14		48 kHz	Stereo	48	SBR	PS	
3.2.15		48 kHz	Stereo	32	SBR		
3.2.16		48 kHz	Stereo	40	SBR		
3.2.17		48 kHz	Stereo	48	SBR		
3.2.18		48 kHz	Stereo	56	SBR		
3.2.19		48 kHz	Stereo	64	SBR		
3.2.20		48 kHz	Stereo	72	SBR		
3.2.21		48 kHz	Stereo	80	SBR		
3.2.22		48 kHz	Stereo	88	SBR		
3.2.23		48 kHz	Stereo	96	SBR		
3.2.24		48 kHz	Stereo	56			
3.2.25		48 kHz	Stereo	64			
3.2.26		48 kHz	Stereo	72			
3.2.27		48 kHz	Stereo	80			
3.2.28		48 kHz	Stereo	88			
3.2.29		48 kHz	Stereo	96			
3.2.30		48 kHz	Stereo	128			
3.2.31		48 kHz	Stereo	136			
3.2.32		48 kHz	Stereo	192			

Table 7: DAB+ audio (HE-AACv2) parameters with other protection levels

Test number	Protection level	Sampling rate	Audio mode	Sub-channel size (kbps)	SBR	PS	Valid result
3.3.1	EEP-1A	48 kHz	Stereo	32	SBR	PS	Audio plays for 15 seconds without any interruptions or audio artefacts
3.3.2		48 kHz	Stereo	64	SBR		
3.3.3		48 kHz	Stereo	96			
3.3.4	EEP-2A	48 kHz	Stereo	32	SBR	PS	
3.3.5		48 kHz	Stereo	96			
3.3.6		48 kHz	Stereo	144			
3.3.7	EEP-4A	48 kHz	Stereo	32	SBR	PS	
3.3.8		48 kHz	Stereo	96			
3.3.9		48 kHz	Stereo	192			
3.3.10	EEP-1B	48 kHz	Stereo	32	SBR	PS	
3.3.11		48 kHz	Stereo	96			
3.3.12		48 kHz	Stereo	160			
3.3.13	EEP-2B	48 kHz	Stereo	32	SBR	PS	
3.3.14		48 kHz	Stereo	96			
3.3.15		48 kHz	Stereo	192			
3.3.16	EEP-3B	48 kHz	Stereo	32	SBR	PS	
3.3.17		48 kHz	Stereo	96			
3.3.18		48 kHz	Stereo	192			
3.3.19	EEP-4B	48 kHz	Stereo	32	SBR	PS	
3.3.20		48 kHz	Stereo	96			
3.3.21		48 kHz	Stereo	192			

The tests specified in table 8 shall be performed using suitable ETI files.

Table 8: Audio parameter changes

Test number	Test description	Valid result
3.4.1	An ETI file describing an ensemble with a programme service with a DAB audio primary component encoded in a 64 kbps subchannel, mono, 24 kHz sampling rate, UEP-3 is played on the baseband encoder. The file contains an audio parameter change which is aligned to the audio super frame which changes the sampling rate to 48 kHz. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the parameter change.	Minimal disturbance to audio; no artefacts and a maximum mute of 250 ms.
3.4.2	An ETI file describing an ensemble with a programme service with a DAB audio primary component encoded in a 128 kbps subchannel, mono, 48 kHz sampling rate, UEP-3 is played on the baseband encoder. The file contains an audio parameter change which changes the audio mode to stereo. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the parameter change.	No interruption to audio.
3.4.3	An ETI file describing an ensemble with a programme service with a DAB audio primary component encoded in a 128 kbps subchannel, stereo, 48 kHz sampling rate, UEP-3 is played on the baseband encoder. The file contains an audio parameter change which changes the audio mode to joint stereo. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the parameter change.	No interruption to audio.
3.4.4	An ETI file describing an ensemble with a programme service with a DAB+ audio primary component encoded in a 64 kbps subchannel, mono, 32 kHz sampling rate, EEP-3A is played on the baseband encoder. The file contains an audio parameter change which changes the sampling rate to 48 kHz. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the parameter change.	Minimal disturbance to audio; no artefacts and a maximum mute of 250 ms.
3.4.5	An ETI file describing an ensemble with a programme service with a DAB+ audio primary component encoded in a 64 kbps subchannel, mono, 32 kHz sampling rate, EEP-3A is played on the baseband encoder. The file contains an audio parameter change which changes the audio mode to mono with SBR. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the parameter change.	Minimal disturbance to audio; no artefacts and a maximum mute of 250 ms.
3.4.6	An ETI file describing an ensemble with a programme service with a DAB+ audio primary component encoded in a 64 kbps subchannel, mono with SBR, 32 kHz sampling rate, EEP-3A is played on the baseband encoder. The file contains an audio parameter change changes the audio mode to stereo with SBR. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the parameter change.	Minimal disturbance to audio; no artefacts and a maximum mute of 250 ms.

7.4 Character sets

The testing in this clause ensures that the DUT is able to handle all character set decoding correctly. The minimum character support is for all characters in the Complete EBU Latin-based repertoire, see ETSI TS 101 756 [2], annex C, encoded using all three settings of the Charset field in FIG type 1 labels.

The tests are performed in transmission mode I using a conducted method. The test setup is shown in figure 3. Any band III channel may be used. The signal level shall be set to -70 dBm. The tests specified in table 9 shall be performed using suitable ETI files.

Table 9: Character set testing

Test number	Test description	Valid result
4.1.1	The DUT will support the display of all characters from the Complete EBU Latin-based repertoire character set when the Charset field = 0000 (Complete EBU Latin-based repertoire). The ETI files for product testing (see annex A) may be used.	All characters are displayed correctly
4.1.2	The DUT will support the display of all characters from the Complete EBU Latin-based repertoire character set when the Charset field = 0110 (UCS-2 encoding). ETI files containing FIG 1 service labels containing the 8 characters of the short labels for product testing (see tables 42 and 45) may be used.	All characters are displayed correctly
4.1.3	The DUT will support the display of all characters from the Complete EBU Latin-based repertoire character set when the Charset field = 1111 (UTF-8 encoding). ETI files containing FIG 1 service labels containing the 8 characters of the short labels for product testing (see tables 42 and 45) may be used.	All characters are displayed correctly

7.5 R.F. performance

7.5.1 DAB test signal configuration

The testing in this clause ensures that the DUT has the required R.F. performance. The majority of the test methods require the generation of DAB signals in accordance with table 10. The measurements can be made with either an audio signal (OOI method) or a bit-stream (BER method).

Table 10: DAB test signal configuration, measurement device and required result

Method	DAB signal	Measurement device	Required result
OOI	"Sine+" audio service: 1 kHz tone at a level of -3 dBFS, Audio coding: mono, DAB+ audio	Monitor audio output of device under test	Unimpaired 1 kHz tone for the duration of the monitoring period
BER	"BER" stream data service: known data pattern (e.g. all 1s)	BER meter	BER ≤ 10^{-4} for the duration of the monitoring period
Both	Mode I DAB signal to ETSI EN 300 401 [1]; 128 kbps sub-channel, EEP-3A protection		

The spectrum of the generated DAB signals shall be in accordance with figure 4.

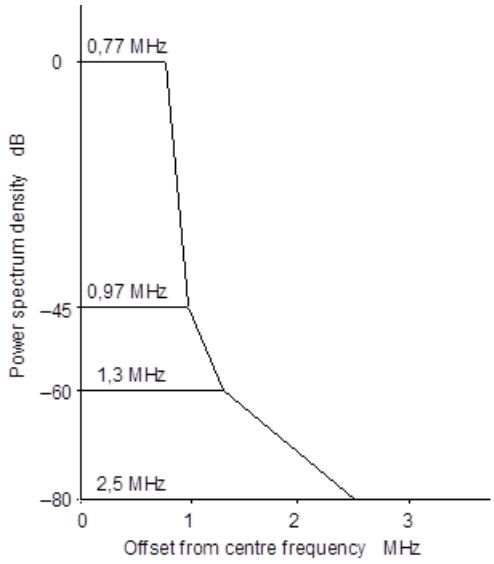


Figure 4: Spectrum mask of the DAB signal

7.5.2 Gaussian sensitivity

The Gaussian sensitivity measurement set up is given in figure 5.

Figure 5: Conducted test set up for Gaussian sensitivity

For each of the 38 centre frequencies given in annex E, the following test method shall be followed:

1) The baseband encoder is set up with the DAB signal required for either the OOI or BER measurement according to table 10.

2) The signal generator is set to the required frequency. The signal level is adjusted to -70 dBm as measured at the input to the receiver.

3) The receiver is tuned to the frequency of the signal generator and the required service is selected using the UI. For the OOI method, the audio level is set so to provide clean 1 kHz audio tone at 75 dBA weighted SPL when measured 30 cm from the audio output.

4) The level of the signal generator is reduced to -98,8 dBm for the OOI method or -97,7 dBm for the BER method as measured at the input to the receiver.

5) If the required result given in table 10 is met for a monitoring period of 10 seconds then the receiver has passed the test for this required frequency.

The results shall be recorded as test numbers 5.1.cn, where cn is the channel number given in annex E.

7.5.3 Gaussian sensitivity - audio test

The Gaussian sensitivity measurement set up given in figure 5 shall be used.

Table 11: DAB audio test signal configuration, measurement device and required result

DAB signal	Measurement device	Required result
"OOI Music" audio service: Royalty free music, Audio coding: stereo, DAB audio	Monitor audio output of device under test	The sound image should be substantially intact and recognizable
Mode I DAB signal to ETSI EN 300 401 [1]; 128 kbps subchannel, UEP-3 protection		

Test method:

1) The baseband encoder is set up with the DAB signal as specified in table 11.

2) The signal generator is set to channel 11C. The signal level is adjusted to -70 dBm as measured at the input to the receiver.

3) The receiver is tuned to the frequency of the signal generator and the required service is selected using the UI. The audio level is set so to provide clean audio at 75 dBA weighted SPL when measured 30 cm from the audio output.

4) The level of the signal generator is reduced to -97,7 dBm as measured at the input to the receiver.

5) If the required result given in table 11 is met for a monitoring period of 10 seconds then the receiver has passed the test.

The result shall be recorded as test number 5.1.39.

7.5.4 Rayleigh sensitivity

The Rayleigh sensitivity measurement set up is given in figure 6.

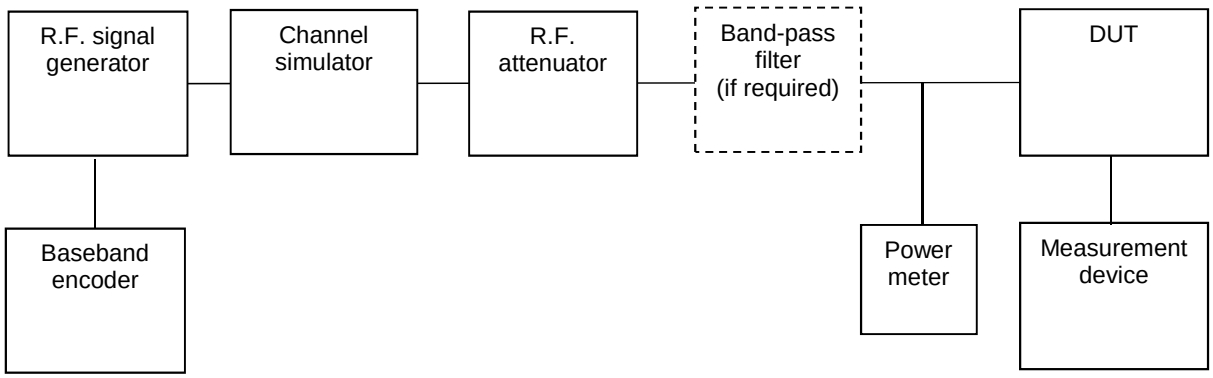


Figure 6: Conducted test set up for Rayleigh sensitivity

For each of the channel models given in table 12, the following test method shall be followed:

1) The baseband encoder is set up with the DAB signal required for either the OOI or BER measurement according to table 10.

2) The signal generator is set to the channel 12B. The signal level is adjusted to -70 dBm as measured at the input to the receiver.

3) The channel simulator is set to the required channel profile (see also annex D).

4) The receiver is tuned to the frequency of the signal generator and the required service is selected using the UI. For the OOI method, the audio level is set so to provide clean 1 kHz audio tone at 75 dBA weighted SPL when measured 30 cm from the audio output.

5) The level of the signal generator is reduced to -93,3 dBm for the OOI method or -92,2 dBm for the BER method as measured at the input to the receiver.

6) If the required result given in table 10 is met for a monitoring period of 60 seconds then the receiver has passed the test for this channel profile.

Table 12: Sensitivity in a Rayleigh fading channel

Test number	Test description	Valid result
5.2.1	Urban channel: see annex D	Test passed
5.2.2	Rural channel: see annex D	Test passed
5.2.3	SFN channel: see annex D	Test passed

7.5.5 Adjacent channel selectivity

The adjacent channel selectivity measurement set up is given in figure 7.

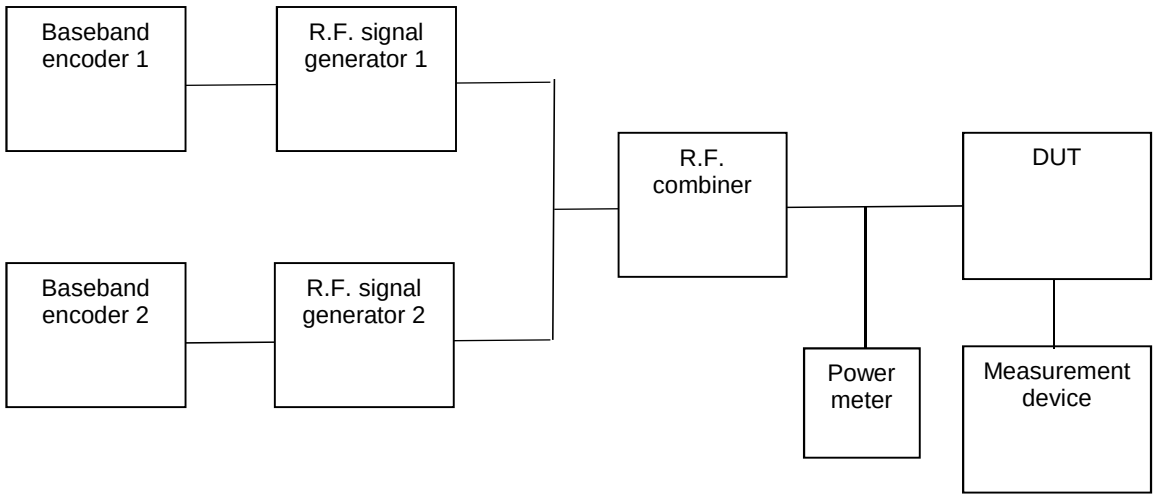


Figure 7: Conducted test set up for adjacent channel selectivity

The test shall be performed with the interferer frequency set to each of the three upper and lower adjacent channels, as given in table 13.

NOTE: The frequency of the interferer channel may not correspond to a centre frequency given in annex E.

Table 13: Frequency and power offsets for adjacent channel selectivity

Interferer channel	Frequency offset (MHz)	Power offset (dB)
1: lower third adjacent channel	-5,136	+45
2: lower second adjacent channel	-3,428	+40
3: lower first adjacent channel	-1,712	+35
4: upper first adjacent channel	+1,712	+35
5: upper second adjacent channel	+3,428	+40
6: upper third adjacent channel	+5,136	+45

For each of the 38 centre frequencies given in annex E, the following test method shall be followed:

1) The baseband encoders are set up with the DAB signal required for either the OOI or BER measurement according to table 10.

2) Signal generator 1 is set to the desired wanted frequency. The signal level is adjusted to -70 dBm as measured at the input to the receiver with signal generator 2 switched off.

3) The receiver is tuned to the frequency of signal generator 1 and the required service is selected using the UI. For the OOI method, the audio level is set so to provide clean 1 kHz audio tone at 75 dBA weighted SPL when measured 30 cm from the audio output.

4) Signal generator 2 is set to the desired interferer channel - that is to the desired frequency offset from the wanted signal as given in table 13. The signal level is adjusted to the required level as measured at the input to the receiver with signal generator 1 switched off - that is to the desired power offset as given in table 13.

5) Signal generator 1 is switched back on.

6) If the required result given in table 10 is met for a monitoring period of 10 seconds then the receiver has passed for this wanted frequency and interferer channel.

7) Testing continues at step 4 with next row of table 13 until all six tests have been performed.

8) If each of the six interferer channels have been passed then the receiver has passed the test for this wanted frequency.

The results shall be recorded as test numbers 5.3.cn, where cn is the channel number given in annex E.

7.5.6 Extended adjacent channel selectivity

The adjacent channel selectivity measurement set up given in figure 7 shall be used.

The test shall be performed with the interferer frequency set to the centre frequency of each DAB channel (see annex E) except the three lower and three upper adjacent channels and the wanted frequency. The power offset shall be +45 dB.

For each of the 38 centre frequencies given in annex E, the following test method shall be followed:

1) The baseband encoders are set up with the DAB signal required for either the OOI or BER measurement according to table 10.

2) Signal generator 1 is set to the desired wanted frequency. The signal level is adjusted to -70 dBm as measured at the input to the receiver with signal generator 2 switched off.

3) The receiver is tuned to the frequency of signal generator 1 and the required service is selected using the UI. For the OOI method, the audio level is set so to provide clean 1 kHz audio tone at 75 dBA weighted SPL when measured 30 cm from the audio output.

4) Signal generator 2 is set to the desired interferer frequency (see annex E), starting at channel 5A (unless this channel is excluded). The signal level is adjusted to -25 dBm as measured at the input to the receiver with signal generator 1 switched off.

5) Signal generator 1 is switched back on.

6) If the required result given in table 10 is met for a monitoring period of 10 seconds then the receiver has passed for this wanted frequency and adjacent channel offset.

7) Testing continues at step 4 with interferer frequency set to the next channel (unless excluded) until all channels have been tested.

8) If all the interferer channels have been passed then the receiver has passed the test for this wanted frequency.

The results shall be recorded as test numbers 5.4.cn, where cn is the channel number given in annex E.

7.5.7 Power variation adjacent channel selectivity

The adjacent channel selectivity measurement set up given in figure 7 shall be used.

The test shall be performed with the wanted frequency set to channel 12 B and the interferer frequency set first to channel 12A and then to channel 12C. The wanted power level shall be -90 dBm for the low power test and -50 dBm for the high power test. In both tests the power offset shall be +35 dBm.

For each of the power levels given in table 14, the following test method shall be followed:

1) The baseband encoders are set up with transmission mode I DAB signals to ETSI EN 300 401 [1], each carrying a number of different audio services. The spectrum of the generated DAB signals shall be in accordance with figure 4.

2) Signal generator 1 is set to channel 12B. The wanted signal level is adjusted to the desired level as measured at the input to the receiver with signal generator 2 switched off.

3) Signal generator 2 is set to channel 12A. The signal level is adjusted to the wanted signal level +35 dB as measured at the input to the receiver with signal generator 1 switched off.

4) Signal generator 1 is switched back on.

5) A band scan is performed. If all the audio services in both ensembles are present in the service list then the receiver has passed the test with the interferer on channel 12A.

6) Signal generator 2 is set to channel 12C.

7) A band scan is performed. If all the audio services in both ensembles are present in the service list then the receiver has passed the test with the interferer on channel 12C.

8) If both interferer channels have been passed then the receiver has passed the test for this power level.

Table 14: Power variation adjacent channel selectivity

Test number	Test description	Valid result
5.5.1	Low power test -90 dBm	Test passed
5.5.2	High power test -50 dBm	Test passed

7.6 Reconfigurations

The testing in this clause ensures that the DUT is able to handle reconfigurations correctly.

The tests are performed in transmission mode I using a conducted method. The test setup is shown in figure 3. Any band III channel may be used. The signal level shall be set to -70 dBm. The tests specified in tables 15 to 21 shall be performed using suitable ETI files.

Table 15: Adding a secondary component

Test number	Test description	Valid result
6.1.1	An ETI file describing an ensemble with a programme service with a DAB audio primary component is played on the baseband encoder. The file contains a reconfiguration which adds a DAB audio secondary component to the service. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. No interruption to audio occurs
6.1.2	An ETI file describing an ensemble with a programme service with a DAB audio primary component and a DAB audio secondary service component is played on the baseband encoder. The file contains a reconfiguration which adds a second DAB audio secondary component to the service. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. No interruption to audio occurs
6.1.3	An ETI file describing an ensemble with a programme service with a DAB audio primary component is played on the baseband encoder. The file contains a reconfiguration which adds a data secondary component to the service. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. No interruption to audio occurs
6.1.4	An ETI file describing an ensemble with a programme service with a DAB+ audio primary component is played on the baseband encoder. The file contains a reconfiguration which adds a DAB+ audio secondary component to the service. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. No interruption to audio occurs
6.1.5	An ETI file describing an ensemble with a programme service with a DAB+ audio primary component is played on the baseband encoder. The file contains a reconfiguration which adds a data secondary component to the service. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. No interruption to audio occurs

Table 16: Removing a secondary component

Test number	Test description	Valid result
6.2.1	An ETI file describing an ensemble with a programme service with a DAB audio primary component and a DAB audio secondary service component is played on the baseband encoder. The file contains a reconfiguration which removes the secondary component from the service. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. No interruption to audio occurs
6.2.2	An ETI file describing an ensemble with a programme service with a DAB audio primary component and two DAB audio secondary service components is played on the baseband encoder. The file contains a reconfiguration which removes the second secondary component from the service. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the first secondary service component. 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. No interruption to audio occurs
6.2.3	An ETI file describing an ensemble with a programme service with a DAB audio primary component and a data secondary service component is played on the baseband encoder. The file contains a reconfiguration which removes the secondary component from the service. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. No interruption to audio occurs
6.2.4	An ETI file describing an ensemble with a programme service with a DAB+ audio primary component and two DAB+ audio secondary service components is played on the baseband encoder. The file contains a reconfiguration which removes the first secondary component from the service. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the second secondary service component. 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. No interruption to audio occurs
6.2.5	An ETI file describing an ensemble with a programme service with a DAB audio primary component and a DAB audio secondary service component is played on the baseband encoder. The file contains a reconfiguration which removes the secondary component from the service. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the secondary service component. 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. The DUT automatically selects and plays the primary component
6.2.6	An ETI file describing an ensemble with a programme service with a DAB+ audio primary component and a DAB+ audio secondary service component is played on the baseband encoder. The file contains a reconfiguration which removes the secondary component from the service. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the secondary service component. 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. The DUT automatically selects and plays the primary component

Table 17: Removing a service

Test number	Test description	Valid result
6.3.1	An ETI file describing an ensemble with a programme service with a DAB audio primary component only is played on the baseband encoder. The file contains a reconfiguration which removes the service. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. The audio mutes without audio artefacts
6.3.2	An ETI file describing an ensemble with a programme service with a DAB audio primary component and two DAB audio secondary service component is played on the baseband encoder. The file contains a reconfiguration which removes the entire service. Perform the necessary steps on the DUT to clear the service list and perform a band scan. 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. The audio mutes without audio artefacts
6.3.3	An ETI file describing an ensemble with a programme service with a DAB+ audio primary component and two DAB+ audio secondary service component is played on the baseband encoder. The file contains a reconfiguration which removes the entire service. Perform the necessary steps on the DUT to clear the service list and perform a band scan. 1) Select the first secondary service component. 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. The audio mutes without audio artefacts

Table 18: Moving CU locations

Test number	Test description	Valid result
6.4.1	An ETI file describing an ensemble with a programme service with a DAB audio primary component only is played on the baseband encoder. The file contains a reconfiguration which moves the start CU of the service component to a lower value but where some of the CUs allocated to the service component are common to both configurations. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. No interruption to audio occurs
6.4.2	An ETI file describing an ensemble with a programme service with a DAB audio primary component only is played on the baseband encoder. The file contains a reconfiguration which moves the start CU of the service component to a lower value but where none of the CUs allocated to the service component are common to both configurations. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. No interruption to audio occurs
6.4.3	An ETI file describing an ensemble with a programme service with a DAB audio primary component only is played on the baseband encoder. The start CU of the service component = 0. The file contains a reconfiguration which moves the start CU of the service component to a value that corresponds to the service component using CU 863. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. No interruption to audio occurs
6.4.4	An ETI file describing an ensemble with a programme service with a DAB audio primary component only is played on the baseband encoder. The start CU of the service component corresponds to the service component using CU 863. The file contains a reconfiguration which moves the start CU of the service component to 0. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. No interruption to audio occurs

Table 19: Sub-channel bit-rate changes

Test number	Test description	Valid result
6.5.1	An ETI file describing an ensemble with a programme service with a DAB audio primary component in a 128 kbps subchannel, 48 kHz sampling rate, UEP-3 is played on the baseband encoder. The file contains a reconfiguration which changes the size of the subchannel to 192 kbps. Perform the necessary steps on the DUT to clear the service list and perform a band scan. 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. No interruption to audio occurs
6.5.2	An ETI file describing an ensemble with a programme service with a DAB audio primary component in a 192 kbps subchannel, 48 kHz sampling rate, UEP-3 is played on the baseband encoder. The file contains a reconfiguration which changes the size of the subchannel to 128 kbps. Perform the necessary steps on the DUT to clear the service list and perform a band scan. 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. No interruption to audio occurs
6.5.3	An ETI file describing an ensemble with a programme service with a DAB audio primary component in a 128 kbps subchannel, 24 kHz sampling rate, UEP-3 is played on the baseband encoder. The file contains a reconfiguration, aligned with the audio super frame boundary, which changes the size of the subchannel to 160 kbps. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. No interruption to audio occurs
6.5.4	An ETI file describing an ensemble with a programme service with a DAB audio primary component in a 160 kbps subchannel, 24 kHz sampling rate, UEP-3 is played on the baseband encoder. The file contains a reconfiguration, aligned with the audio super frame boundary, which changes the size of the subchannel to 128 kbps. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. No interruption to audio occurs
6.5.5	An ETI file describing an ensemble with a programme service with a DAB+ audio primary component in a 128 kbps subchannel, 48 kHz sampling rate, EEP-3A is played on the baseband encoder. The file contains a reconfiguration, aligned with the audio super frame boundary, which changes the size of the subchannel to 192 kbps. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. Minimal disturbance to audio; no artefacts and a maximum mute of 250 ms
6.5.6	An ETI file describing an ensemble with a programme service with a DAB+ audio primary component in a 192 kbps subchannel, 48 kHz sampling rate, EEP-3A is played on the baseband encoder. The file contains a reconfiguration, aligned with the audio super frame boundary, which changes the size of the subchannel to 128 kbps. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. Minimal disturbance to audio; no artefacts and a maximum mute of 250 ms

Table 20: Protection level changes

Test number	Test description	Valid result
6.6.1	An ETI file describing an ensemble with a programme service with a DAB audio primary component at 128 kbps full rate, UEP-4 is played on the baseband encoder. The file contains a reconfiguration which changes only the protection of the subchannel to UEP-3. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. No interruption to audio occurs
6.6.2	An ETI file describing an ensemble with a programme service with a DAB audio primary component at 128 kbps full rate, UEP-3 is played on the baseband encoder. The file contains a reconfiguration which changes only the protection of the subchannel to UEP-4. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. No interruption to audio occurs
6.6.3	An ETI file describing an ensemble with a programme service with a DAB+ audio primary component at 96 kbps, 48 kHz,EEP-4A is played on the baseband encoder. The file contains a reconfiguration which changes only the protection of the subchannel to EEP-1A. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. No interruption to audio occurs

Table 21: Combined changes

Test number	Test description	Valid result
6.7.1	An ETI file describing an ensemble with a programme service with a DAB audio primary component in a 128 kbps subchannel, 48 kHz sampling rate, UEP-3 and a DAB audio secondary component in a 32 kbps subchannel, 24 kHz sampling rate, UEP-3 is played on the baseband encoder. The file contains a reconfiguration which changes the DAB audio primary component subchannel size to 192 kbps and removes the DAB audio secondary component. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. No interruption to audio occurs
6.7.2	An ETI file describing an ensemble with a programme service with a DAB audio primary component in a 160 kbps subchannel, 48 kHz sampling rate, UEP-3 is played on the baseband encoder. The file contains a reconfiguration which changes the DAB audio primary component subchannel size to 128 kbps and adds a DAB audio secondary component in a 32 kbps subchannel, 24 kHz sampling rate, UEP-3. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. No interruption to audio occurs
6.7.3	An ETI file describing an ensemble with a programme service with a DAB+ audio primary component in a 128 kbps subchannel, 48 kHz sampling rate, EEP-3A and a DAB+ audio secondary component in a 32 kbps subchannel, 32 kHz sampling rate, EEP-3A is played on the baseband encoder. The file contains a reconfiguration which changes the DAB+ audio primary component subchannel size to 160 kbps and removes the DAB+ audio secondary component. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. Minimal disturbance to audio; no artefacts and a maximum mute of 250 ms
6.7.4	An ETI file describing an ensemble with a programme service with a DAB audio primary component in a 128 kbps subchannel, 48 kHz sampling rate, UEP-3 and a DAB audio secondary component in a 32 kbps subchannel, 24 kHz sampling rate, UEP-3 is played on the baseband encoder. The file contains a reconfiguration which changes the DAB audio primary component subchannel size to 192 kbps and removes the DAB audio secondary component. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the secondary service component. 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. The DUT automatically selects and plays the primary component

7.7 Service list handling

The testing in this clause ensures that the DUT is able to acquire ensembles and services in different circumstances and manage the service list correctly.

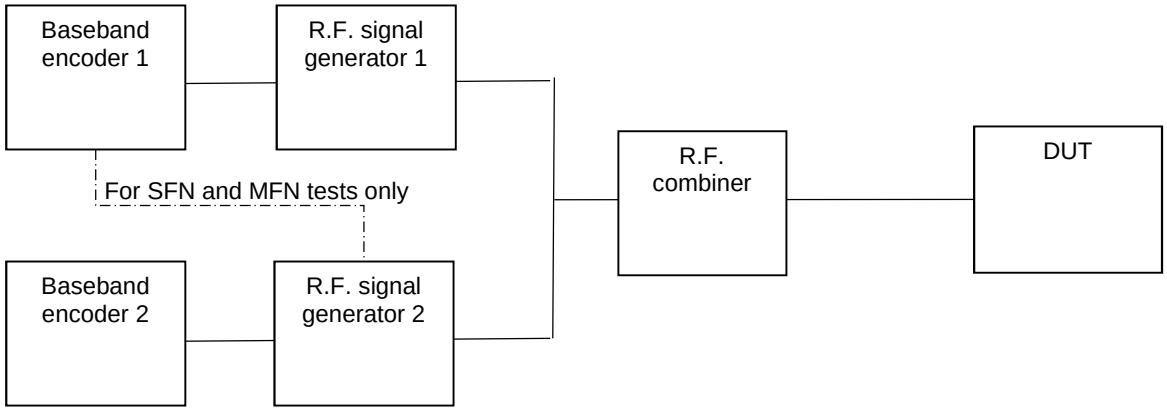


Figure 8: Test set up with two signal generators

The tests are performed in transmission mode I using a conducted method. The test setup is shown in figure 8. The channels to be used are specified in each test. The signal level shall be set to -70 dBm from each signal generator, unless specified differently by the individual test. The tests specified in tables 22 to 29 shall be performed using suitable ETI files. Where labels are specified in the test description they shall be used.

Table 22: Initial scan

Test number	Test description	Valid result
7.1.1	An ETI file describing "Ensemble1" containing a range of audio services is played on baseband encoder 1 with signal generator 1 set to channel 9D. A second ETI file describing "Ensemble2" containing a different range of audio services is played on baseband encoder 2 with signal generator 2 set to channel 11B. Perform the necessary steps on the DUT to clear the service list and perform a band scan.	The service list of the DUT displays the labels of all services from Ensemble1 and Ensemble2 but displays no other labels.
7.1.2	Select all services from the service list in turn.	All services from Ensemble1 and Ensemble2 can be selected; correct audio is played.

Table 23: A new multiplex launches

Test number	Test description	Valid result
7.2.1	After performing test 7.1.2, switch off signal generator 2. A third ETI file describing "Ensemble3" containing a different range of audio services is played on baseband encoder 2. Switch on signal generator 2 set to channel 7D. Perform a band scan.	The service list of the DUT displays the labels of all services from Ensemble1 and Ensemble3. See note.
7.2.2	Select all services from the service list in turn.	All services from Ensemble1 and Ensemble3 can be selected; correct audio is played.
NOTE: It may also display the labels from Ensemble2, although they may be marked as unavailable.		

Table 24: Multiplex changes frequency

Test number	Test description	Valid result
7.3.1	After performing test 7.2.2, set signal generator 2 to channel 10A. Perform a band scan.	The service list of the DUT displays the labels of all services from Ensemble1 and Ensemble3. Importantly, it does not list any label more than once (i.e. the services on Ensemble3 that have moved frequency do not appear twice). See note.
7.3.2	Select all services from the service list in turn.	All services from Ensemble1 and Ensemble3 can be selected; correct audio is played.
NOTE: It may also display the labels from Ensemble2, although they may be marked as unavailable.		

Table 25: Service moves to a new ensemble

Test number	Test description	Valid result
7.4.1	An ETI file describing "Ensemble1" containing a range of services is played on baseband encoder 1 with signal generator 1 set to channel 9D. A second ETI file describing "Ensemble2" containing a different range of services is played on baseband encoder 2 with signal generator 2 set to channel 11B. Perform the necessary steps on the DUT to clear the service list: 1) Perform a band scan then select a service from Ensemble1. 2) Switch off signal generator 1 and reconfigure Ensemble2 so that the selected service from Ensemble1 is available on Ensemble2. 3) Perform a band scan and reselect the service.	1. The selected service plays 2. The selected service stops playing 3. The selected service plays

Table 26: Re-selection after signal loss

Test number	Test description	Valid result
7.5.1	After performing test 7.4.1, switch off signal generator 2. After 10 seconds switch signal generator 2 back on. See note.	The correct audio will resume within 3 seconds of the R.F. signal being available again. Some audio impairments during the loss and recovery of the signal are permissible.
NOTE: No alternate service is available; i.e. no active links are signalled.		

Table 27: Duplicate handling

Test number	Test description	Valid result
7.6.1	An ETI file describing "Ensemble 1" containing a range of services is played on baseband encoder 1 with signal generator 1 set to channel 8D. A second ETI file describing "Ensemble 2" with one service common to "Ensemble 1" is played on baseband encoder 2 with signal generator 2 set to channel 10B. Perform the necessary steps on the DUT to clear the service list and then perform a band scan. Select the common service.	The service list contains only one instance of the service label of the common service. The service plays.
7.6.2	After performing test 7.6.1, a third ETI file describing "Ensemble 3" with one service common to "Ensemble 1" and "Ensemble 2" is played on baseband encoder 2 with signal generator 2 set to channel 7A. Perform the necessary steps on the DUT to clear the service list and then perform a band scan. Select the common service.	The service list contains only one instance of the service label of the common service. The service plays.

Table 28: Unsupported components

Test number	Test description	Valid result
7.7.1	An ETI file describing an ensemble with the following services: • label - TMID - ASCTy / DSCTy, UATy • "DAB audio" - stream audio, ASCTy = DAB audio • "DAB+audio" - stream audio, ASCTy = DAB+ audio • "Rsvd audio" - stream audio, ASCTy = 27 • "Stm data" - stream data: DSCTy = 18, UATy = 99 • "Pkt data" - packet data: DSCTy = 8, UATy = 33 • is played on the baseband encoder. The content of each service is arbitrary. Perform the necessary steps on the DUT to clear the service list and perform a band scan.	The DUT lists ***only*** "DAB audio" and "DAB+ audio" in the service list
7.7.2	An ETI file describing an ensemble with a programme service with a DAB audio primary component and a packet data secondary component as follows: label - TMID - ASCTy / DSCTy, UATy Primary: "DAB audio" - stream audio, ASCTy = DAB audio Secondary: "Pkt data" - packet data: DSCTy = 8, UATy = 33 is played on the baseband encoder. The content of each service component is arbitrary. Perform the necessary steps on the DUT to clear the service list and perform a band scan.	The DUT lists ***only*** "DAB audio" in the service list
7.7.3	An ETI file describing an ensemble with a programme service with a DAB audio primary component and 11 secondary components, arranged in the following sequence in the FIG 0/2: 4 data components, a DAB+ audio component, 2 data components, a DAB audio component, 3 data components is played on the baseband encoder. The audio of each component shall be different and easily identifiable. The content of all the data components shall be signalled with DSCTy = 8, UATy = 33 and is arbitrary. All secondary components shall have service component labels. Perform the necessary steps on the DUT to clear the service list and perform a band scan.	The DUT lists ***only*** the service label of the audio service and the service component labels of the two audio secondary components in the service list

Table 29: Service / service component label changes

Test number	Test description	Valid result
7.8.1	An ETI file describing an ensemble with a programme service with a DAB audio primary component is played on the baseband encoder. The file contains a reconfiguration which adds a DAB audio secondary component to the service. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. The service list contains the service component label of the added secondary service component
7.8.2	An ETI file describing an ensemble with a programme service with a DAB audio primary component and a DAB audio secondary service component is played on the baseband encoder. The file contains a reconfiguration which adds a second DAB audio secondary component to the service. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. The service list contains the service component label of the added secondary service component
7.8.3	An ETI file describing an ensemble with a programme service with a DAB audio primary component is played on the baseband encoder. The file contains a reconfiguration which adds a data secondary component to the service. The content of the data component shall be signalled as SPI and is arbitrary. Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. The service list ***does not*** contain the service component label of the added secondary service component
7.8.4	An ETI file describing an ensemble with a programme service with a DAB audio primary component is played on the baseband encoder. The file contains a reconfiguration at which only the service label changes (other services in the ensemble simultaneously change MCI). Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. The service label changes to the new label; the service list contains the new service label but ***not*** the old service label
7.8.5	An ETI file describing an ensemble with a programme service with a DAB audio primary component and a DAB audio secondary component is played on the baseband encoder. The file contains a reconfiguration at which only the service label changes (other services in the ensemble simultaneously change MCI; the service component label of the secondary component does not change). Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the service (primary component). 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. The service component label ***does not*** change; the service list contains the new service label but ***not*** the old service label
7.8.6	An ETI file describing an ensemble with a programme service with a DAB audio primary component and a DAB audio secondary component is played on the baseband encoder. The file contains a reconfiguration at which only the service component label of the secondary component changes (other services in the ensemble simultaneously change MCI; the service label does not change). Perform the necessary steps on the DUT to clear the service list and perform a band scan: 1) Select the secondary service component. 2) Observe the DUT behaviour during the reconfiguration.	1. The audio plays 2. The service component label changes; the service list contains the new service component label but ***not*** the old service component label

7.8 Domestic core technology

The testing in this clause ensures that the DUT is able to handle dynamic label decoding and presentation correctly and store the best available frequency in an MFN.

Core technology designed **exclusively for in-vehicle products** is not required to pass the tests in clause 7.8. However, **any** core technology supporting dynamic label shall pass the tests specified in tables 30 to 34.

The tests specified in tables 30 to 34 shall be performed using suitable ETI files. The tests are performed in transmission mode I using a conducted method. The test setup is shown in figure 3. Any band III channel may be used. The signal level shall be set to -70 dBm. The content of the dynamic labels is arbitrary and shall be coded with the Charset field = 0000 (Complete EBU Latin-based repertoire) unless otherwise stated. The X-PAD shall contain other user applications (e.g. SlideShow, SPI) and DL Plus commands so that all aspects of dynamic label retrieval are tested.

Table 30: Dynamic label transport methods

Test number	Test description	Valid result
8.1.1	DUT is able to decode and display dynamic label text carried within a DAB audio service component with **full rate** audio encoding using **short** X-PAD	The dynamic label is displayed correctly
8.1.2	DUT is able to decode and display dynamic label text carried within a DAB audio service component with **half rate** audio encoding using **short** X-PAD	
8.1.3	DUT is able to decode and display dynamic label text carried within a DAB audio service component with **full rate** audio encoding using **variable** X-PAD	
8.1.4	DUT is able to decode and display dynamic label text carried within a DAB audio service component with **half rate** audio encoding using **variable** X-PAD	
8.1.5	DUT is able to decode and display dynamic label text carried within a DAB+ audio service component using **short** X-PAD	
8.1.6	DUT is able to decode and display dynamic label text carried within a DAB+ audio service component using **variable** X-PAD	

Table 31: Maximum length dynamic label in all character sets

Test number	Test description	Valid result
8.2.1	DUT is able to decode and display a 128 byte dynamic label when the Charset field = 0000 (Complete EBU Latin-based repertoire).	The dynamic label is displayed correctly
8.2.2	DUT is able to decode and display a 128 byte dynamic label when the Charset field = 0110 (UCS-2 encoding) and the characters are selected from the Complete EBU Latin-based repertoire.	
8.2.3	DUT is able to decode and display a 128 byte dynamic label when the Charset field = 1111 (UTF-8 encoding) and the characters are selected from the Complete EBU Latin-based repertoire including 1-byte, 2-byte and 3-byte characters.	

Table 32: Minimum length dynamic label

Test number	Test description	Valid result
8.3.1	DUT is able to decode and display a 1 byte dynamic label.	The dynamic label is displayed correctly

Table 33: Dynamic label control codes

Test number	Test description	Valid result
8.4.1	DUT is able to handle an end of headline control code (0x0B)	The control code is not displayed. If supported by the DUT, the end of headline control code will be handled correctly, emphasizing the headline.
8.4.2	DUT is able to handle a preferred word break control code (0x1F)	The control code is not displayed. If supported by the DUT, the preferred word break control code will cause the long word to be split correctly: when a split is made the hyphen character will be shown at the end of the first portion of the word and the second portion of the word will be presented on the next line of the display.
8.4.3	DUT is able to handle a preferred line break control code (0x0A)	The control code is displayed as a space character. If supported by the DUT the preferred line break control code will cause the following text to appear on the next line of the display.

Table 34: Dynamic label clear command

Test number	Test description	Valid result
8.5.1	The DUT will correctly handle a dynamic label clear display command	The dynamic label is immediately removed from the display and the display remains blank until the next dynamic label is received

The tests specified in table 35 shall be performed using suitable ETI files. The tests are performed in transmission mode I using a conducted method. The test setup is shown in figure 8. The channels to be used are specified in each test. The signal level shall be set to -70 dBm from each signal generator, unless specified differently by the individual test.

Table 35: MFN support

Test number	Test description	Valid result
8.6.1	An ETI file describing a range of services is played on baseband encoder 1 with signal generator 1 set to channel 9D. Baseband encoder 1 also feeds signal generator 2 set to channel 11B with the signal level set to **-95 dBm** (baseband encoder 2 is disconnected). No FIG 0/21 frequency information is provided. Perform the necessary steps on the DUT to clear the service list and then perform a band scan. Select a service.	The receiver plays the service from the ensemble on channel 9D (the strongest signal). This shall be confirmed by switching off signal generator 2 and there being no audio impairment.
8.6.2	An ETI file describing a range of services is played on baseband encoder 1 with signal generator 1 set to channel 9D with the signal level set to **-95 dBm**. Baseband encoder 1 also feeds signal generator 2 set to channel 11B (baseband encoder 2 is disconnected). No FIG 0/21 frequency information is provided. Perform the necessary steps on the DUT to clear the service list and then perform a band scan. Select a service.	The receiver plays the service from the ensemble on channel 11B (the strongest signal). This shall be confirmed by switching off signal generator 1 and there being no audio impairment.

7.9 In-vehicle core technology

The testing in this clause ensures that the DUT is able to correctly deal with service following and announcements.

Core technology designed **exclusively for domestic products** is not required to pass the tests specified in clause 7.9.

The tests are performed in transmission mode I using a conducted method. The test setup is shown in figure 8. The channels to be used are specified in each test. The signal level shall be set to -70 dBm from each signal generator, unless specified differently by the individual test. The tests specified in tables 36 to 38 shall be performed using suitable ETI files. Traffic announcements shall be enabled on the DUT.

Table 36: SFN, MFN and OE following

Test number	Test description	Valid result
9.1.1	An ETI file describing "Ensemble 1" containing a range of services is played on baseband encoder 1 with signal generator 1 set to channel 12B. Baseband encoder 1 is also connected to signal generator 2 (baseband encoder 2 is disconnected) which is also set to channel 12B. The two signal generators shall be configured to provide co-timed outputs. Perform the necessary steps on the DUT to clear the service list and then perform a band scan. Select a service. Vary the power levels of both signal generators independently between -110 dBm and 0 dBm ensuring that one of the signal generators is always at a signal level greater than -95 dBm.	No breakup in audio is ever heard
9.1.2	An ETI file describing "Ensemble 1" containing a range of services is played on baseband encoder 1 with signal generator 1 set to channel 10C. Baseband encoder 1 is also connected to signal generator 2 (baseband encoder 2 is disconnected) which is set to channel 8D. Perform the necessary steps on the DUT to clear the service list and then perform a band scan. Select a service. Vary the power levels of both signal generators independently between -110 dBm and 0 dBm ensuring that one of the signal generators is always at a signal level greater than -95 dBm.	The DUT will follow between the two signals according to the available signal level without intervention from the user; short audio interruptions may be present during switching.
9.1.3	An ETI file describing "Ensemble 1" containing a range of services including SId1:"Service 1" is played on baseband encoder 1 with signal generator 1 set to channel 9D. A second ETI file describing "Ensemble 2" containing a range of services including SId1:"Service 1", with identical audio content to SId1:"Service 1", is played on baseband encoder 2 with signal generator 2 set to channel 10B. Perform the necessary steps on the DUT to clear the service list and then perform a band scan. Select "Service 1". Vary the power levels of both signal generators independently between -110 dBm and 0 dBm ensuring that one of the signal generators is always at a signal level greater than -95 dBm.	The DUT will follow between the two ensembles according to the available signal level without intervention from the user; short audio interruptions may be present during switching.

Table 37: DAB service linking

Test number	Test description	Valid result
9.2.1	An ETI file describing "Ensemble 1" containing a range of services including SId1:"Service 1" is played on baseband encoder 1 with signal generator 1 set to channel 8D. A second ETI file describing "Ensemble 2" containing a range of services including SId2:"Service 2", with identical audio content to SId1:"Service 1", is played on baseband encoder 2 with signal generator 2 set to channel 10B. A hard link (FIG 0/6) connecting the SId1 and SId2 is signalled on each ensemble with the Linkage Actuator flag is set to 1 (activated). Frequency information for each ensemble is signalled (FIG 0/21). OE Service information is signalled (FIG 0/24). Perform the necessary steps on the DUT to clear the service list and then perform a band scan. Select "Service 1". Vary the power levels of both signal generators independently between -110 dBm and 0 dBm ensuring that one of the signal generators is always at a signal level greater than -95 dBm.	The DUT will follow the hard link between the two ensembles according to the available signal level without intervention from the user; short audio interruptions may be present during switching. The service label will change as the DUT follows the available signal.
9.2.2	After performing test 9.2.1, set the Linkage Actuator flag in both ensembles to 0 (de-activated). Vary the power levels of both signal generators independently between -110 dBm and 0 dBm ensuring that one of the signal generators is always at a signal level greater than -95 dBm.	The DUT will NOT alter the service that it is tuned to; audio mutes may occur when the signal level of the tuned ensemble falls below the sensitivity threshold.
9.2.3	After performing test 9.2.2, adjust the power levels of both signal generators to -70 dBm. Set the Linkage Actuator flag in both ensembles to 1 (activated). After 5 seconds switch off the signal generator providing the tuned ensemble.	The DUT will follow the hard link to the other ensemble without intervention from the user.
9.2.4	An ETI file describing "Ensemble 1" containing a range of services including SId3:"Service 3" is played on baseband encoder 1 with signal generator 1 set to channel 8D. A second ETI file describing "Ensemble 2" containing a range of services including SId4:"Service 4", with different audio content to SId3:"Service 3" is played on baseband encoder 2 with signal generator 2 set to channel 10B. A soft link (FIG 0/6) connecting SId3 and SId4 is signalled on each ensemble with the Linkage Actuator flag is set to 1 (activated). Frequency information for each ensemble is signalled (FIG 0/21). OE Service information is signalled (FIG 0/24). Perform the necessary steps on the DUT to clear the service list and then perform a band scan. Select "Service 1". Vary the power levels of both signal generators independently between -110 dBm and 0 dBm ensuring that one of the signal generators is always at a signal level greater than -95 dBm.	The DUT will offer a soft link alternative when the signal quality of the tuned service becomes poor. The radio will not follow without user selection at the point of loss unless an overriding menu choice allows automatic selection of soft linked services.

Table 38: DAB announcements

Test number	Test description	Valid result
9.3.1	An ETI file describing "Ensemble 1" containing a range of services including SId1:"Service 1" and SId2:"Service 2" is played on baseband encoder 1 with signal generator 1 set to channel 11D. Signal generator 2 is turned off. Announcement support (FIG 0/18) with ASu flag 1 set to 1 and Cluster Ids 2, 3 and 4 is signalled for SId1. Perform the necessary steps on the DUT to clear the service list and then perform a band scan. Select "Service 1": 1) Activate an announcement switch (FIG 0/19) with ClusterId = 3, ASw flag 1 set to 1 and the sub-channel of "Service2", 2) After 20 seconds deactivate the announcement switch.	1. The audio switches to "Service 2". 2. The audio switches back to "Service 1".
9.3.2	After performing test 9.3.1: 1) Activate an announcement switch (FIG 0/19) with ClusterId = 22, ASw flag 1 set to 1 and the sub-channel of "Service2", 2) Aft er 20 seconds deactivate the announcement switch.	1. The audio does not change. 2. The audio does not change.
9.3.3	After performing test 9.3.2, select "Service1": 1) Activate an announcement switch (FIG 0/19) with ClusterId = 2, ASw flag 1 set to 1 and the sub-channel of "Service2". 2) Switch off signal generator 1. 3) After 5 seconds switch on signal generator 1. 4) After 20 seconds deactivate the announcement switch.	1. The audio switches to "Service 2". 2. The audio mutes. 3. The audio of "Service 2" resumes. 4. The audio switches back to "Service 1".
9.3.4	After performing test 9.3.3: 1) Activate an announcement switch (FIG 0/19) with ClusterId = 3, ASw flag 1 set to 1 and the sub-channel of "Service2". 2) Switch off signal generator 1. 3) Deactivate the announcement switch. 4) After 5 seconds switch on signal generator 1.	1. The audio switches to "Service 2". 2. The audio mutes. 3. No change. 4. The audio switches back to "Service 1".
9.3.5	After performing test 9.3.4, select a non-broadcast audio source (e.g. CD, USB, AUX), if available: 1) Activate an announcement switch (FIG 0/19) with ClusterId = 4, ASw flag 1 set to 1 and the sub-channel of "Service2", 2) After 20 seconds deactivate the announcement switch.	1. The audio switches to "Service 2". 2. The audio switches back to the non-broadcast source.

The following tests require a DAB signal in transmission mode I and an FM with RDS signal and are carried out using a conducted method. The test setup is shown in figure 8. The channels and frequencies to be used are specified in each test. The DAB signal level shall be set to -70 dBm, unless specified differently by the individual test. The tests specified in tables 39 to 40 shall be performed using suitable ETI files and RDS signals.

Table 39: FM Service following

Test number	Test description	Valid result
9.4.1	An ETI file describing "Ensemble 1" containing a range of services including SId1:"Service 1" is played on baseband encoder 1 with signal generator 1 set to channel 8D. Baseband encoder 2 is set up to provide an FM-RDS signal with the same audio content, the PI code set to SId1, the PS name set to "FM-RDS1" and with signal generator 2 set to 98 MHz with a signal level of -70 dBm. Perform the necessary steps on the DUT to clear the service list and then perform a band scan. Select "Service 1". Vary the power levels of both signal generators independently between -110 dBm and 0 dBm ensuring that one of the signal generators is always at a signal level greater than -85 dBm.	The DUT will follow between DAB and FM according to signal quality without intervention from the user; DAB will be preferred whenever the DAB signal level provides error free reception; short audio interruptions may be present during switching.
9.4.2	An ETI file describing "Ensemble 1" containing a range of services including SId1:"Service 1" is played on baseband encoder 1 with signal generator 1 set to channel 9C. Baseband encoder 2 is set up to provide an FM-RDS signal with the same audio content, the PI code set to PI1 (which shall be different to SId1), the PS name set to "FM-RDS1" and with signal generator 2 set to 98 MHz with a signal level of -70 dBm. A hard link (FIG 0/6) connecting the two services is signalled on the DAB ensemble with the Linkage Actuator flag set to 1 (activated). Frequency information for the FM-RDS service is signalled (FIG 0/21). Perform the necessary steps on the DUT to clear the service list and then perform a band scan. Select "Service 1". Vary the power levels of both signal generators independently between -110 dBm and 0 dBm ensuring that one of the signal generators is always at a signal level greater than -85 dBm.	The DUT will follow the hard link between DAB and FM according to signal quality without intervention from the user; DAB will be preferred whenever the DAB signal level provides error free reception; short audio interruptions may be present during switching.
9.4.3	An ETI file describing "Ensemble 1" containing a range of services including SId1:"Service 1" is played on baseband encoder 1 with signal generator 1 set to channel 9C. Baseband encoder 2 is set up to provide an FM-RDS signal with different audio content, the PI code set to SId1, the PS name set to "FM-RDS2" and with signal generator 2 set to 98 MHz with a signal level of -70 dBm. A "dead link" (FIG 0/6 with IdLQ = 01 and zero PI codes) is signalled on the DAB ensemble with the Linkage Actuator flag set to 1 (activated). Frequency information for the FM-RDS service is signalled (FIG 0/21). Perform the necessary steps on the DUT to clear the service list and then perform a band scan. Select "Service 1". Vary the power levels of both signal generators independently between -110 dBm and 0 dBm ensuring that one of the signal generators is always at a signal level greater than -85 dBm.	The DUT will NOT alter the service that it is tuned to; audio mutes may occur when the signal level of the tuned ensemble falls below the sensitivity threshold.

Table 40: FM announcements

Test number	Test description	Valid result
9.5.1	An ETI file describing "Ensemble 1" containing a range of services including SId1:"Service 1" is played on baseband encoder 1 with signal generator 1 set to channel 11D. Baseband encoder 2 is set up to provide an FM-RDS signal with different audio content, the PI code set to PI1 (different to SId1), the PS name set to "FM-RDS" and with signal generator 2 set to 98 MHz with a signal level of -70 dBm. Announcement support (FIG 0/18) with ASu flag 1 set to 1 and Cluster Ids 2, 3 and 4 is signalled for SId1. No FIG 0/19 is signalled. Perform the necessary steps on the DUT to clear the service list and then perform a band scan. Select "Service 1". 1) Activate an FM traffic announcement on the FM-RDS service. 2) After 20 seconds deactivate the announcement.	1. The audio does not change. 2. The audio does not change.
9.5.2	An ETI file describing "Ensemble 1" containing a range of services including SId1:"Service 1" is played on baseband encoder 1 with signal generator 1 set to channel 11D. Baseband encoder 2 is set up to provide an FM-RDS signal with different audio content, the PI code set to SId1, the PS name set to "FM-RDS" and with signal generator 2 set to 98 MHz with a signal level of -70 dBm. Announcement support (FIG 0/18) with ASu flag 1 set to 1 and Cluster Ids 2, 3 and 4 is signalled for SId1. No FIG 0/19 is signalled. Perform the necessary steps on the DUT to clear the service list and then perform a band scan. Select "Service 1". 1) Activate an FM traffic announcement on the FM-RDS service. 2) After 20 seconds deactivate the announcement.	1. The audio does not change. 2. The audio does not change.

8 Test Specification for Products

8.1 Introduction

Clause 8 provides high level descriptions for the testing that provides evidence that the product meets the Minimum Requirements set out in clauses 5 and 6.

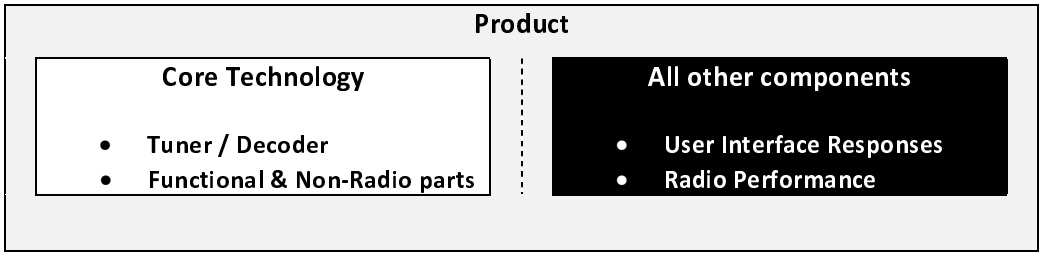


Figure 9: Place of all other components testing in overall scheme

The following types of DAB receiver are identified as forming the main groupings of products. Other types which come about in the future - or otherwise not listed here - will also be addressable by application of the test methods where appropriate.

Table 41: Product types

Product Type	Capabilities and features
Transportable systems, Hi-fi and micro systems which may or may not include audio sources such as portable music players or CD players etc.	Rigid whip antennas or free wire antennas Built-in user interface with input finger control and visual display Antenna input or fixed antenna Mains powered, mains adapter powered through a DC input socket or battery powered, or any of these Loudspeaker(s) for audio output Optional headphone and line outputs
Portable receivers, "lounge" or "kitchen" receivers	Rigid whip antennas or free wire antennas Built-in user interface with input finger control and visual display Antenna input or fixed antenna Mains powered, mains adapter powered through a DC input socket or battery powered, or any of these Loudspeaker(s) for audio output Optional headphone and line outputs
Hand portable or pocket receivers	Mains adapter powered through a DC input socket or battery powered or both Integral antenna or via earphone connector With earphones and with or without a loudspeaker output
Self-contained aftermarket vehicle receivers (i.e. in-vehicle accessories)	Vehicle powered in the range 8 V to 32 V DC User interface integrated or part of the product package Antenna input or fixed antenna Loudspeaker, line-out or external loudspeaker connectors
Self-contained in-vehicle receivers for OEM and aftermarket fitments	User interface integrated or part of the product package Antenna input Line-out and / or external loudspeaker connectors

Receiver products shall be designed to meet the minimum requirements described in clauses 5 and 6. Products shall be tested against limits provided in this clause 8, using calculated measurement margins. This philosophy ensures that products at the design limits achieve the correct performance criteria to be granted use of the Mark.

8.2 Applicability of the tests

All types of receivers are required to pass the user interface responses tests described in clause 8.3. The testing consists of four tests, the aims of which are:

- To ensure that the receiver can tune to an ensemble and play an audio service.
- To ensure that the receiver can correctly add services from another ensemble to the service list.
- To ensure that the user interface for scanning meets the Minimum Requirements.
- To ensure that service labels are displayed correctly.
- To ensure that dynamic labels are displayed correctly on domestic products (not required for in-vehicle products).
- To ensure that the receiver can tune to and play an FM service.

Domestic receivers supplied without an antenna and in-vehicle receivers with an antenna connector are required to pass the conducted sensitivity tests, as described in clause 8.4.4.

Domestic receivers supplied with an antenna - either fixed or detachable - and in-vehicle receivers without an antenna connector are required to pass the radiated sensitivity test with a signal induced at the antenna, as described in clause 8.4.5.

A fully representative sample of the receiver - such as the consumer would obtain from retail outlets - shall be tested.

The ETI files necessary to perform the tests are described in annex A and are available at https://docbox.etsi.org/Broadcast/Open/PRODUCT-STREAM_V1.0.zip. The tests require specialized test equipment and knowledge specific to radio product testing.

8.3 Product test for the user interface responses

8.3.1 Introduction

This method description forms part of the Product test for the user interface responses.

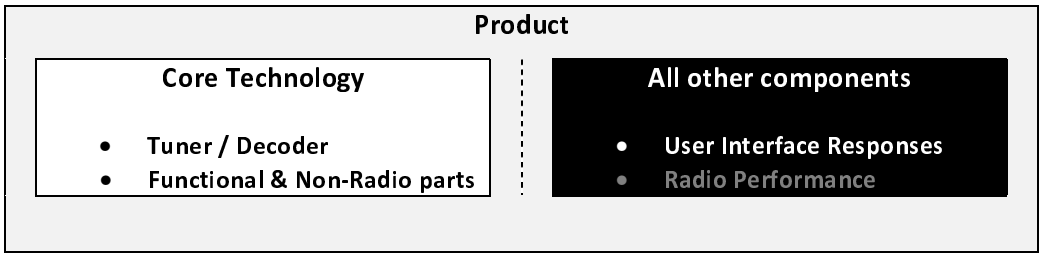


Figure 10: Place of user interface responses testing in overall scheme

8.3.2 User Interface tests

The testing consists of four tests, the aims of which are:

- To ensure that the DUT can tune to, and identify an ensemble in Band-III, and play an audio service.
- To ensure that the DUT can correctly add another ensemble in Band-III to the service list.
- To ensure that the user interface for scanning meets the Minimum Requirements.
- To ensure that service labels are displayed correctly.
- To ensure that dynamic labels are displayed correctly on domestic products (not required for in-vehicle products).
- To ensure that the receiver can tune to and play an FM service (not required for adapter products).

The tests shall be performed in sequence, starting with Test 1 and continuing to Test 5. This procedure is required since the state of the DUT at the beginning of each test is dependent on the previous tests.

Adapters designed to use the display of an in-vehicle FM-RDS receiver shall be tested with the DUT coupled to an FM-RDS receiver with a graphic display that is known to correctly render the complete RDS character set.

The DUT will be exposed to the test streams and the behaviour of the DUT will be verified.

The test streams described in annex A are used for these tests.

The following equipment is needed:

- Baseband player and signal generator suitable for playing an ETI file and for generating an RF output of -50 dBm.
- Suitable means to couple the output of the signal generator to the input of the DUT; direct cable or antenna.

8.3.3 Test 1 - Scan add new services

- Objective:
  - To prove that the DUT can discover and show all DAB and DAB+ audio services in an ensemble and that the method for initiating the band scan meets the Minimum Requirements.
- Method:
  - Setup the baseband encoder and play stream PRODUCT-STREAM-01_V1.0.eti.
  - Set the signal generator to an unused DAB channel and the signal level to -50 dBm.

- Turn on the DUT.
- Perform the necessary steps to clear the service list and perform a band scan.
- Leave the DUT switched on.

- Required results:
  - The band scan was initiated by the press of a single button on the device or, if it is a feature in a menu structure, it was in the top level of the menu, or one level down.
  - The service list contains all services from PRODUCT-STREAM-01_V1.0.eti; listed by either long (16 character) or short (8 character) label with every character rendered correctly: for products with a graphic display, use table 42; for products with a starburst display, use table 43; for adapters that use an FM-RDS display, use table 44. The order of presentation is at the manufacturer's choice.

Table 42: Display of service labels for test 1 - graphic display

16 character	8 character
Sine+	Sine+
OOI Music	OOIMusic
AABBCCDDEEFFGGHH	ABCDEFGH
##&&@@[[]]( ))	#&@[]( )
0011223344556677	01234567
8899++--**//==°°	89+-*/=°
hhggffeeddccbbaa	hgfedcba
€€££$$__©©%%<<>>	€£$_©%<>
¡¿¡¿"»"»'«'«?!?!	¡¿»"'«?!
¡¡¿¿..,,::;;??!!	¡¿.,:;?!
NOTE: The font used is at the manufacturer's choice.	

Table 43: Display of service labels for test 1 - Starburst display

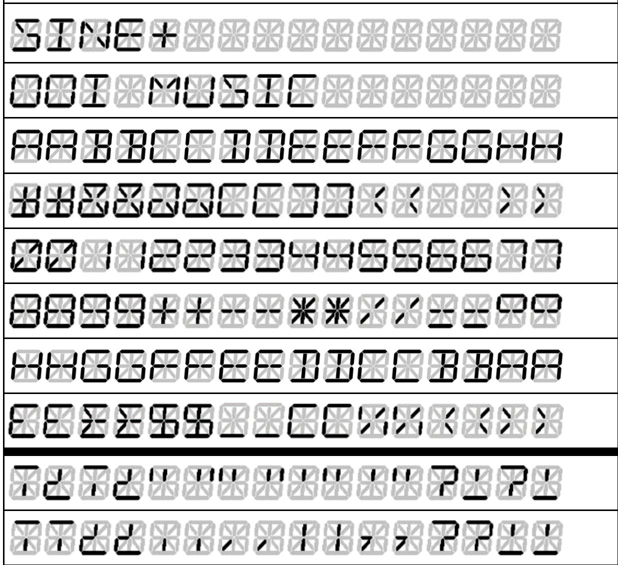
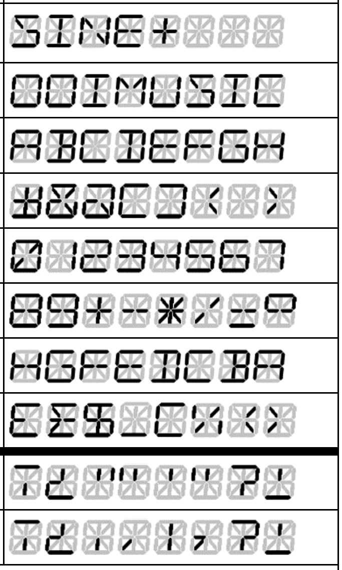
16 character	8 character
	
NOTE: For the bottom two labels only, "best efforts" presentation is acceptable; the character is recognizable but the precise segments used may vary from those shown.	

Table 44: Display of service labels for test 1 - adapter using FM-RDS graphic display

8 character
Sine+
OOIMusic
ABCDEFGH
#&@[]( )
01234567
89+-*/=°
hgfedcba
€£$_©%<>
¡¿""''"?!
¡¿.,:;?!

8.3.4 Test 2 - Play audio and view label for audio service

- Objective:
  - To ensure that the DUT can select a service, play out the audio and that the label for the audio playing is correct.
- Method:
  - Select "OOI Music" from the service list.
  - Listen for audio.

- Leave the DUT switched on.

- Required result:
  - Audio is played out as expected (music is heard).

8.3.5 Test 3 - Dynamic label is displayed and displayed correctly

In-vehicle receivers are not required to pass this test.

- Objective:
  - To ensure that the DUT can display a dynamic label and in doing so prove that the control codes are correctly handled by the receiver.

- Method:
  - Display the dynamic label;
  - Compare the dynamic label displayed to the examples shown below:

EXAMPLE 1: On a single line, scrolling display, without headline capability:

```
Product Test This message includes ABCDEFGHIJKLMNOPQRSTUVWXYZ and many short
words to show all is well
```

NOTE 1: The <EOH> and <PWB> are not displayed at all; the <PLB> is displayed as a space.

EXAMPLE 2: On a single line, scrolling display, with headline capability (in this example showing the headline in bold):

Product Test This message includes ABCDEFGHIJKLMNOPQRSTUVWXYZ and many short words to show all is well

NOTE 2: Recognizing the <EOH> causes the text to appear in bold until the <EOH> is reached. The <EOH> and <PWB> are not displayed at all; the <PLB> is displayed as a space.

EXAMPLE 3: On a four-line display with 16 characters per line, with headline capability:

Product Test	**Product Test**	**Product Test**	**Product Test**	**Product Test**
This message	includes	ABCDEFGHIJKLM-	NOPQRSTUVWXYZ	and many
includes	ABCDEFGHIJKLM-	NOPQRSTUVWXYZ	and many	short words to
ABCDEFGHIJKLM-	NOPQRSTUVWXYZ	and many	short words to	show all is well

NOTE 3: The headline is emphasized and remains in the top line of the display whilst the lower three lines scroll the message line by line. The <PWB> divides the long word and is displayed as a hyphen. The <PLB> forces a new line.

EXAMPLE 4: On an eight-line display with 32 characters per line:

```
Product Test
This message includes
ABCDEFGHIJKLMNOPQRSTUVWXYZ and
many
short words to show all is well
```

NOTE 4: The headline is emphasized on the top line of the display which is large enough to display the rest of the label without scrolling. The <PWB> is not needed and not displayed. The <PLB> forces a new line in this case, but other presentations are also acceptable.

- Required results:
  - All characters and formatting in the dynamic label are as expected.

8.3.6 Test 4 - Scan and add another ensemble

- Objective:
  - To ensure that the DUT can discover another ensemble and show these new services in the service list.
- Method:
  - Turn off the DUT;
  - Turn off the signal generator;
  - Setup the baseband encoder and play stream PRODUCT-STREAM-02_V1.0.eti;
  - Set the signal generator to a different unused DAB channel and the signal level to -50 dBm;
  - Turn on the DUT and perform a band scan.
- Required result:
  - The service list contains all services from PRODUCT-STREAM-02_V1.0.eti; listed by either long (16 character) or short (8 character) label with every character rendered correctly: for products with a graphic display, use table 45; for products with a starburst display, use table 46; for adapters that use an FM-RDS display, use table 47. The order of presentation is at the manufacturer's choice; the services listed in tables 42, 43, or 44 respectively may also be present.

Table 45: Display of additional service labels for Test 4 - graphic display

16 character	8 character
ĂĞIJKLMNĂĞIJKLMN	ĂĞIJKLMN
ĄĘĮŲĄĘĮŲOPQROPQR	ĄĘĮŲOPQR
ĀĒĪŪSTVŁĀĒĪŪSTVŁ	ĀĒĪŪSTVŁ
ÁÉÍÓÚÁÉÍÓÚĆĹŃĆĹŃ	ÁÉÍÓÚĆĹŃ
ÀÈÌÒÙWXYÀÈÌÒÙWXY	ÀÈÌÒÙWXY
ÂÊÎÔÛZÆŒÂÊÎÔÛZÆŒ	ÂÊÎÔÛZÆŒ
ÄËÏÖÜŸŋØÄËÏÖÜŸŋØ	ÄËÏÖÜŸŋØ
ÃÕÑŔŚÝŹUÃÕÑŔŚÝŹU	ÃÕÑŔŚÝŹU
ÅŮÇĢĶĻŅŞÅŮÇĢĶĻŅŞ	ÅŮÇĢĶĻŅŞ
ĚČĎŇŘŠŤŽĚČĎŇŘŠŤŽ	ĚČĎŇŘŠŤŽ
ĖİĊĠŻĖİĊĠŻĐĦŁĐĦŁ	ĖİĊĠŻĐĦŁ
ĽŞŢĽŞŢŐŰßŵÞŐŰßŵÞ	ĽŞŢŐŰßŵÞ
nmlkjiğănmlkjiğă	nmlkjiğă
rqpoųįęąrqpoųįęą	rqpoųįęą
łvtsūīēāłvtsūīēā	łvtsūīēā
ńĺćńĺcúóíéáúóíéá	ńĺcúóíéá
yxwùòìèàyxwùòìèà	yxwùòìèà
œæzûôîêâœæzûôîêâ	œæzûôîêâ
øŋÿüöïëäøŋÿüöïëä	øŋÿüöïëä
uźýśŕñõãuźýśŕñõã	uźýśŕñõã
şņļķģçůåşņļķģçůå	şņļķģçůå
žťšřňďčěžťšřňďčě	žťšřňďčě
łħđłħđżġċıėżġċıė	łħđżġċıė
þŷðűőþŷðűőţşľţşľ	þŷðűőţşľ
NOTE: The font used is at the manufacturer's choice	

Table 46: Display of additional service labels for Test 4 - starburst display

16 character	8 character
AGIUKLMNAGIUKLMN	AGIUKLMN
AEIUAEIUOPQROPQR	AEIUOPQR
AEIUSTVLAEIUSTVL	AEIUSTVL
AEIOUAEIOUCLNCLN	AEIOUCLN
AEIOUWXYAEIOUWXY	AEIOUWXY
AEIOUZÆŒAEIOUZÆŒ	AEIOUZÆŒ
AEIOUYNØAEIOUYNØ	AEIOUYNØ
AONRSYZUAONRSYZU	AONRSYZU
AUCGKLNSAUCGKLNS	AUCGKLNS
ECDNRSTZECDNRSTZ	ECDNRSTZ
EICGZEICGZDHLDHL	EICGZDHL
LSTLSTOURWPOURWP	LSTOURWP
NMLKUIGANMLKUIGA	NMLKUIGA
RQPOUIEARQPOUIEA	RQPOUIEA
LVTSUIEALVTSUIEA	LVTSUIEA
NLCNLCUOIEAUOIEA	NLCUOIEA
YXWUOIEAYXWUOIEA	YXWUOIEA
ŒÆZUOIEAŒÆZUOIEA	ŒÆZUOIEA
ØNYUOIEAØNYUOIEA	ØNYUOIEA
UZYSRNOAUZYSRNOA	UZYSRNOA
SNLKGCUASNLKGCUA	SNLKGCUA
ZTSRNDCEZTSRNDCE	ZTSRNDCE
LHDLHDZGCIEZGCIE	LHDZGCIE
PYDUOPYDUOTSLTSL	PYDUOTSL

Table 47: Display of additional service labels for Test 4 - adapter using FM-RDS graphic display

8 character
AĞIJKLMN
AEIUOPQR
AEIUSTVŁ
ÁÉÍÓÚĆLN
ÀÈÌÒÙWXY
ÂÊÎÔÛZÆŒ
ÄËÏÖÜYŋØ
ÃÕÑŔŚÝŹU
ÅUÇGKLNŞ
EČDNŘŠTŽ
EİCGZÐHL
LSTOUßŵÞ
nmlkjiğa
rqpouiea
łvtsuiea
ńlćúóíéá
yxwùòìèà
œæzûôîêâ
øŋyüöïëä
uźýśŕñõã
şnlkgçuå
žtšřňdčě
lhđzgcıe
þŷðuotsl
NOTE: All diacritical marks shown should be present on a fully capable FM-RDS display

8.3.7 Test 5 - Select and play FM services

Adapter products are not required to pass this test.

- Objective:
  - To prove that the DUT can select and play FM services.

- Method:
  - Select 3 FM services in the location where testing is taking place and tune to each and listen.
- Required results:
  - The audio plays for 15 seconds on each service without any interruptions or audio artefacts.

8.4 Product test for radio performance

8.4.1 Introduction

This method description forms part of the Product test for radio performance.

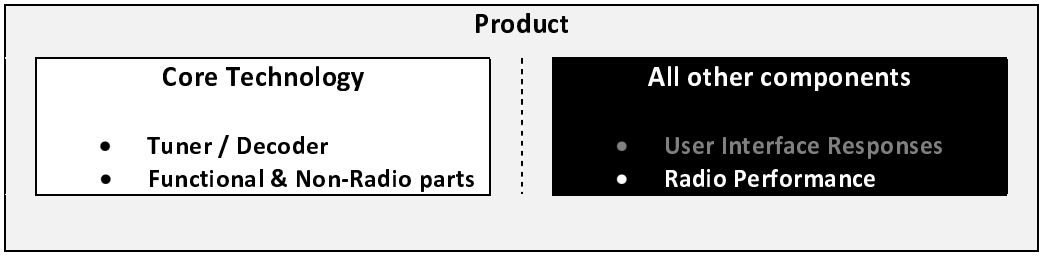


Figure 11: Place of radio performance testing in overall scheme

This method description forms part of the final receiver product test for radio performance, to show that the conducted or radiated sensitivity of a product meet the Minimum Requirements.

A "go / no go" RF power level pass / fail test method is used which is straightforward and time efficient.

The testing shall be carried out in carefully qualified and accredited test facilities, or by an alternate methodology which is approved by the operator of the certification scheme.

The four basic receiver types are tested as follows:

- Domestic products supplied with an antenna shall be tested using the radiated test method.
- Domestic products supplied without an antenna shall be tested using the conducted test method.
- In-vehicle products with an antenna connector shall be tested using the conducted test method.
- In-vehicle products with a fixed antenna (i.e. no antenna connector is available) shall be tested as domestic products using the radiated test method.

8.4.2 Standard test conditions

8.4.2.1 Environmental

- Ambient Temperature 15 °C to 35 °C
- Relative Humidity 25 % to 75 %
- Atmospheric pressure 86 kPa to 106 kPa
- Mains Voltage (EU) 230 V RMS ± 10 % 50 Hz ± 6 %
- Mains Voltage (Non-EU) According to laboratory norms

8.4.2.2 The OOI test

Products will typically not provide a means to determine the BER and therefore a test method is specified which allows the audio output of the product to be used to determine the radio performance.

The success / failure criterion is the quality of an audio tone delivered by the product, when supplied with a specifically encoded test stream. The audio output of the product is monitored over a 10 second period for the detection of audio impairments. An impairment is defined as any recognizable deviation from a constant amplitude audio tone; for example audio drops or gaps, or bursts of non-programme sound image - sometimes called "burbles", "tweets", "chirps" or "birdies".

The required test stream is provided in the ETI file detailed in clause A.1. The service named "Sine+" consists of a 1 kHz, sine wave -3 dBFS, mono image, encoded as DAB+ audio in a 128 kbit/s subchannel at protection level EEP-3A.

The audio level at the listeners ears shall be set to > 75 dBA weighted SPL at 30 cm and the listening environment shall be a quiet room, or alternately using isolating headphones. Automated monitoring is also permitted.

8.4.3 RF test frequencies, pass / fail limits

The pass / fail limits are derived from:

1) The Minimum Requirements set out in clauses 5 and 6;

2) A correction factor of -1,1 dBm to take account of the difference between the BER of 10^{-4} and the point at which the test signal ceases to provide clean tone;

3) Measurement uncertainties. The test facility will identify the measurement uncertainties for radiated and conducted measurements and declare these in the results report for each product test.

The conducted test pass / fail signal threshold, S_c, at the connector of the receiver is the required target of -97,7 dBm plus the correction factor of -1,1 dBm plus a measurement uncertainty allowance Y_{tf}.

Y_{tf} is defined as the conducted uncertainty value (U.V.) calculated by the test facility in dB, and

S_c = -97,7 - 1,1 + $|Y_{tf}|$ (positive magnitude of Y_{tf}) dBm

In any case, the maximum permitted value of $|Y_{tf}|$ is 0,4 dB.

The radiated test pass / fail signal threshold, S_r, is the required target of 34,4 + 20log10(F/220) dBµV/m plus the correction factor of -1,1 dBµV/m plus a measurement uncertainty allowance X_{tf}.

The test facility will seek to minimize the uncertainties for setting of field strength intensity in the test zone and for the OOI measurement process by choice of equipment and methods and will calculate and report the uncertainty value (U.V.) which prevails at the time of test.

X_{tf} is defined as the radiated uncertainty value (U.V.) for the test facility in dB, and

S_r = 34,4 + 20log10(F/220) - 1,1 + $|X_{tf}|$ (positive magnitude of X_{tf}) dBµV/m

In any case, the maximum permitted value of $|X_{tf}|$ is 4 dB.

8.4.4 Method for conducted sensitivity test

8.4.4.1 Initial conditions- measurement uncertainty calculation

In order to maximize measurement accuracy and repeatability certain test conditions are stipulated and shall be adhered to.

The Uncertainty Value, U.V. (for the whole process, including power level and OOI test) will be established by the test facility and if < 0,4 dB, used to calculate the dBm in column C of table C.3; if equal or greater than 0,4 dB, then column E shall be used. The U.V. shall be recorded in box Y of table C.3. An example calculation of the measurement uncertainty is given in table C.1.

8.4.4.2 Empirical method - 1 kHz tone, DAB+ audio, EEP-3A

Figure 12: Conducted test set up for domestic and in-vehicle receivers

1) The measurement set-up is given in figure 12 for the purpose of explanation of method.
2) The signal generator shall be connected to the RF input of the receiver under test.
3) The acoustic output shall be monitored through speakers or headphones connected to the receiver.
4) Check that the set-up is working with these steps:
   a) Set the RF input power level to -80 dBm. Set the frequency to channel 10A.
   b) Play the specified stream PRODUCT-STREAM-01_V1.0.eti.
   c) Tune the receiver to channel 10A or initiate a band scan. Select the service "Sine+".
   d) Expected result - the 1 kHz tone can be heard with no impairments.
   e) Set the RF input power level to -110 dBm.
   f) Expected result - 1 kHz cannot be heard (the receiver may also display that the service is not available).

If the results are as expected, continue with the measurement:

5) Using table C.3, set the generator frequency to channel 5A, given in column B. Repeat the following steps for test numbers 1 to 38.
6) Set the RF input power level to the value in column C or column E.
7) Tune the receiver to the set frequency or initiate a band scan.
8) Select the service "Sine+" - if it is not in the service list then mark "Fail" against this frequency and go to step 11 else continue.
9) A 1 kHz tone should be heard - if it is not then mark "Fail" against this frequency and go to step 11 else continue.
10) Listen for audio impairments in the 1 kHz tone over a period of 10s - if no impairments are heard then mark "Pass" against this frequency else mark "Fail".
11) Set the generator to the next frequency given in column B. Continue at step 7.

Results shall be submitted in a standardized way using the test report format in clause C.3.

8.4.4.3 Empirical method - music stream, DAB audio, UEP-3

1) The measurement set-up is given in figure 12 for the purpose of explanation of method.
2) The signal generator shall be connected to the RF input of the receiver under test.
3) The acoustic output shall be monitored through speakers or headphones connected to the receiver.
4) Using table C.3, set the generator frequency to channel 11C, given in column B.
5) Set the RF input power level to the value corresponding to test number 39, column C or column E (**important**: this value is **not** the same as for the Sine+ test).
6) Play the specified stream PRODUCT-STREAM-01_V1.0.eti.
7) Tune the receiver to the set frequency or initiate a band scan.
8) Select the service "OOI Music".
9) During a listening period of least 10 seconds, verify that the sound is substantially intact and recognizable. In this case mark the test as a "Pass"; otherwise mark as a "Fail".

8.4.5 Method for radiated sensitivity test

8.4.5.1 Initial conditions - measurement uncertainty calculation

In order to maximize measurement accuracy and repeatability certain test conditions are stipulated and shall be adhered to.

The Uncertainty Value - U.V. (for the whole process, including field strength and OOI test) will be established by the test facility and if < 4 dB, used to calculate the dBµV/m in column C of table C.4. If equal or greater than 4dB, then column E will be used. The U.V. will be recorded in box X of table C.4. An example calculation of the measurement uncertainty is given in table C.2.

8.4.5.2 Empirical method - 1 kHz tone, DAB+ audio, EEP-3A

In order to obtain the required test accuracy and repeatability, this method is to be used in test facilities meeting the standards required for receiver testing and free field, radiated electromagnetic wave conditions.

A G-TEM cell with sufficiently large internal dimensions shall be used for the radiated test. The dimensions shall allow accommodation of the equipment with a stable zone of field distribution.

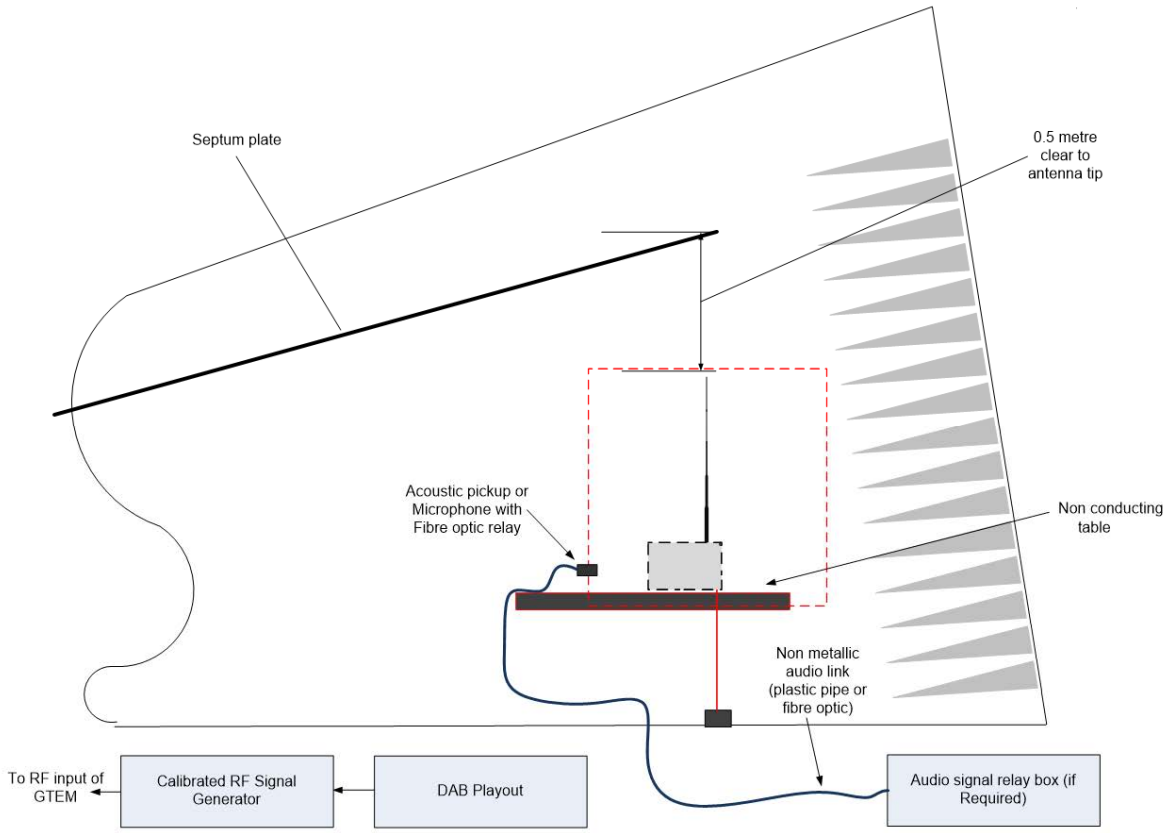


Figure 13: Generalized receiver configuration in G-TEM cell

The DUT shall be placed such that its antenna is on the centreline (long axis) of the G-TEM cell, and in the "operating plane" of the cell. The operating plane is perpendicular to the longitudinal axis of the cell and its position is dependent on the size of the particular G-TEM cell in use.

A wire antenna (typically used by clock radios) shall be supported vertically from the receiver using a non-conducting support structure and not more than 5 mm away from the body of the DUT.

An earphone antenna (typically used by hand-held radios or mobile phones) shall be placed close to the floor, but separated from it by a non-conducting spacer, and the earphone shall be attached to a non-conducting support which holds the earpieces 15 cm apart with the lead running vertically downwards to its full extent to connect to the DUT.

The power supply cable shall run vertically to the floor of the G-TEM cell and any excess lead shall be coiled at floor level.

If a G-TEM cell is not available, a FAR / SAR arrangement may be used. It shall provide the equivalent test environment to that of the G-TEM cell. It is important to control mains and PSU leads as they may act both as an antenna counterpoise, and as a radiative element for interference which can influence the overall sensitivity result.

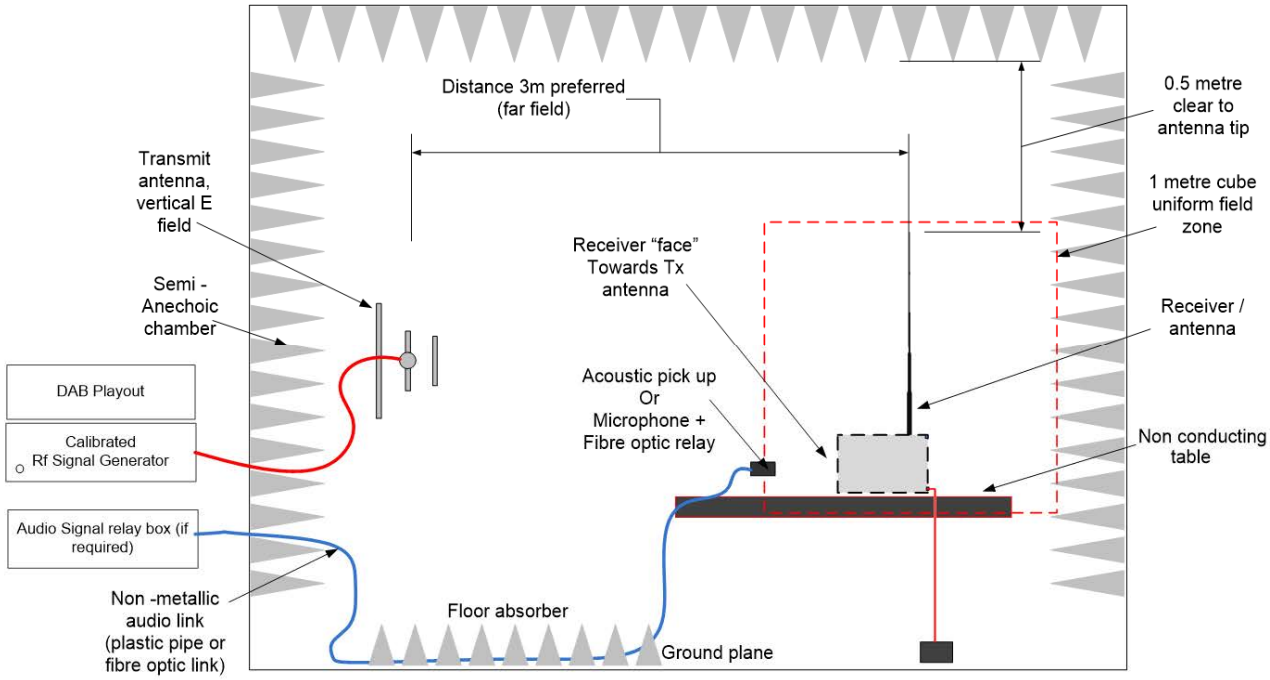


Figure 14: Generalized receiver configuration in large anechoic test chamber

NOTE: It is beneficial to have a uniform field volume proportionate to the size of the DUT - 1 m × 1 m × 1 m is a minimum.

1) The measurement set-up is given in figure 13 for G-TEM cell and in figure 14 for FAR/SAR.

2) The signal generator shall be connected to the RF input of the chamber.

3) The audio level from the speaker should be controlled to achieve a 75dBA SPL at 30 cm distance. The acoustic output shall be monitored through the sound link relay to speakers or headphones outside the chamber.

4) Check that the set-up is working with these steps:

   a) Set the field strength to 55 dBµV/m. Set the frequency to channel 10A.

   b) Play the specified stream PRODUCT-STREAM-01_V1.0.eti.

   c) Tune the receiver to channel 10A or initiate a band scan. Select the service "Sine+".

   d) Expected result - the 1 kHz tone can be heard with no impairments.

   e) Set the field strength to 15 dBµV/m.

   f) Expected result - 1 kHz cannot be heard (the receiver may also display that the service is not available).

If the results are as expected, continue with the measurement:

5) Using table C.4, set the generator frequency to channel 5A, given in column B. Repeat the following steps for test numbers 1 to 38.

6) Set the field strength to the value in column C or column E.

7) Tune the receiver to the set frequency or initiate a band scan.

8) Select the service "Sine+" - if it is not in the service list then mark "Fail" against this frequency and go to step 11 else continue.

9) A 1 kHz tone should be heard - if it is not then mark "Fail" against this frequency and go to step 11 else continue.

10) Listen for audio impairments in the 1 kHz tone over a period of 10s - if no impairments are heard then mark "Pass" against this frequency else mark "Fail".

11) Set the generator to the next frequency given in column B. Continue at step 6.

Results shall be submitted in a standardized way using the test report format in clause C.4.

8.4.5.3 Empirical method - music stream, DAB audio, UEP-3

1) The measurement set-up is given in figure 13 for G-TEM cell and in figure 14 for FAR/SAR.

2) The signal generator shall be connected to the RF input of the chamber.

3) The audio level from the speaker should be controlled to achieve a 75dBA SPL at 30 cm distance. The acoustic output shall be monitored through the sound link relay to speakers or headphones outside the chamber.

4) Using table C.4, set the generator frequency to channel 11C, given column B.

5) Set the field strength to the value corresponding to test number 39, column C or column E (**important**: this value is **not** the same as for the Sine+ test).

6) Play the specified stream PRODUCT-STREAM-01_V1.0.eti.

7) Tune the receiver to the set frequency or initiate a band scan.

8) Select the service "OOI Music"

9) During a listening period of least 10 seconds, verify that the sound is substantially intact and recognizable. In this case mark the test as a "Pass"; otherwise mark as a "Fail".

Annex A (normative): Product test streams

A.1 PRODUCT-STREAM-01_V1.0.eti

This file contains a 120 minute long ETI (NI) test stream. The ensemble label is PRODUCTMUX1, the EId is CCCC and the ensemble contains the services (10 subchannels) shown in table A.1. It is available at https://docbox.etsi.org/Broadcast/Open/PRODUCT-STREAM_V1.0.zip.

Table A.1: Services in PRODUCT-STREAM-01_V1.0.eti

Service label SId	Bit rate/codec Protection	Audio Content	Dynamic label (see note)
Sine+ C000	128k AAC EEP-3A	1kHz tone -3 dBFS mono image	AAC 128 kbps 1 kHz tone for sensitivity testing
OOI Music C001	128k MP2 UEP-3	Royalty free music (see note 1) 0 dBFS stereo image	Product Test<EOH> This message includes ABCDEFGHIJKLM<PWB>NOPQRSTUVWXYZ and many<PLB>short words to show all is well (see note 2)
AABBCCDDEEFFGGHH C002	128k MP2 UEP-3	1,5 kHz tone	MP2 128 kbps 1,5 kHz tone
##&&@@[[]](( )) C003	96k AAC EEP-3A	2 kHz tone	AAC 96 kbps 2 kHz tone
0011223344556677 C004	96k AAC EEP-3A	3 kHz tone	AAC 96 kbps 3 kHz tone
8899++--**//==°° C005	96k AAC EEP-3A	4 kHz tone	AAC 96 kbps 4 kHz tone
hhggffeeddccbbaa C006	64k AAC EEP-3A	5 kHz tone	AAC 64 kbps 5 kHz tone
€€ff$$__©©%%<<>> C007	64k AAC EEP-3A	6 kHz tone	AAC 64 kbps 6 kHz tone
¡"¡"«¿«¿»?»?'!'! C008	64k AAC EEP-3A	7 kHz tone	AAC 64 kbps 7 kHz tone
¡¡¿¿..,,::;;??!! C009	64k AAC EEP-3A	8 kHz tone	AAC 64 kbps 8 kHz tone
NOTE 1: The music file is AKMusic AK033-"Good Time Grooves - Jazz n Funk", track 11 "newyorkskyline". NOTE 2: <PLB> indicates the "preferred line break" control code 0x0A; <EOH> indicates the "end of headline" control code 0x0B; <PWB> indicates the "preferred word break" control code 0x1F.			

A.2 PRODUCT-STREAM-02_V1.0.eti

This file contains a 2 minute long ETI (NI) test stream. The ensemble label is PRODUCTMUX2, the EId is DDDD and the ensemble contains the services (two subchannels) shown in table A.2. It is available at https://docbox.etsi.org/Broadcast/Open/PRODUCT-STREAM_V1.0.zip.

Table A.2: Services in PRODUCT-STREAM-02_V1.0.eti

Service label SId	Bit rate/codec Protection	Audio Content	Dynamic label
ĂĞIJKLMNĂĞIJKLMN D001	48k AAC EEP-3A	2 kHz tone	AAC 48 kbps 2 kHz tone
ĄĘĮŲĄĘĮŲOPQROPQR D002	48k AAC EEP-3A	1 kHz tone	AAC 48 kbps 1 kHz tone
ĀĒĪŪSTVŁĀĒĪŪSTVŁ D003	48k AAC EEP-3A	2 kHz tone	AAC 48 kbps 2 kHz tone
ÁÉÍÓÚÁÉÍÓÚĆĹŃĆĹŃ D004	48k AAC EEP-3A	1 kHz tone	AAC 48 kbps 1 kHz tone
ÀÈÌÒÙWXYÀÈÌÒÙWXY D005	48k AAC EEP-3A	2 kHz tone	AAC 48 kbps 2 kHz tone
ÂÊÎÔÛZÆŒÂÊÎÔÛZÆŒ D006	48k AAC EEP-3A	1 kHz tone	AAC 48 kbps 1 kHz tone
ÄËÏÖÜŸŋØÄËÏÖÜŸŋØ D007	48k AAC EEP-3A	2 kHz tone	AAC 48 kbps 2 kHz tone
ÃÕÑŔŚÝźUÃÕÑŔŚÝźU D008	48k AAC EEP-3A	1 kHz tone	AAC 48 kbps 1 kHz tone
ÅŮÇĢĶĻŅŞÅŮÇĢĶĻŅŞ D009	48k AAC EEP-3A	2 kHz tone	AAC 48 kbps 2 kHz tone
ĚČĎŇŘŠŤŽĚČĎŇŘŠŤŽ D010	48k AAC EEP-3A	1 kHz tone	AAC 48 kbps 1 kHz tone
ĖİĊĠŻĖİĊĠŻÐĦŁÐĦŁ D011	48k AAC EEP-3A	2 kHz tone	AAC 48 kbps 2 kHz tone
ŁŞŢŁŞŢŐŰßŵÞŐŰßŵÞ D012	48k AAC EEP-3A	1 kHz tone	AAC 48 kbps 1 kHz tone
nmlkjiğănmlkjiğă D013	48k AAC EEP-3A	2 kHz tone	AAC 48 kbps 2 kHz tone
rqpoųįęarqpoųįęa D014	48k AAC EEP-3A	1 kHz tone	AAC 48 kbps 1 kHz tone
łvtsūīēāłvtsūīēā D015	48k AAC EEP-3A	2 kHz tone	AAC 48 kbps 2 kHz tone
ńĺćńĺćúóíéáúóíéá D016	48k AAC EEP-3A	1 kHz tone	AAC 48 kbps 1 kHz tone
yxwùòìèàyxwùòìèà D017	48k AAC EEP-3A	2 kHz tone	AAC 48 kbps 2 kHz tone
œæzûôîêâœæzûôîêâ D018	48k AAC EEP-3A	1 kHz tone	AAC 48 kbps 1 kHz tone
øŋÿüöïëäøŋÿüöïëä D019	48k AAC EEP-3A	2 kHz tone	AAC 48 kbps 2 kHz tone
uźýśńõãuźýśńõã D020	48k AAC EEP-3A	1 kHz tone	AAC 48 kbps 1 kHz tone
şņļķģçůåşņļķģçůå D021	48k AAC EEP-3A	2 kHz tone	AAC 48 kbps 2 kHz tone
žťšřňďčěžťšřňďčě D022	48k AAC EEP-3A	1 kHz tone	AAC 48 kbps 1 kHz tone
łħđłħđżġċıėżġċıė D023	48k AAC EEP-3A	2 kHz tone	AAC 48kbps 2 kHz tone
þŷðűőþŷðűőţşľţşľ D024	48k AAC EEP-3A	1 kHz tone	AAC 48 kbps 1 kHz tone

Annex B (normative): Character mapping for RDS head units

Table B.1: Mapping of character codes for display on FM-RDS receivers

Received DAB character	DAB code point	RDS code point	RDS character displayed		Received DAB character	DAB code point	RDS code point	RDS character displayed
Ę	0x01	0x45	E		Ą	0x60	0x41	A
Į	0x02	0x49	I		«	0x7B	0x22	"
Ų	0x03	0x55	U		ů	0x7C	0x75	u
Ă	0x04	0x41	A		»	0x7D	0x22	"
Ė	0x05	0x45	E		Ľ	0x7E	0x4C	L
Ď	0x06	0x44	D		Ħ	0x7F	0x48	H
Ș	0x07	0x53	S		Ÿ	0x8F	0x59	Y
Ț	0x08	0x54	T		ÿ	0x9F	0x79	y
Ċ	0x09	0x43	C		Ķ	0xA0	0x4B	K
Ġ	0x0C	0x47	G		Ņ	0xA1	0x4E	N
Ĺ	0x0D	0x4C	L		Ģ	0xA3	0x47	G
Ż	0x0E	0x5A	Z		Ő	0xA8	0x4F	O
Ń	0x0F	0x4E	N		Ā	0xAC	0x41	A
ą	0x10	0x61	a		Ē	0xAD	0x45	E
ę	0x11	0x65	e		Ī	0xAE	0x49	I
į	0x12	0x69	i		Ū	0xAF	0x55	U
ų	0x13	0x75	u		ķ	0xB0	0x6B	k
ă	0x14	0x61	a		ņ	0xB1	0x6E	n
ė	0x15	0x65	e		Ļ	0xB2	0x4C	L
ď	0x16	0x64	d		ģ	0xB3	0x67	g
ș	0x17	0x73	s		ļ	0xB4	0x6C	l
ț	0x18	0x74	t		Ű	0xB8	0x55	U
ċ	0x19	0x63	c		ľ	0xBA	0x6C	l
Ň	0x1A	0x4E	N		ā	0xBC	0x61	a
Ě	0x1B	0x45	E		ē	0xBD	0x65	e
ġ	0x1C	0x67	g		ī	0xBE	0x69	i
Í	0x1D	0x6C	I		ū	0xBF	0x75	u
ż	0x1E	0x7A	z		Ť	0xEE	0x54	T
ł	0x24	0x6C	l		ť	0xFE	0x74	t
Ů	0x5C	0x55	U		ħ	0xFF	0x68	h
Ł	0x5E	0x4C	L					
NOTE: All other code points are unchanged.								

Annex C (normative): Product testing

C.1 Conducted measurement uncertainty calculation (example)

Table C.1: Example of conducted measurement uncertainty calculation

Item	Uncertainty	dB	db squared
1	Uncertainty baseband signal and RF level from signal generator (power meter used to set level)	0,25	0,0625
2	Uncertainty loss (variability) in conducted RF matching when using matching pad	0	0
3	Variability in the noise / self-interference of the receiver	0,2	0,04
4	Variability in the acoustic OOI measurement	0,25	0,0625
	Sum of squares		0,165
	Root sum squares ±dB	**0,4**	

C.2 Radiated measurement uncertainty calculation (example)

Table C.2: Example of radiated measurement uncertainty calculation

Item	Uncertainty	dB	db squared
1	Uncertainty in free field strength at receiver test zone: • Items include: • Uncertainty in signal level from signal generator • RF cable loss0.04 • Signal generator - antenna mismatch variability • Antenna calibration variability • Spurious signal coupling variability • Polarization variability	2,98	8,8804
2	uncertainty (variability) in conducted sensitivity of receiver (due to changes of environment / PSU etc. lead coupling effects)	0,2	0,04
3	Variability in the gain of the antenna system due to placement differences	2	4
4	Variability in the noise / self-interference of the antenna system due to placement differences	2	4
5	Variability in the acoustic OOI measurement	0,25	0,0625
	Sum of squares		16,9829
	Root sum squares ±dB	**4,1**	

C.3 Conducted test result template

Table C.3: Conducted test result template

Receiver Make Model and type and serial number ……					Mains voltage / Frequency ……	
Date and time of test ……			Test personnel names: …… ……		Box Y. Measurement uncertainty value, (U.V.) Y_{tf} in dB for 95% confidence: ……	
List attached files / diagrams / Photos / video clips: ……					Other Calibration data / test equipment ……	
Use Column C and D OR Column E and F						
	A	B	C	D	E	F
Test No.	Channel	Frequency (MHz)	Input power (dBm) using U.V. in Box X	PASS / FAIL	Input power (dBm) using maximum allowed limit	PASS / FAIL
"Sine+", AAC, EEP-3A						
1	5A	174,928	(-98,8+Y_{tf})		-98,4	
2	5B	176,640	(-98,8+Y_{tf})		-98,4	
3	5C	178,352	(-98,8+Y_{tf})		-98,4	
4	5D	180,064	(-98,8+Y_{tf})		-98,4	
5	6A	181,936	(-98,8+Y_{tf})		-98,4	
6	6B	183,648	(-98,8+Y_{tf})		-98,4	
7	6C	185,360	(-98,8+Y_{tf})		-98,4	
8	6D	187,072	(-98,8+Y_{tf})		-98,4	
9	7A	188,928	(-98,8+Y_{tf})		-98,4	
10	7B	190,640	(-98,8+Y_{tf})		-98,4	
11	7C	192,352	(-98,8+Y_{tf})		-98,4	
12	7D	194,064	(-98,8+Y_{tf})		-98,4	
13	8A	195,936	(-98,8+Y_{tf})		-98,4	
14	8B	197,648	(-98,8+Y_{tf})		-98,4	
15	8C	199,360	(-98,8+Y_{tf})		-98,4	
16	8D	201,072	(-98,8+Y_{tf})		-98,4	
17	9A	202,928	(-98,8+Y_{tf})		-98,4	
18	9B	204,640	(-98,8+Y_{tf})		-98,4	
19	9C	206,352	(-98,8+Y_{tf})		-98,4	
20	9D	208,064	(-98,8+Y_{tf})		-98,4	
21	10A	209,936	(-98,8+Y_{tf})		-98,4	
22	10B	211,648	(-98,8+Y_{tf})		-98,4	
23	10C	213,360	(-98,8+Y_{tf})		-98,4	
24	10D	215,072	(-98,8+Y_{tf})		-98,4	
25	11A	216,928	(-98,8+Y_{tf})		-98,4	
26	11B	218,640	(-98,8+Y_{tf})		-98,4	
27	11C	220,352	(-98,8+Y_{tf})		-98,4	
28	11D	222,064	(-98,8+Y_{tf})		-98,4	
29	12A	223,936	(-98,8+Y_{tf})		-98,4	
30	12B	225,648	(-98,8+Y_{tf})		-98,4	
31	12C	227,360	(-98,8+Y_{tf})		-98,4	
32	12D	229,072	(-98,8+Y_{tf})		-98,4	
33	13A	230,784	(-98,8+Y_{tf})		-98,4	
34	13B	232,496	(-98,8+Y_{tf})		-98,4	
35	13C	234,208	(-98,8+Y_{tf})		-98,4	

Receiver Make Model and type and serial number ……					Mains voltage / Frequency ……	
Date and time of test ……			Test personnel names: …… ……		Box Y. Measurement uncertainty value, (U.V.) Y_{tf} in dB for 95% confidence: ……	
List attached files / diagrams / Photos / video clips: ……					Other Calibration data / test equipment ……	
Use Column C and D OR Column E and F						
	A	B	C	D	E	F
Test No.	Channel	Frequency (MHz)	Input power (dBm) using U.V. in Box X	PASS / FAIL	Input power (dBm) using maximum allowed limit	PASS / FAIL
"Sine+", AAC, EEP-3A						
36	13D	235,776	(-98,8+Y_{tf})		-98,4	
37	13E	237,488	(-98,8+Y_{tf})		-98,4	
38	13F	239,200	(-98,8+Y_{tf})		-98,4	
"OOI Music", MP2, UEP-3						
39	11C	220,352	(-97,7+Y_{tf})		-97,3	

C.4 Radiated test result template

Table C.4: Radiated test result template

Receiver Make Model and type and serial number ……					Mains voltage / Frequency ……	
Date and time of test ……			Test personnel names: …… ……		Box X. Measurement uncertainty value, (U.V.) X_{tf} in dB for 95% confidence: ……	
List attached files / diagrams / Photos / video clips: ……					Other Calibration data / test equipment ……	
Use Column C and D OR Column E and F						
	A	B	C	D	E	F
Test No.	Channel	Frequency (MHz)	Field strength (dBµV/m) using U.V. in Box X	PASS / FAIL	Field strength (dBµV/m) using maximum allowed limit	PASS / FAIL
"Sine+", AAC, EEP-3A						
1	5A	174,928	(31,3 + X_{tf})		35,3	
2	5B	176,640	(31,4 + X_{tf})		35,4	
3	5C	178,352	(31,5 + X_{tf})		35,5	
4	5D	180,064	(31,6 + X_{tf})		35,6	
5	6A	181,936	(31,6 + X_{tf})		35,6	
6	6B	183,648	(31,7 + X_{tf})		35,7	
7	6C	185,360	(31,8 + X_{tf})		35,8	
8	6D	187,072	(31,9 + X_{tf})		35,9	
9	7A	188,928	(32,0 + X_{tf})		36,0	
10	7B	190,640	(32,1 + X_{tf})		36,1	
11	7C	192,352	(32,1 + X_{tf})		36,1	
12	7D	194,064	(32,2 + X_{tf})		36,2	
13	8A	195,936	(32,3 + X_{tf})		36,3	
14	8B	197,648	(32,4 + X_{tf})		36,4	
15	8C	199,360	(32,4 + X_{tf})		36,4	
16	8D	201,072	(32,5 + X_{tf})		36,5	
17	9A	202,928	(32,6 + X_{tf})		36,6	
18	9B	204,640	(32,7 + X_{tf})		36,7	

Receiver Make Model and type and serial number ……..		Mains voltage / Frequency ……
Date and time of test ……	Test personnel names: …… ……	Box X. Measurement uncertainty value, (U.V.) X_{tf} in dB for 95% confidence: ……
List attached files / diagrams / Photos / video clips: ……		Other Calibration data / test equipment ……

Use Column C and D OR Column E and F						
	A	B	C	D	E	F
Test No.	Channel	Frequency (MHz)	Field strength (dBµV/m) using U.V. in Box X	PASS / FAIL	Field strength (dBµV/m) using maximum allowed limit	PASS / FAIL
"Sine+", AAC, EEP-3A						
19	9C	206,352	(32,7 + X_{tf})		36,7	
20	9D	208,064	(32,8 + X_{tf})		36,8	
21	10A	209,936	(32,9 + X_{tf})		36,9	
22	10B	211,648	(33,0 + X_{tf})		37,0	
23	10C	213,360	(33,0 + X_{tf})		37,0	
24	10D	215,072	(33,1 + X_{tf})		37,1	
25	11A	216,928	(33,2 + X_{tf})		37,2	
26	11B	218,640	(33,2 + X_{tf})		37,2	
27	11C	220,352	(33,3 + X_{tf})		37,3	
28	11D	222,064	(33,4 + X_{tf})		37,4	
29	12A	223,936	(33,5 + X_{tf})		37,5	
30	12B	225,648	(33,5 + X_{tf})		37,5	
31	12C	227,360	(33,6 + X_{tf})		37,6	
32	12D	229,072	(33,7 + X_{tf})		37,7	
33	13A	230,784	(33,7 + X_{tf})		37,7	
34	13B	232,496	(33,8 + X_{tf})		37,8	
35	13C	234,208	(33,8 + X_{tf})		37,8	
36	13D	235,776	(33,9 + X_{tf})		37,9	
37	13E	237,488	(34,0 + X_{tf})		38,0	
38	13F	239,200	(34,0 + X_{tf})		38,0	
"OOI Music", MP2, UEP-3						
39	11C	220,352	(34,4 + X_{tf})		38,4	

Annex D (normative): Characteristics of a Rayleigh channel

D.1 Simulation of the mobile radio channel

The mobile radio channel is described by highly dispersive multi-path propagation caused by reflection and scattering. The paths between transmitter and receiver can be considered to consist of large reflectors and/or scatterers at some distance to the receiver, giving rise to a number of waves that arrive in the vicinity of the receiver with random amplitudes and delays. Close to the receiver, these paths are further randomized by local reflections/diffractions.

For a moving receiver, the angle of incidence of the received signal at the antenna shall also be taken into account, since it affects the Doppler shift associated with a wave arriving from a particular direction.

Propagation models for the description of the above mobile radio channel have been defined in order to allow practical simulation by means of a hardware simulator. They comprise echo profiles covering the specific reception conditions in conventional networks as well as in Single Frequency Networks (SFN).

The propagation models are presented below in terms of the time delay, amplitude coefficient and the Doppler spectra associated with each delay path:

- a discrete number of taps, each determined by its time delay and its average power;
- the Rayleigh distributed amplitude of each tap, varying according to a Doppler spectrum $S(\tau_i, f)$, where i is the tap index.

D.2 Doppler spectrum types

D.2.1 General

For the modelling of the channel, five types of Doppler spectra are defined. They describe the relation of power density versus Doppler shift, i. e. the influence of the speed of the moving car and the impacts of the surrounding terrain.

The following abbreviations are used:

- $f_d = v/\lambda$ represents the maximum Doppler shift, with vehicle speed v [m/s] and wavelength λ [m].
- $G(A, f_1, f_2)$ is the Gaussian function:

  G(magnitude, Doppler shift, standard deviation of Gaussian distribution)

$$G(f) = A \exp\left(\frac{(f - f_1)^2}{2f_2^2}\right)$$

D.2.2 Doppler spectrum: CLASS

CLASS is the classical Doppler spectrum and is to be used for paths with delays up to 0,5 µs, ($\tau_i \leq 0{,}5$ µs).

(CLASS)
$$S(\tau_i, f) = \frac{A}{\sqrt{1 - \left(f / f_d\right)^2}} \qquad \text{for } f \in \left]-f_d, f_d\right[$$

D.2.3 Doppler spectrum: GAUS1

GAUS1 is the sum of two Gaussian functions and is used for excess delay times in the range of 0,5 µs to 2 µs, (0,5 µs $\leq \tau_i \leq$ 2 µs).

(GAUS1) $$S(\tau_i,f) = G\,(A, -0{,}8\,f_d, 0{,}05\,f_d) + G\,(A_1, +0{,}4\,f_d, 0{,}1\,f_d)$$

where A_1 is 10 dB below A.

D.2.4 Doppler spectrum: GAUS2

GAUS2 is also the sum of two Gaussian functions and is used for paths with delays in excess of 2 µs, ($\tau_i >$ 2 µs).

(GAUS2) $$S(\tau_i,f) = G\,(B, +0{,}7\,f_d, 0{,}1\,f_d) + G\,(B_1, -0{,}4\,f_d, 0{,}15\,f_d)$$

where B_1 is 15 dB below B.

D.2.5 Doppler spectrum: GAUSDAB

GAUSDAB is composed of a Gaussian function and is used for special DAB profiles.

(GAUSDAB) $$S(\tau_i,f) = G\,(A, \pm 0{,}7\,f_d, 0{,}1\,f_d)$$

where $+0{,}7\,f_d$ applies for even path numbers and $-0{,}7\,f_d$ for odd, except path 1.

D.2.6 Doppler spectrum: RICE

RICE is the sum of a classical Doppler spectrum and one direct path, so that the total multi-path contribution is equal to that of the direct path. This spectrum is used for the shortest path of the model for propagation in rural areas.

(RICE) $$S(\tau_i, f) = \frac{0{,}41}{2\pi f_d \sqrt{1 - \left(f / f_d\right)^2}} + 0{,}91\,\delta(f - 0{,}7\,f_d)$$

for $f \in \left]-f_d, f_d\right[$

D.3 Propagation models

D.3.1 General

The multi-path propagation model is based on a transversal filter structure, each tap representing a signal path associated with a certain delay and modulated by the appropriate Doppler spectrum.

Continuous delay power profiles for different types of terrain are specified to describe the models. These continuous profiles are approximated by the discrete parameter settings of hardware fading simulators according to clause D.4.

D.3.2 Typical rural (non-hilly) area (RA)

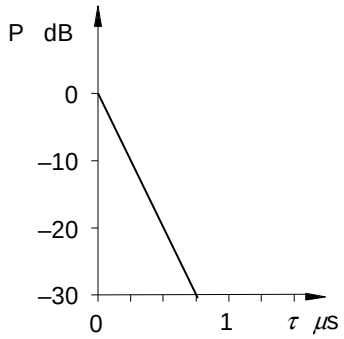


Figure D.1: Continuous delay power profile *P*(*τ*) for RA

$$P(\tau) = \begin{cases} \exp(-\tau/\tau_m) & \text{for } 0 < \tau < 0{,}7 \\ 0 & \text{elsewhere} \end{cases}$$

τ_m = 0,108 µs

D.3.3 Typical urban (non-hilly) area (TU)

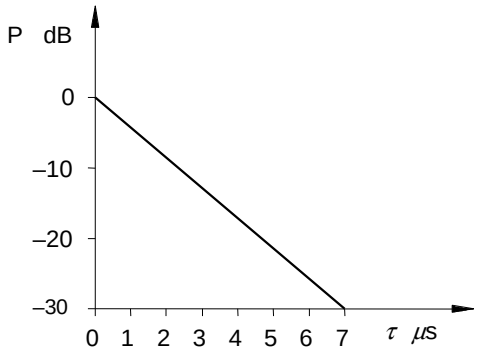


Figure D.2: Continuous delay power profile *P*(*τ*) for TU

$$P(\tau) = \begin{cases} \exp(-\tau/\tau_m) & \text{for } 0 < \tau < 7 \\ 0 & \text{elsewhere} \end{cases}$$

τ_m = 1 µs

D.4 Tap setting for hardware simulators

Hardware multi-tap fading simulators use the propagation model described in clause D.3. They are equipped with a finite number of taps (3 to 16 taps) which can be set to discrete values of $S(\tau_i)$ in both amplitude and delay.

Further, the assignment of a particular Doppler spectrum to each path is possible to simulate the mobile channel, i.e. the moving receiver. The Doppler spectrum requires the maximum Doppler shift for complete definition. This can be chosen directly at the simulator or by selecting the centre frequency and driving speed.

The tap setting below is given for simulators comprising up to 12 taps and for simulators with reduced model settings up to 6 taps.

The delay spread mentioned in tables D.1 to D.5 is defined by the equation:

$$S_{\mathrm{D}}^2 = \frac{1}{P_{\mathrm{m}}} \sum_{i=1}^{I} \tau_{\mathrm{i}}^2 P(\tau_{\mathrm{i}}) - \left[\frac{1}{P_{\mathrm{m}}} \sum_{i=1}^{I} \tau_{\mathrm{i}} P(\tau_{\mathrm{i}}) \right]^2$$

where I is the total number of taps and $P_{\mathrm{m}} = \sum_{i=1}^{I} P(\tau_{\mathrm{i}})$ is the total transmitted power.

Table D.1: Four tap setting for typical rural (non-hilly) area (RA)

Tap No	Delay µs	Power (linear)	Power dB	Doppler category	S_D µs
1	0	1	0	RICE	
2	0,2	0,63	-2	CLASS	0,1 ± 0,02
3	0,4	0,1	-10	CLASS	
4	0,6	0,01	-20	CLASS	

Table D.2: Six tap setting for typical rural (non-hilly) area (RA)

Tap No	Delay µs	Power (linear)	Power dB	Doppler category	S_D µs
1	0	1	0	RICE	
2	0,1	0,4	-4	CLASS	
3	0,2	0,16	-8	CLASS	0,1 ± 0,02
4	0,3	0,06	-12	CLASS	
5	0,4	0,03	-16	CLASS	
6	0,5	0,01	-20	CLASS	

Table D.3: Twelve tap setting for typical urban (non-hilly) area (TU)

Tap No	Delay µs	Power (linear)	Power dB	Doppler category	S_D µs
1	0	0,4	-4	CLASS	
2	0,1	0,5	-3	CLASS	
3	0,3	1	0	CLASS	
4	0,5	0,55	-2,6	CLASS	
5	0,8	0,5	-3	GAUS1	
6	1,1	0,32	-5	GAUS1	1,0 ± 0,1
7	1,3	0.2	-7	GAUS1	
8	1,7	0,32	-5	GAUS1	
9	2,3	0,22	-6,5	GAUS2	
10	3,1	0,14	-8,6	GAUS2	
11	3,2	0,08	-11	GAUS2	
12	5,0	0,1	-10	GAUS2	

Table D.4: Six tap setting for typical urban (non-hilly) area (TU)

Tap No	Delay µs	Power (linear)	Power dB	Doppler category	S_D µs
1	0	0,5	-3	CLASS	
2	0,2	1	0	CLASS	
3	0,5	0,63	-2	CLASS	1,0 ± 0,1
4	1,6	0,25	-6	GAUS1	
5	2,3	0,16	-8	GAUS2	
6	5,0	0,1	-10	GAUS2	

Table D.5: Tap setting for single-frequency networks (SFN)

Tap No	Delay μs	Power (linear)	Power dB	Doppler category	S_D μs
1	0	0,93	0	CLASS	
2	100	0,046	-13	GAUSDAB	
3	220	0,015	-18	GAUSDAB	
4	290	6×10^{-3}	-22	GAUSDAB	
5	385	3×10^{-3}	-26	GAUSDAB	
6	480	8×10^{-4}	-31	GAUSDAB	
7	600	6×10^{-4}	-32	GAUSDAB	

Annex E (normative): Centre frequencies

Table E.1: Centre frequencies

Channel no.	DAB block	Centre frequency (MHz)
1	5A	174,928
2	5B	176,640
3	5C	178,352
4	5D	180,064
5	6A	181,936
6	6B	183,648
7	6C	185,360
8	6D	187,072
9	7A	188,928
10	7B	190,640
11	7C	192,352
12	7D	194,064
13	8A	195,936
14	8B	197,648
15	8C	199,360
16	8D	201,072
17	9A	202,928
18	9B	204,640
19	9C	206,352
20	9D	208,064
21	10A	209,936
22	10B	211,648
23	10C	213,360
24	10D	215,072
25	11A	216,928
26	11B	218,640
27	11C	220,352
28	11D	222,064
29	12A	223,936
30	12B	225,648
31	12C	227,360
32	12D	229,072
33	13A	230,784
34	13B	232,496
35	13C	234,208
36	13D	235,776
37	13E	237,488
38	13F	239,200

History

Document history		
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