
Technical policy guidance for DAB multiplex licensees

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1. Introduction

- 1.1 This document is intended to give supplementary guidance to the technical provisions of individual licences awarded to radio multiplex licensees¹. It outlines what Ofcom expects to be its general approach in applying some of the provisions of the Digital Radio Technical Code, and in the approval of transmission proposals. Licensees should note that Ofcom cannot restrict in advance the way in which it will exercise its discretion, so it may be that Ofcom will take a different approach to the one outlined in this guidance in a particular case.
- 1.2 The areas of activity addressed in this document are:
- Multiplex technical management;
 - Approval of transmitter proposals, and their subsequent bringing on-air;
 - Planning standards.
- 1.3 The document also provides commentary on other aspects of the Digital Radio Technical Code.

¹ This covers radio multiplex licences awarded under the Broadcasting Act 1996 (as amended), and the associated licences awarded under the Wireless Telegraphy Act 2006 to the radio multiplex licensees.

2. Multiplex technical management

Background

As well as the general duties applicable to all areas of Ofcom's work that are set out in section 3 of the Communications Act 2003, Ofcom also has duties and powers that relate specifically to radio multiplex licensing.

Ofcom has a wide discretion to include in radio multiplex licences such conditions as appear to Ofcom to be appropriate having regard to any duties that Ofcom or the licensee has under the Broadcasting Acts of 1990 and 1996, or the Communications Act 2003 (section 43(1)(a) of the Broadcasting Act 1996). Ofcom also has a specific power to include conditions enabling Ofcom to supervise and enforce technical standards in connection with the provision of the licensed service (section 43(1)(b) Broadcasting Act 1996).

Section 54 of the Broadcasting Act 1996 requires Ofcom to secure particular aims by imposing appropriate conditions in radio multiplex licences. One of the things that Ofcom is required to secure is that the signals carrying the radio multiplex service attain high standards in terms of technical quality and reliability throughout so much of the area or locality for which the service is provided as is for the time being reasonably practicable (section 54(1)(g) of the Broadcasting Act 1996).

Audio characteristics

- 2.1 Ofcom believes that whether a digital sound programme service is broadcast in stereo or mono is an important characteristic of that service, and as such any variations to these characteristics must be considered in accordance with the requirements of section 54(6A) or (6B) of the Broadcasting Act 1996.
- 2.2 We recognise that radio multiplex licensees require flexibility in how they allocate capacity, and do not seek to restrict this. In the vast majority of cases, the broadcaster and/or multiplex operator will be best placed to determine the characteristics of the services they are providing. We do not accept, however, that left to itself, the market will necessarily reflect the interests of consumers.
- 2.3 As a matter of general policy Ofcom is likely to refuse a request for a change in audio characteristics only in cases where the capacity freed-up by the change is to be allocated to services which, in Ofcom's view, would not be in the best interests of citizens and consumers. Such an example may be where a multiplex licensee using its full capacity for stereo radio services proposes to reduce these radio services to mono, in order to allocate the permitted 30% data capacity to provide, for example, a closed user group service, and where we judge this would not be in the public interest.
- 2.4 We believe that such a move would generally (in respect of a national radio multiplex licence) unacceptably diminish the capacity of the programme services provided under that licence to appeal to a variety of tastes and interests, or would generally (in respect of

a local radio multiplex licence) unacceptably narrow the range of programmes available by way of digital sound programme services in the area. The policy is therefore designed to ensure that the multiplex as a whole – not an individual service – continues to cater for the overall tastes and interests of listeners.

- 2.5 Small-scale radio multiplexes are subject to some different requirements in legislation to national and local multiplexes, being required to achieve reasonable standards of technical quality. Consequently, Ofcom does not regulate the audio characteristics of the services on small-scale radio multiplexes.

3. Approval of transmitter proposals

- 3.1 The location and characteristics of individual transmitters of a multiplex need to be agreed by Ofcom before a licence can be issued. The constraints applying to this decision are set out within the licence advertisement. These constraints are generally framed in relation to the avoidance of:
- interference to other users (elsewhere in the UK and abroad) which use the same frequency;
 - coverage beyond the licensed area; and
 - interference leading to coverage hole punching to other multiplexes in the same area (through technical interactions known as ‘Adjacent Channel Interference’ and ‘Blocking’)
- 3.2 Section 4 provides further information on the first two points. This section provides guidance on Ofcom’s approach to dealing with the third mechanism.

Adjacent channel interference and blocking (“hole punching”)

- 3.3 In considering applications by a licensee for a new transmitter site or the modification of an existing one, Ofcom will consider whether and to what extent this would lead to ‘hole punching’² in the coverage of other multiplexes serving the same area. Where our analysis suggests that a significant impact will occur, licensees will need to consider and agree with Ofcom mitigating measures before the new transmitter or modification can be implemented. Licensees will need to inform other DAB multiplex licensees of their plans to launch or modify a transmitter, together with details of Ofcom’s assessment of the risk the transmitter presents to reception of other services, and any mitigating actions that will be undertaken.

General principles and process

- 3.4 Parties that wish to build a new DAB transmitter must avoid causing undue interference to other multiplexes. The following steps are to be undertaken before a new transmitter or modification to an existing transmitter can be brought on-air:
- Licensees must develop plans that minimise the risk of causing undue interference to existing multiplexes through taking account of the site selection guidance set out in this section;
 - Details of the proposed transmitter or modification will need to be provided to Ofcom using the proforma in Annex A1;

² Where a transmitter site is not used by all DAB services available in the area, some receivers near the transmitter site may lose reception of some or all of the services not broadcast from that location. The effect is to punch a hole in the coverage of the victim service(s).

- Ofcom will carry out an assessment of the likelihood that the proposal will result in coverage hole punching to other DAB multiplexes providing a service in the area, and share the results with the proposer;
- If our analysis predicts a significant impact to either household or major road coverage, the proposer will need to suggest and agree with Ofcom measures to mitigate the impact before we will give approval for the transmitter or modification to be implemented;
- If Ofcom gives approval to the proposal, the proposing licensee will need to inform other DAB licensees of their plans for bringing the transmitter or modification on-air, and share with those other licensees details of Ofcom's hole punching assessment and any mitigating measures. Notification will be required even if Ofcom predicts no impact to other licensees.

Site Selection Guidance

3.5 To avoid the need for mitigation techniques that are costly (such as providing a filler transmitter to restore coverage lost through hole punching) or reduce coverage (such as power reductions once a transmitter has been built), it is important to avoid undue interference at the transmission network design stage.

3.6 The following factors have been identified as useful in avoiding undue interference:

- Use existing DAB transmission sites where possible.
 - Details of on-air DAB sites can be found on the Ofcom website at <https://www.ofcom.org.uk/spectrum/information/radio-tech-parameters>
 - Where a site exists but it is not viable to use it, the risk of interference can be reduced by choosing an alternative location which is as close as possible to, and at the same height, as the existing one.
 - If another service already operates a transmitter in the new service's planned area, that existing site might cause interference to the new service. Co-siting or near-siting will help to reduce any interference to the new service from existing ones.
 - Where reasonably practical, licensees should ensure that any new site they establish can be used by other operators should they wish to do so.
- Sites not located directly by populated areas and/or major roads generally have a lesser impact on other services.
- Low radiated powers have an impact over a smaller radius than higher powers.
- Locating transmitting aerials high above the ground helps to avoid interference at ground level.
- Multiple tier antennas help to reduce signal levels close to the site and can therefore reduce the risk of hole punching occurring.

3.7 Conversely the following increase the likelihood of interference:

- Installing transmitting antennas at a low height.
- Using a high transmitter power.
- Building a transmitter in an area where the other multiplexes have modest signal levels

- Tower block sites where the antenna points toward other tower blocks.
- Using sites located close to housing in urban areas or adjacent to major roads.

3.8 Radio frequency engineering is a specialised activity and licensees that do not possess the necessary skills in-house should engage the services of a competent transmission contractor to assist in the selection, assessment and building of transmitter infrastructure.

Information to be provided to Ofcom

- 3.9 The party proposing a new transmitter or modification to an existing transmitter must provide Ofcom with details including:
- Contact details for the party proposing the transmitter or modification;
 - Location of the transmitter;
 - Details and status of arrangements for accessing the site, and the work needed to bring it on-air;
 - The transmitter's proposed technical parameters; and
 - Distance from housing or main roads.
- 3.10 Applicants should use the form provided in Annex A1 which also includes a link to an electronic file that should be used for providing the transmitter's technical parameters.

Ofcom's assessment

- 3.11 Ofcom will use the transmitter details provided by the proposer to model the impact that the new transmitter may have on reception of other DAB services in the vicinity. We will use the ATDI HTZ planning tool to predict the signal levels in the vicinity of the proposed transmitter and compare those with the predicted signal levels of other DAB multiplexes that are available in the area³.
- 3.12 We will then identify the areas where the proposed transmitter's signal levels are greater than those of other multiplexes by more than the protection ratios set out in Section 5 Table 7. By default, we will use protection ratio figures for 99% outdoor locations, although where necessary, we will also carry out sensitivity analysis using alternative values of protection ratio as shown in Section 5 Table 8 to determine the likely severity of any real world reception conditions.
- 3.13 Where our analysis suggests that the protection ratios will be exceeded, we will produce maps of the relevant location showing coverage of the other multiplex services and the areas where reception may be affected. We will also count the households and lengths of major road affected.

Approval to bring a transmitter on-air where there is a low likely impact

- 3.14 Where the population or road length affected is zero or small (i.e. below the significance thresholds set out in paragraph 3.22 below), we will share the results of our analysis with

³ Further information on the HTZ tool and settings used by Ofcom are available in Annex A2.

the proposer, and give approval to build the transmitter. Before the transmitter can be brought on air, the proposer will however first need to:

- a) agree a date with Ofcom for when the transmitter will come on air, and ensure that it is correctly licensed at launch;
- b) notify other multiplex licensees of the planned on-air date – this notification should normally give at least two weeks' notice in advance, and also include details of Ofcom's assessment of the impact to the reception of other multiplexes; and
- c) arrange for tests to be carried out to confirm that the new transmitter is operating in compliance with the licensee's Broadcasting Act and Wireless Telegraphy Act licences, and provide evidence to Ofcom within five working days of the transmitter coming on-air.

3.15 Further details of what needs to be done to bring a transmitter on-air are available in Section 4 of this document

Procedure where there is a significant predicted impact on reception of other services that is likely insignificant in reality

3.16 If Ofcom's analysis suggests that there could be a significant impact on reception of other services, we will carry out a sensitivity analysis to help determine the likely severity of the impact on real world reception conditions.

3.17 Our sensitivity analysis will consider the predicted impact with the default protection ratio in Section 5, Table 7 decreased in 4dB steps to determine the distribution of the impact (as shown in cases 1-4 in Section 5, Table 8). If the impact is reduced to negligible levels in cases 2 or 3 (i.e. the majority of the areas predicted to be affected by ACI are only likely to exceed the protection ratio by a small margin, and therefore most receivers should be unaffected) we deem that the risk of real world hole punching to be small. We will share the results of our analysis with the proposer, and give approval to build the transmitter subject to the proposer undertaking to carry out a reception survey when the transmitter is being tested to confirm that there is not a larger impact than expected.

3.18 The proposer will need to carry out the steps a) to c) in para 3.14 above, as well as carrying out a reception survey and sharing the results with Ofcom and the other multiplex licensees within five working days of the transmitter coming on-air. If there is a larger impact than predicted Ofcom may require the transmitter be switched off until further work is carried out to assess and mitigate the impact.

Procedure where there is a significant predicted impact on reception of other services that may be significant in reality

3.19 If Ofcom's analysis suggests that there could be a significant impact on reception of other services, and our sensitivity analysis does not reduce the impact to an insignificant amount, Ofcom will ask the proposer to suggest mitigating measures such as amending the design or location of the transmitter.

- 3.20 Where these measures are successful in reducing the predicted impact below the level that which we deem significant, then Ofcom will proceed with approving the proposal as described in paragraphs 3.16-3.18
- 3.21 Where it is not possible to reduce the predicted impact sufficiently through proactive mitigation measures, Ofcom may consider giving approval to proceed on a trial basis if the licensee undertakes to carry out a drive survey or listener impact test that confirms the extent of the impact to other services is small. In this situation, the proposer will need to:
- a) agree a date with Ofcom for when the transmitter will be tested on-air, and ensure that it is correctly licensed;
 - b) notify other multiplex licensees of the planned test date – this notification should normally give at least two weeks’ notice in advance, and include a copy of Ofcom’s assessment of the impact to reception of other multiplexes, and what tests will be carried out to assess the real world impact to those other services;
 - c) Arrange for tests to be carried out to confirm that the new transmitter is operating in compliance with the licensee’s Broadcasting Act and Wireless Telegraphy Act licences, and also to confirm the impact to reception of other services;
 - d) Carry out a drive survey to assess the reception of the potentially affected multiplexes with and without the new transmitter switched on;
 - e) Share the results of the drive survey/viewer impact tests with Ofcom and the other multiplex licensees within five working days of the test being carried out. If the survey results confirm a significant real world impact, Ofcom may require the transmitter to be switched off until Ofcom and the licensee have agreed what further mitigating action is required and that action has been completed and a repeat survey carried out; and
 - f) provide evidence to Ofcom of the transmitter’s compliance with the licensee’s Broadcasting Act and Wireless Telegraphy Act licences within five working days of the transmitter tests being carried out.

Significance thresholds

- 3.22 Experience to date is that our predictions overstate the impact on reception of other services, as we have on purpose selected fairly conservative assumptions to ensure reception is protected almost everywhere. We will continue to review the thresholds for what we consider to be significant predicted impacts as we gather further evidence of how well predictions match experience in the real world. For guidance, Ofcom proposes to use the thresholds in the guidance box below, although these may vary depending on specific circumstances (for example whether predicted losses occur to coverage that is already patchy or at the edge of coverage)

Guideline significance thresholds for predicted impacts to be used in initial assessments and sensitivity analysis

25 households

or

150m of major roads in towns

or

400m of major roads in areas where traffic is usually likely to be flowing at the national speed limit

Mitigating the impact a new transmitter may have on reception of other services

- 3.23 Measures that can be applied to the transmitter to mitigate the impact on reception of other services are as provided in the section on ‘Site selection guidance’ above. Where it would be difficult or may be undesirable to make changes to the selected transmitter site, proposers can elect to carry out tests at their own risk to quantify the impact that their transmitter has on reception of other services. This information can inform the decision on whether changes to the transmitter parameters are necessary, and would need to be provided to Ofcom and other affected multiplex licensees.

Requirements for measurements and drive tests

- 3.24 Drive tests of the area surrounding a proposed transmitter site with a logging receiver and suitable aerial will enable the proposer to gather data on the signal levels of the other multiplexes in the area. These can be used in combination with predictions of the likely signal level from the proposed new transmitter to assess whether there will be an impact on listeners in-home or in cars in the area. Alternatively, drive tests can be carried out during test transmissions from the proposed new transmitter location to measure the actual impact on reception in the area (see section 3.30 and following on Listener impact tests).
- 3.25 To be of most use, a test receiver capable of continuous signal logging should be used that records the following for each multiplex providing a service in the area:
- Location (from a GPS reference) at which each measurement is made
 - Field strength at that location
 - Bit error rate at that location

- 3.26 Data from these measurements can be used to produce ‘coloured trail’ maps of the signals from existing services. Examples of such maps are available in Annex I of the EBU document ‘Guidelines for DAB Network Planning’⁴.
- 3.27 If a test transmitter is used (or the measurements are being undertaken to confirm the impact following installation and commissioning of a transmitter), then measurements of each multiplex should be carried out with and without the test or new transmitter on air. Coloured trail maps can then be produced to illustrate clearly where reception has been degraded by the new transmitter and to confirm where it has not. Assessment of degradation can be through logging bit error ratio, locations where receiver loses reception, or by comparing signal levels.
- 3.28 Any drive test measurements should be recorded electronically and made available to other multiplex operators as part of the liaison process. The results should be accompanied by a brief narrative report which clearly explains the findings of the tests. The licensee should be prepared to make raw measurement data to Ofcom or other multiplex licensees on request.
- 3.29 Further information on the prediction and measurement of the impact of a new transmitter is available in a report published by the European Broadcasting Union⁵ (see particularly section 5.2.1.2 and Annex I).

Listener impact tests

- 3.30 Any licensee may carry out a site test or fully implement a site on a trial basis to assess the impact it might have on other services. This option can be used to gather the information described above on real world impact. Building the transmitter would be at the sole risk and expense of the licensee and the implementation of a site does not mean that Ofcom will allow it to continue operating after testing. If the proposer wishes to proceed with carrying out a trial transmission, the following procedure must be followed.
- a) The trial transmitter must be correctly licensed, and Ofcom must agree to the trial before it goes ahead.
 - b) The installation must be commissioned and use equipment that is compliant with the Ofcom Digital Radio Technical Code.
 - c) Any licensee that might be affected must be informed at least two weeks before the test transmissions commence. The potentially-affected licensee(s) may require that tests are scheduled to avoid certain programming periods or special events.
 - d) Any other relevant licensee that wishes to carry out their own reception tests during the test transmission period must be allowed to do so.
 - e) Tests should last no longer than six hours if licensed under a non-operational trial licence.

⁴ EBU Tech 3391, <https://tech.ebu.ch/docs/tech/tech3391.pdf>

⁵ EBU Tech 3391, <https://tech.ebu.ch/publications/tech3391>

- f) If there is a significant impact on listeners in the area, Ofcom may require the test transmission to cease immediately.
- g) Following the test transmissions, a test report should be produced and circulated to the other multiplex operators and to Ofcom.
- h) In the event of significant impact, the licensee of the new site may be required to put in place measures to restore some, or all, of the lost reception. The transmitter must be turned off while the required remedies are implemented. Some options to achieve this might include one or more of:
 - Reducing the power of the transmitter
 - Modifying the antenna system
 - Moving the site
- i) Providing filler transmitters for the affected services.

Notification to other DAB multiplex licensees

Identifying the other multiplexes serving an area which need to be contacted

- 3.31 To identify those local and national DAB services which might be affected by a new service, proposers can find an initial indication of the DAB services available in the vicinity of the proposed site by using the online postcode coverage checker at <http://getdigitalradio.com/?slide=check-your-available-stations>.
- 3.32 Coverage maps for local DAB services can be found on the Ofcom website at <http://static.ofcom.org.uk/static/radiolicensing/mcamaps/DABmaps.htm>.
- 3.33 Ofcom publishes coverage maps for small scale DAB services once they come on-air. These can be found on the Ofcom website at <https://www.ofcom.org.uk/tv-radio-and-on-demand/information-for-industry/radio-broadcasters/coverage/small-scale-dab>.
- 3.34 When considering the impact on other services only the coverage of on-air services within their licensed areas needs to be taken into consideration.
- 3.35 A list of multiplex licensee contact details can be found at <http://static.ofcom.org.uk/static/radiolicensing/html/radio-stations/digital/digital-multiplexes-main.htm>, and the relevant department at the BBC can be contacted via email at distribution_broadcast_coordination@bbc.co.uk.

Timescales

- 3.36 Ofcom's consideration and agreement to a technical plan that is not subject to international coordination requirements, will take two to four months depending on the complexity of the plan, and the number of other applications Ofcom is considering. In some cases, international coordination will be required – this will depend on the location of the proposed transmitter and its technical characteristics (power, frequency, antenna

pattern and height). If international coordination is required, this will normally take around six to eight months to complete. Where an objection is raised by another country's administration the timeline will be significantly longer, and a successful outcome cannot be guaranteed.

4. Bringing a new transmitter on-air

- 4.1 The process for Ofcom considering and approving proposals from licensees to add a transmitter will vary depending on the licence the proposer holds, and whether the transmitter is part of (or a modification to) the application against which their licence was awarded, or whether the transmitter is to be built in addition to the original commitment. Proposers should consult the Guidance Notes published when they applied for their licence, or consult Ofcom's Broadcast Licensing team if they require clarification of the process.
- 4.2 The guidance given below assumes that Ofcom has given initial agreement to a proposal from an applicant to build one or more transmitters, either through a licence award, or through agreement with an existing licensee that they can add a transmitter to their on-air service.
- 4.3 Following Ofcom's initial agreement, a licensee will need to carry out the following steps to bring a transmitter on-air:
- a) Appoint specialists and contractors working on its behalf to procure and build the infrastructure;
 - b) Finalise negotiations regarding access to sites and other infrastructure, including any sharing agreements;
 - c) Seek agreement from Ofcom for the proposed transmitters. This step will include Ofcom assessing the potential impact that the transmitter would have on reception of other services, as detailed in Section 3. Final site details⁶ need to be sent to Ofcom for approval and this can take two to four months depending on the complexity of the plan. If international coordination is required, the timescale is extended to six to eight months, if other countries' administrations are in agreement, and longer if they are not. Where Ofcom believes that objections can be resolved we may allow licensees to launch on a non-interference, non-protected basis at the licensee's own risk. Due to the time taken to co-ordinate services it is therefore important that Ofcom receives the final transmitter plans as quickly as possible. These should be sent in the same electronic format as for licence applications to: broadcastradioeng@ofcom.org.uk
 - d) [For new multiplexes] To have built the DAB multiplexing and signal distribution system including:
 - i) Installation of the multiplexing centre and associated equipment;
 - ii) signal encoding for programme services and distribution of the signal feeds to the multiplexing centre; and

⁶ If the proposed transmitter is different to what was originally included in a licence application, it is important that the final plan does not differ materially from what was proposed in the application, and any change to the plan will need to deliver broadly equivalent coverage. This is especially important for competed-for licences.

- iii) distribution of the multiplexed signal to the transmission site(s).
 - e) [For new multiplexes] Finalise carriage agreements with the providers of the programme services that your multiplex will carry at launch;
 - f) [For new multiplexes] Obtain Service ID codes (mandatory)
 - g) Obtain Transmitter Identification Information Codes (optional) from Ofcom;
 - h) Confirm when the transmitters are planned to come on air and arrange with Ofcom for the licence to be granted or varied with an agreed date when transmissions are expected to commence.
 - i) At least 20 working days before the commencement date, send details of the final equipment and antennas that have been installed to Ofcom for checking against the antenna patterns included in the licence to broadcastradiocompliance@ofcom.org.uk;
 - j) Commission and carry out acceptance test of the transmitter equipment to ensure compliance with Ofcom's Digital Radio Technical Code and EMF licence condition. Once the licence has been granted and has commenced, you can carry out final on-air checks for each transmitter. If these are satisfactory and confirm full compliance with the licence's technical requirements, the transmitter(s) can remain on air; and
 - k) Provide Ofcom with evidence of compliance with the licence and Digital Radio Technical Code within five working days of putting any transmitter into service via email to broadcastradiocompliance@ofcom.org.uk. The tests carried out under j) and the associated evidence sent to Ofcom should provide a reasonable confidence level that transmissions will remain compliant after commissioning. There is a checklist in Annex A3 that provides a list of the tests that licensees will need to carry out to demonstrate compliance.
- 4.4 It is the licensee's responsibility to ensure that its transmissions comply with the requirements of its Broadcasting Act and Wireless Telegraphy Act licences, and to provide Ofcom with evidence of that compliance as detailed above. Ofcom may choose to attend acceptance tests as they are being carried out by a licensee, or to visit a transmitter site subsequently to verify the measurements that have been made. If we find evidence of non-compliance, we may require that transmitter to be switched off until it is able to be brought into compliance. Where, in Ofcom's opinion, the non-compliance has occurred as a consequence of the negligence of the licensee, Ofcom reserves the right to charge the licensee for attendance at the site, and for any return visits. The charge (as of December 2022) would be up to £775 per day.

5. Planning Standards: wanted coverage and interference protection

- 5.1 In assessing licence applications, Ofcom has to take a number of statutory criteria into account in deciding whether and to whom to award a multiplex licence. One of these is the extent of coverage provided.
- 5.2 Ofcom assesses the extent of coverage delivered in terms of two modes of reception; ‘outdoor’ or ‘mobile’ and ‘portable indoor’, at each 50m x 50m square of territory within the licence area. All coverage assessment will be carried out on the basis of level 3 error protection being used, specifically unequal error protection level 3 or UEP-3 for DAB services and equal error protection level 3A or EEP-3A for DAB+ services.
- 5.3 The methods and thresholds used to produce the coverage predictions are summarised below:

Outdoor Coverage

- 5.4 Coverage in a mobile environment will be assessed in terms of the number of kilometres and percentage of ‘A’ roads and motorways within the licence area that receive a field strength of at least 54 dB(μ V/m) at 10m above ground level. The derivation of this field strength is given in Table 3 below.

Table 3: Derivation of Minimum Median Field Strength for In-Car Reception

UEP		3
Noise bandwidth	(MHz)	1.5
Thermal noise	(dBm)	-112.22
Required C/N	(dB)	8.4
Receiver noise figure	(dB)	7
Rayleigh implementation margin	(dB)	4.6
Minimum receiver signal level	(dBm)	-92.2
Frequency	(MHz)	220
Wavelength	(m)	1.36
Receiving antenna gain	(dBi)	-2.9
Required field strength	(μ V/m)	54.6
Required field strength	(dB μ V/m)	34.7
Height Gain	(dB)	10
Required percentage of locations	(%)	99

Inverse Normal function	For 99% locations	2.33
Outdoor Location Variation	(dB)	4.0
Additional field strength required	(dB)	19.3
Minimum Median Field Strength	(dB μ V/m)	54.0

Indoor coverage

5.5 To define coverage to portable receivers within an indoor environment account will be taken of the penetration loss of the building type around the reception point. This will be considered to be either suburban or dense urban and the losses for each category are given in Table 4 below.

Table 4: Building Penetration Loss

Building Type	Median Penetration Loss (dB)	Standard Deviation of Penetration Loss (dB)
Suburban	8	4.4
Dense Urban	15	5

5.6 Indoor coverage will be assessed in terms of the number of households within the licence area that receive a field strength of at least between 63 and 68 dB μ /m in suburban areas and 70 and 75 dB(μ V/m) in a dense urban area. The lower of these pairs indicate a useful service and the latter a robust one. These signals are being received at 10m above ground level. The derivation of these field strengths is given in Table 5 below.

Table 5: Derivation of Minimum Median Field Strength for Indoor Reception

UEP		3			
Reception environment		Suburban		Dense Urban	
Reception quality		Useful	Robust	Useful	Robust
Noise bandwidth	(MHz)	1.5	1.5	1.5	1.5
Thermal noise	(dBm)	-112.22	-112.22	-112.22	-112.22
Required C/N	(dB)	8.4	8.4	8.4	8.4
Receiver noise figure	(dB)	7	7	7	7
Rayleigh implementation margin	(dB)	4.6	4.6	4.6	4.6
Minimum receiver signal level	(dBm)	-92.2	-92.2	-92.2	-92.2
Frequency	(MHz)	220	220	220	220

Wavelength	(m)	1.36	1.36	1.36	1.36
Receiving antenna gain	(dBi)	-8.1	-8.1	-8.1	-8.1
Linear Gain		0.155	0.155	0.155	0.155
Required field strength	($\mu\text{V/m}$)	99.4	99.4	99.4	99.4
Required field strength	(dB $\mu\text{V/m}$)	39.9	39.9	39.9	39.9
Building Penetration Loss	(dB)	8	8	15	15
Height Gain	(dB)	10	10	10	10
Required percentage of locations	(%)	80	95	80	95
Inverse Normal function		0.84	1.64	0.84	1.64
Outdoor Location Variation	(dB)	4.0	4.0	4.0	4.0
Building Penetration Loss SD	(dB)	4.4	4.4	5.0	5.0
Composite Location variation	(dB)	5.95	5.95	6.4	6.4
Additional field strength required	(dB)	23.0	27.8	30.4	35.5
Minimum Median Field Strength	(dB $\mu\text{V/m}$)	62.9	67.7	70.3	75.4

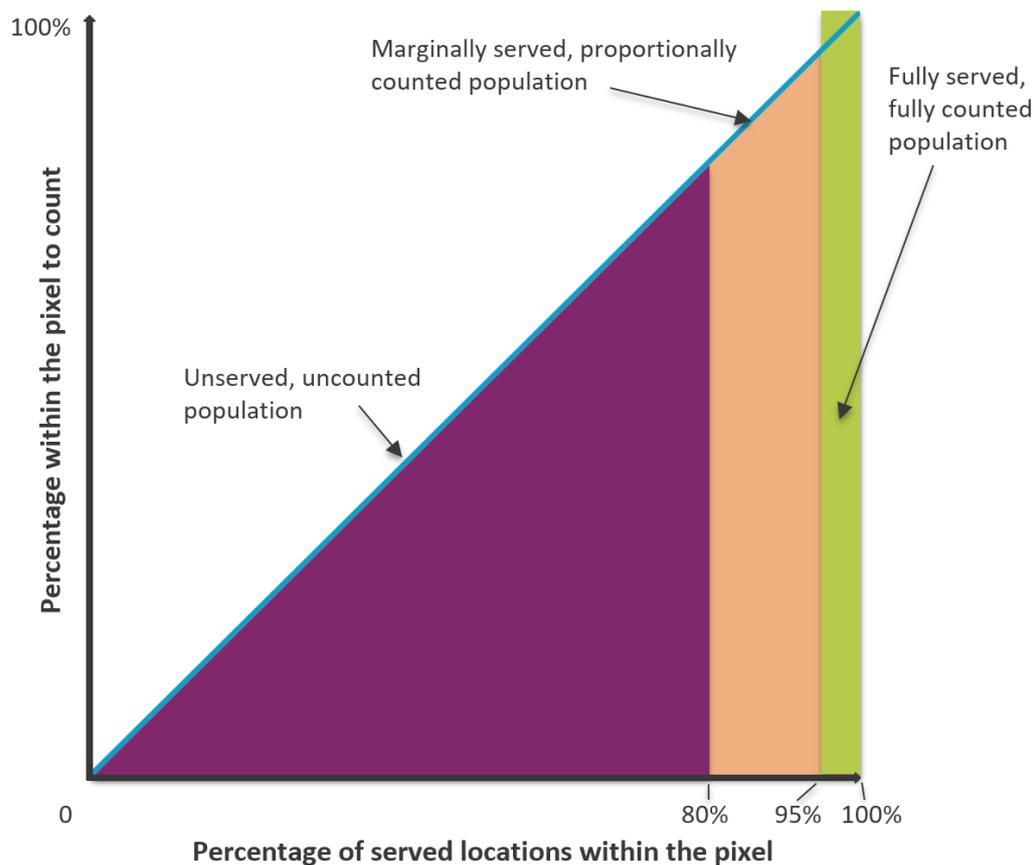
Population counting – indoor reception

- 5.7 We will in general count all of the population in each 50m x 50m pixel where the minimum median field strengths above are achieved. Our default is to use the field strength corresponding to “useful suburban”.
- 5.8 In all cases the 50m x 50m square must also be calculated to be adequately free from interference. These assumed values for wanted coverage are taken as the basis of Ofcom’s interference protection practice (see section below).
- 5.9 We have included below Table 6 and Figure 3 which detail the proportional counting method which Ofcom and others formerly used when calculating local DAB multiplex coverage using the UK Planning Model. This method is no longer in current use by Ofcom for new multiplex licences, but is provided here for information.

Table 6: Proportional counting thresholds

Percentage of pixel locations served	Percentage of pixels population considered served
95% or greater	100%
80% to 94% inclusive	Between 80% and 94% in proportion to locations served ⁷
79% or fewer	0

Figure 3: Diagrammatic representation of the proportional counting thresholds



Licensed areas

- 5.10 Another statutory requirement placed on Ofcom is to define for each radio multiplex an area for which a service is licensed, i.e. a 'licensed area'. Ofcom believes it is most appropriate for licensees to be responsible for network planning and delivering coverage within the minimum of constraints necessary in order to properly address statutory requirements, and the integrity of the licence award process. At the technical level Ofcom gives effect to the principle of the 'licensed area' by defining a geographical area, known as the 'licensed area', within which Ofcom will take steps to control the extent of interference to the licensed service.
- 5.11 The concept of a 'licensed area' is set out in the 1996 Broadcasting Act, in establishing the statutory criteria which Ofcom applies in its licensing of digital radio multiplex licences. In respect of local radio multiplexes, the 'licensed area' is described by Ofcom to reflect its views of what constitutes a coherent local area, consistent with the intentions of legislation, and consistent with Ofcom's statutory duties as specified in the Communications Act of 2003.

5.12 The relevance of the licensed area includes that it defines the area within which Ofcom will apply measures to protect the relevant service from interference to the extent practicable.

Co-channel interference

5.13 In calculating freedom from co-channel interference, the assumptions include that the interfering signals propagate in conditions corresponding to those believed to apply in the least favourable circumstances and which occur only over 1% of the time. A protection margin of 25 dB is applied between wanted and unwanted signals.

5.14 It is assumed that an area of analysis is still served if the median interfering field strength is 25 dB lower than the median of the wanted signals. This margin is derived as follows:

- Receiver protection ratio: 10 dB
- Planning margin for 99% location availability: 15 dB

5.15 The planning margin is derived theoretically as $(4.0 \times 2.33 \times \sqrt{2}) = 13.2$ dB, assuming both wanted and unwanted signals are Gaussian distributed with standard deviations of 4.0 dB, and have a correlation coefficient of 0. However, field tests have indicated that a margin of 15 dB provides a practical achievement of 99% availability in a number of different measurement scenarios, in other words, taking account of the fact that the standard deviation or correlation coefficients may depart from the assumed figure.

5.16 In applying what are general limits to the maximum allowable field strength from one area's network into the protected area of another co-channel service, some account is taken of the fact that most of the wanted service area receives a wanted signal at a significantly higher level than the lowest workable value. In general, there is a positive correlation; where unwanted signals are higher, then so are the wanted signals. Therefore, a 10 dB margin is added to the threshold of allowable interference. If maximum interference into the area is kept to this higher threshold, which tends to 'bite' first on higher, more exposed ground, then the levels in the generality of the area will be lower.

Adjacent channel interference

5.17 Measures to protect reception from adjacent channel interference are only applied within the licensed areas of the services concerned. In assessing the extent of potential interference from DAB services on other frequency blocks, Ofcom uses the protection ratios set out in Table 7.

Table 7 - Protection Margins for different Adjacent Channel Interference conditions

Outdoor percentage locations, %	Indoor percentage locations, %	Protection margin, dB		
		1 st adjacent	2 nd adjacent	≥3 rd adjacent
99	96.0	-22	-27	-32
95	89.2	-26	-31	-36
90	83.2	-28	-33	-38

5.18 Where Ofcom carries out sensitivity tests, we will consider the cases set out in Table 8.

Table 8 – Sensitivity test cases

Case	Outdoor percentage locations, %	Indoor percentage locations, %	Protection margin, dB		
			1 st adjacent	2 nd adjacent	≥3 rd adjacent
1 (default)	99	96	-22	-27	-32
2	95	89	-26	-31	-36
3	81	75	-30	-35	-40
4	57	55	-34	-39	-44

Error Protection (UEP and EEP)

- 5.19 In order to ensure consistency when making coverage predictions, all DAB coverage assessments will be carried out on the basis of Unequal Error Protection level 3 (UEP-3) being used. Section 3.14 of the Digital Radio Technical Code requires that unless otherwise agreed with Ofcom, all transmissions will use UEP-3 for audio and UEP-3A for data services. The DAB+ standard does not support unequal error protection and all services are transmitted with equal error protection (EEP). Consequently Section 3.15 of the Digital Radio Technical Code requires all DAB+ transmissions to use EEP-3A.
- 5.20 Where licensees apply to use UEP-1 or UEP-2, this may be agreed by Ofcom on a case by case basis. However, licensees should be aware that if at a later date the licensee wishes to reduce the level of error protection Ofcom may require that any resulting loss of coverage (and therefore listener disenfranchisement) to be mitigated.
- 5.21 As UEP-3 forms the basis of our coverage planning and interference assessment criteria unless already agreed with Ofcom, we will not allow services to reduce the UEP used below this level (i.e. to UEP-4). This is to ensure a consistent user experience and stability for the receiver market.

A1. DAB transmitter site details

When sending a final technical plan to Ofcom, please include:

- an electronic format file containing all proposed transmitter sites (using the [table of transmission characteristics template](#)); and
- completed transmitter implementation information for each transmitter site. You should delete the example responses in italics and replace them with your own answers.

Proposer

A. Proposer details:

i. Licensee name:

DABCo1

ii. Contact name:

Firstname Lastname

iii. Contact address:

10 The Street

Anytown

AB1 2CD

iv. Contact phone number(s):

01632 964421

v. Contact name:

Mary Jones

vi. Contact email:

user@domain

Recipient multiplex operator

A. Recipient multiplex and operator's details:

- i. Licensee name:

DABCo2

- ii. Licence area:

North West Exampleshire

- iii. Frequency block:

13E

Site details

- B. Transmitter site name:

Ofcom Riverside House

- C. Site description:

Mast/tower block/etc.

Infrastructure details

- D. Basic site details:

- i. National Grid Reference:

SU 123 456

- ii. Site height (metres AOD):

123 m

- iii. Antenna height (metres AGL):

25 m

- iv. Maximum effective radiated power (watts):

75 W

- v. Site address (where available, with postcode):

2a Southwark Bridge Road, London, SE1 9HA

- E. What kind of antenna will you be using? Give manufacturer and model if known. If directional, give direction of main beam.

4 wavelength co-linear / single 3 element Yagi / two tiers of Cardioid antennas

Main beam on 320 degrees ETN

- F. Where will the antenna be mounted? What impact will the mounting and supporting structure have on the overall radiation pattern?

(Please provide photographs of both the building/structure upon which the antenna will be mounted and a photograph showing where the antenna will be mounted and state if planning permission will be required.)

Attached to the northern corner of the mast 25 m agl. Impact of the mast has been taken into account in the supplied antenna pattern. / Attached to pole on the side of the buildings lift housing. The antenna is above surrounding obstructions so no impact on the radiation pattern.

- G. Are you sharing the antenna with any other broadcasters?

No / Antenna shared with the BBC

- H. Where will the feeder cable run between the transmitter and antenna?

Feeder will follow the existing cable tray

- I. Is any building work required and will planning permission be required, if required, how long will it take to be granted?

Transmitter will be in the building's lift room / In a new cabin to be sited next to the mast for which planning permission is required which should be available within [four] months of application.

- J. Is the site a listed building? If so, will any additional permissions be required and how long will it take for these to be granted?

The site is not a listed structure / is a listed building. Additional permissions will be required which should be available within [six] months of application.

- K. Is any building work required? Confirm that all required planning permissions have been obtained.

No, existing infrastructure will be used no planning permissions are required. / Transmitter cabin still to be constructed, planning permission has been approved.

- L. How will the equipment be connected to power?

Power already available at the transmitter location. / Power to be run from nearby building, agreement in place.

- M. How will the equipment receive a programme feed (e.g. what kind of data circuit or connection)?

Fixed link connection direct from the multiplexing location. / Internet feed.

- N. What is the name of the site owner? Do you have written approval to use the proposed site?

Name of site owner from whom we have formal written approval.

- O. Have you agreed all the details listed in boxes C to L with the owner?

Yes, we have written agreement. / No, we are still finalising feeder runs. All other details have been agreed

- P. What is the proposed on-air date for this site?

1 December 2021

Hole punching

- Q. How far is the transmitter site from the nearest housing? Please provide road names.

Nearest housing is within 200 metres of the site at Ponsonby Avenue,

- R. How far is the transmitter site from the nearest major road (or motorway)? Please provide the road names

Nearest major road (A 1162) is within 2 km of the site.

A2. Planning tool settings and comparison predictions

A2.1 In this Annex we provide:

- a) General guidance on coverage planning tools;
- b) The settings that Ofcom uses when using the HTZ planning tool; and
- c) An example of the different figures that can arise when different settings are used on a planning tool.

Planning model data sets and settings

A2.2 Ofcom will use the HTZ planning tool to assess applications for multiplex licences. Ofcom will not penalise applicants for using alternative planning tools, although applications based on coverage predictions that are radically different may need significant adjustments to their technical plans to be compliant with licence advertisement requirements - for example the limits on overlap and overspill coverage, co-block interference and international constraints that apply to advertisements for small-scale DAB licences.

A2.3 Applicants are therefore strongly encouraged to use planning tools that incorporate the following:

- a) An appropriate propagation model suitable for planning broadcast transmission (point to area) using Band III frequencies;
- b) Terrain data to take account of the height of land;
- c) Clutter data to take account of the environment on top of the land, ie whether it is rural and open or urban and more built-up; and
- d) The ability to sum the individual transmitters of the applicants' network.

General guidance

A2.4 Many planning algorithms are available, generally each one is designed for a specific purpose. This may relate to the frequency band over which they are accurate or a specific type of service or application. For the planning of DAB services, an algorithm that calculates field strength along a path profile should be used. Algorithms such as ITU-R Recommendation P-1546 (or P-370 that P-1546 replaced in 2001) do not use path profiles and are more appropriate for general site planning so should not be used. For specific site planning the models described in ITU-R Recommendation 1812 or a combination of Recommendations 525 & 526 would be more appropriate. Other bespoke models, such as the one used by Ofcom, are also valid.

A2.5 For information, the table below shows some examples of the different predictions that a planning tool can deliver when settings and algorithms are altered. The coverage and overlap figures were produced for the same example two-transmitter network, with the results obtained by using different specified settings for each row. In each case the same terrain and clutter models were accessible by the tool.

	Coverage inside licence area (%)	Coverage outside licence area (%)	Overlap with local multiplex (%)
Ofcom settings	97.1	35.7	49.1
Rec 370	63.8	11.0	29.2
Rec 370 + power sum	94.2	5.3	38.9
Rec 370 at 1.5m	70.3	0	27.5
Rec 1546 + power sum	82.5	0.8	32.5
Rec 1812 + power sum	79.0	6.5	33.2
Rec 1812+ Siradel clutter data	89.4	23.5	43.0

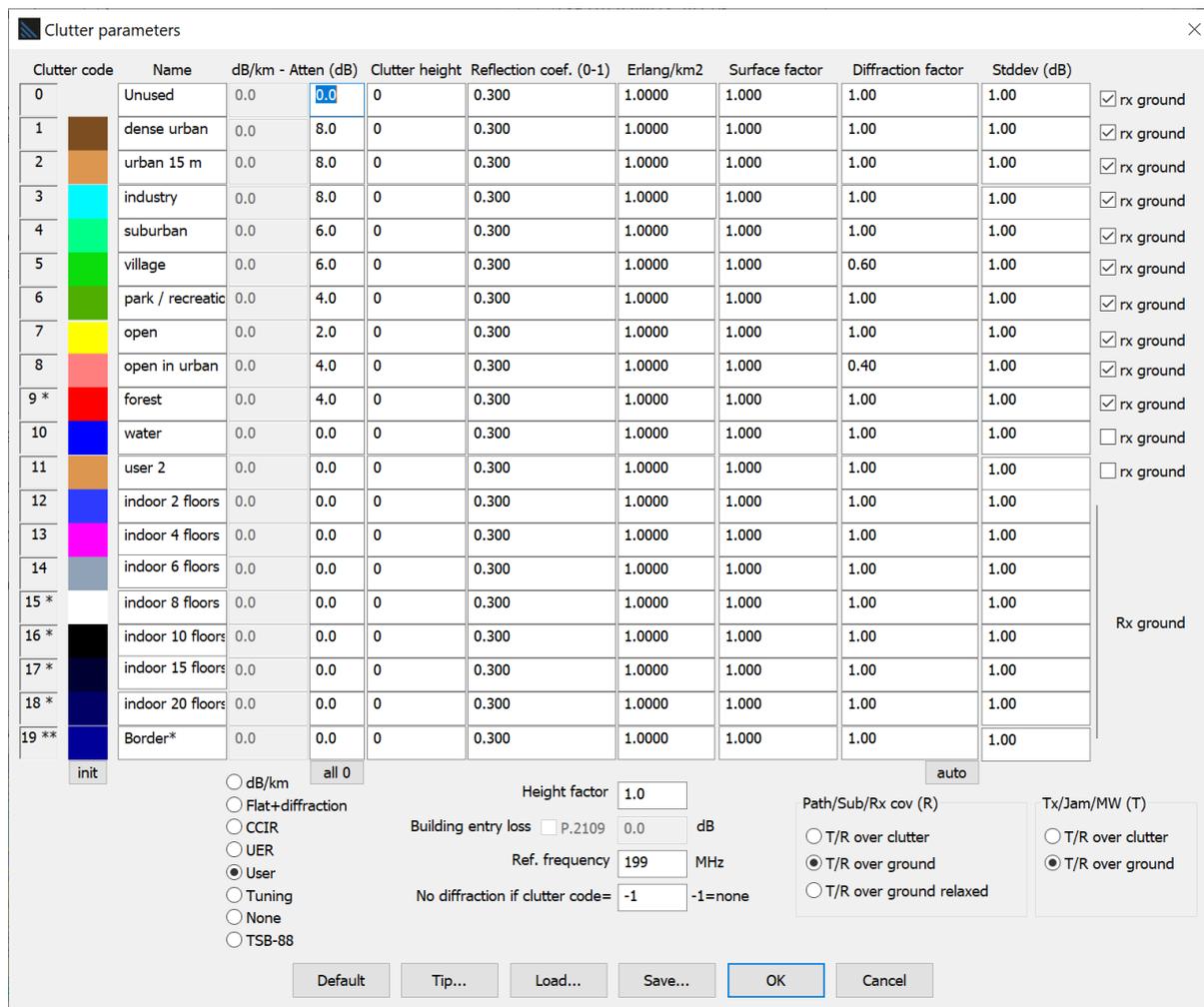
A2.6 Clutter can be used in one of two ways. Firstly, as a simple attenuation loss that is applied around the receive point (as used in Ofcom’s model) or as an additional height defined by the clutter type added along the path between transmitter and receiver.

A2.7 When carrying out their predictions and coverage assessments applicants will need to consider which settings, etc. are the most appropriate for their systems.

Datasets and settings used by Ofcom with the HTZ planning tool

Datasets

- Ordnance Survey terrain data – 50 metre resolution
- Infoterra clutter data – 50 metre resolution,
 - using fixed attenuation around the receive point. See clutter parameters screenshot below for more information which shows the clutter types used and the attenuation applied to each.
- Adult population derived from the 2011 census,
 - Ofcom has provided 2011 census data for the UK as well as all local and small-scale DAB licence areas on its website.

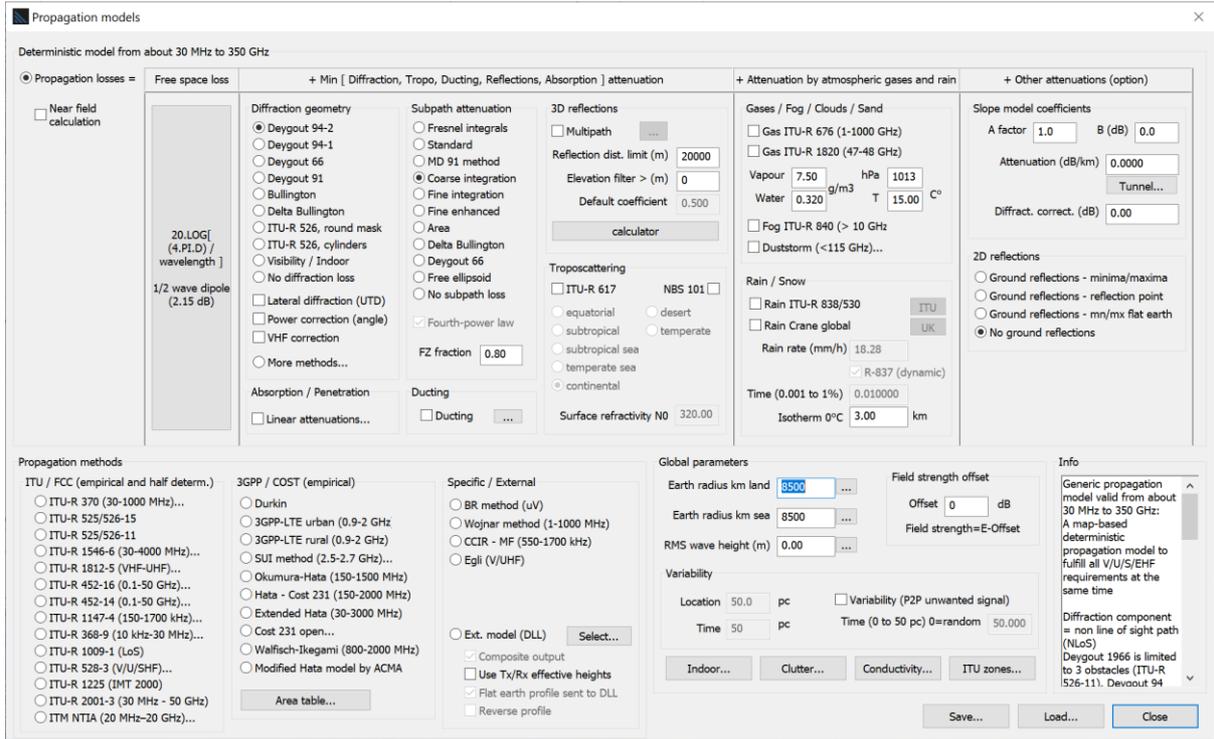


Screenshot of the HTZ communications clutter settings used by Ofcom.

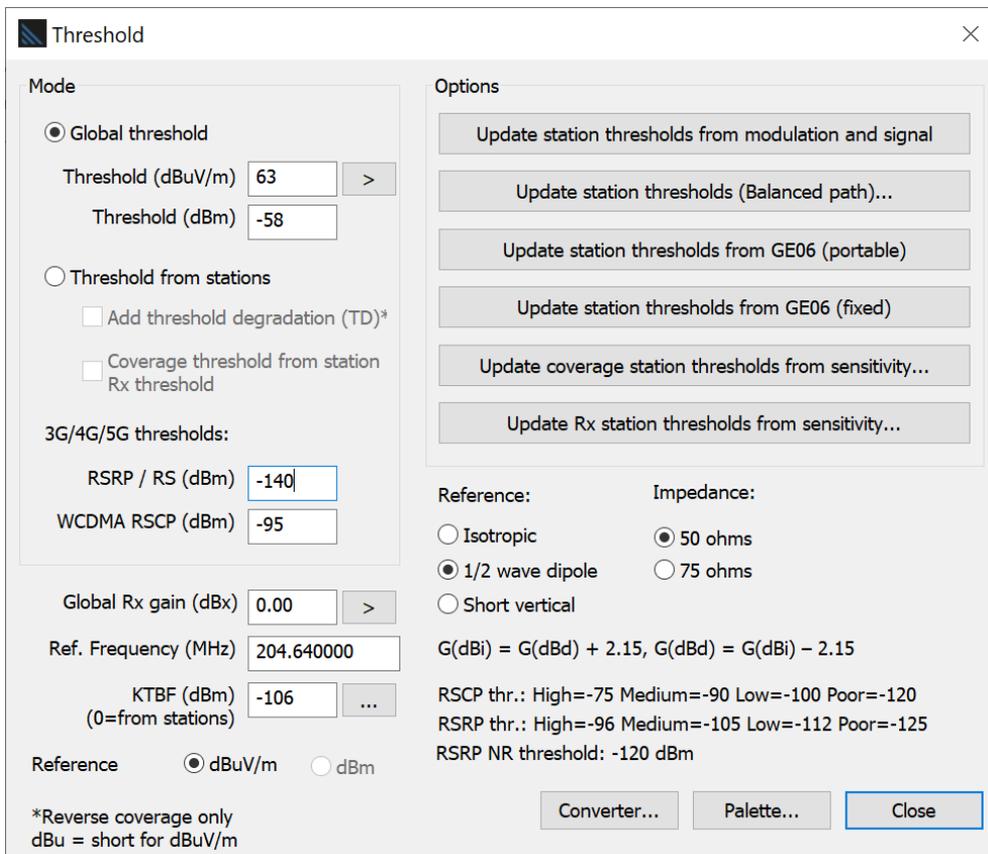
HTZ settings

- Model pre-set – Fresnel
- Diffraction geometry – Deygout 94-2
- Subpath attenuation – coarse integration
- FZ fraction 0.8
- Earth radius (sea and land) - 8,500km.
 - This equates to 4/3 Earth radius for predicting wanted coverage during normal (50% time) propagation conditions.

These settings are shown in the screenshot overleaf:



Screenshot of the HTZ communications prediction model settings used by Ofcom.



Screenshot of the Threshold settings in HTZ used by Ofcom

A3. DAB commissioning checklist

Test or information required	Screenshot or photo required
Date of commissioning	
Engineer name	
Site name and postal address	
Site NGR correct to eight figures	
Antenna type	
Measured loss of transmitter filter (dB)	
Antenna height above ground level (m)	
Antenna gain (dBd)	
Feeder type and calculated loss (dB)	
Calculated transmitter power taking into account licensed ERP, antenna gain and feeder loss (W)	
Directional coupler type	
Directional coupler coupling factor at operating frequency (dB)	
Transmitter type	
Power amplifier type	
Transmitter filter type	
Transmitter pre-filter out of band emissions @ ± 970 kHz (Span 6 MHz, RBW 10kHz, VBW 100 Hz)	Yes
Transmitter pre-filter out of band emissions @ ± 1.75 MHz (Span 6 MHz, RBW 10kHz, VBW 100 Hz)	Yes
Transmitter pre-filter out of band emissions @ ± 3.0 MHz (Span 6 MHz, RBW 10kHz, VBW 100 Hz)	Yes
Transmitter output post filter	Yes
Filter characteristic using tracking generator showing performance at ± 1.75 MHz and ± 3.0 MHz	Yes
Calculated post-filter out of band emissions at ± 1.75 MHz and ± 3.0 MHz (dBc)	
Spurious emissions and harmonics up to 1 GHz (dBc)	Yes

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Emission on 243 MHz (Span 50 kHz, RBW 100 kHz, VBW 10kHz, use high pass filter)	Yes
Antenna return loss (dB)	
Electromagnetic Field (EMF) calculation separation distance (see Ofcom website)	
Confirmation that members of the public cannot access areas closer to the antenna than the EMF separation distance	
List of test equipment used and copy of calibration certificates	Copies of certificates
Site photographs showing the antenna installation and transmitter equipment	Yes

A4. Routes to launch flowchart

A flowchart will be provided in this annex when we publish a final version of this Guidance following consultation.