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National & International Co-ordination Information Sheet

for Licensees, Dealers, Suppliers and Consumers

Information Sheet

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Contents

Purpose of this document

1.1 This document provides information on:

- why national co-ordination is required, and why international co-ordination may be required, prior to a radio assignment being licensed;
- the national and international co-ordination requirements for the Business Radio Unit licenses, including Simple / Light Licenses;
- the use of Memoranda of Understandings (MoU) and Agreements to facilitate the national & international co-ordination processes;
- why it might not be possible to operate an Area Defined assignment at the full licensed power; and
- methods to minimise outgoing and incoming interference from and to UK assignments and to those of our neighbours.

National co-ordination

2.1 National co-ordination is required for two main reasons. These are:

- to protect adjacent UK users from harmful[1] interference from a new assignment; and
- to protect the receiver of a new assignment from harmful interference from existing / planned[2] UK users.

2.2 The assignments within the Technically Assigned licensed channels are co-ordinated nationally by us. Please see section 3, below.

2.3 The assignments within the Area Defined licensed channels are co-ordinated nationally by the relevant licensee. Please see section 4, below.

2.4 The assignments within the Simple Suppliers' licensed channels need to be co-ordinated by the impacted Suppliers licensees in line with the relevant Technical Assigned or Area Defined requirements. For example:

- the short-term co-ordination of temporary use channels, e.g. where used for hire or demonstration purposes, will need to consider the nearby use of the impacted channel by other Suppliers; and
- the short-term co-ordination of temporary use channels, e.g. where used for system parking, will also need to take into consideration the long-term impact to national and international users when the assignment is migrated to a permanent channel.

[1] Interference is not considered harmful when it is permissible interference, e.g. when it is agreed that two or more systems share a channel.
[2] Planned assignments may include those that are awaiting international co-ordination prior to licensing.

2.5 Users within the Simple UK and Simple Site Licensed channels are not required to undertake formal co-ordination checks, but they are required to operate on a non-interference and non-protected basis regarding other UK users and our European neighbours' systems. Guidance on how to meet these requirements is given within section 6, below.

Technically Assigned systems national co-ordination

3.1 Technically Assigned systems vary greatly. They can have a small (up to 3km, e.g. on-site), medium (>3 to 15km), or large (>15 to 120km, e.g. wide-area) coverage radius.

3.2 National co-ordination predictions are performed before a new assignment is licensed to minimise the potential for undue interference to existing users.

3.3 The probability of a proposed assignment interfering within an existing system on the same channel increases as the proposed radiated power and / or antenna height, and therefore coverage area, increases. Likewise, the probability of a proposed assignment interfering with a very nearby system where the receiver channel is adjacent to the transmitter channel of the new assignment also increases as the proposed radiated power and antenna height, and therefore coverage area, increases. NB: for the same mast height, an antenna located on a hill will have a much greater coverage area than an antenna located at sea level.

3.4 The probability of a new assignment interfering[3] within an existing system that is operating on a channel that is licensed for shared-use is likely to increase in proportion to the number of licensees[4]. This effect will be noticed by licensees that have previously enjoyed the sole occupation of a shared-use channel.

3.5 The national co-ordination of Technically Assigned channels is undertaken by Ofcom because, unlike Area Defined channels (see below), they may be shared with other users within a given geographical area.

3.6 The methodology that we use to ascertain whether a proposed assignment may be licensed is detailed within our Technical Frequency Assignment Criteria document (OfW164).

3.7 The methodology includes us analysing the impact of the requested station location, station type, antenna height, antenna type, antenna tilt, and effective radiated power (ERP) to other users.

- NB: down-fire antennas are designed primarily for small coverage radius systems, so delays in licensing may occur if this antenna type is requested for medium or large coverage systems.

[3] The use of channel access codes, e.g. CTCSS tones, may help to reduce audible interference. See section 6, below.

[4] Licensees of shared-use channels need to ensure that their own access is equitable, e.g. they must not use the channel for transmissions that are excessive in length.

Area Defined systems national co-ordination

4.1 Area Defined licenses are intended for users that need to operate a network over a large geographical area and require exclusive spectrum access to achieve this.

4.2 An Area Defined licence can cover the whole of the UK, national areas (e.g. Scotland), or multiples of 50 km x 50 km^2 national grid squares.

4.3 The methodology that we use to decide whether an Area Defined licence is possible is detailed fully within our Technical Frequency Assignment Criteria document OfW164.

4.4 It is the licensee's responsibility to ensure that all national and international co-ordination requirements are met for the initially licensed network and any subsequent amendments made to it.

4.5 National co-ordination is generally achieved by ensuring that the power-summed field strength level, using propagation model P.1546-4 for 50% locations and 50% time, does not exceed the equivalent[5] of -116 dBm within a 12.5 kHz channel at 10m above ground level at and beyond the licensed boundary for frequencies above 100 MHz. For frequencies between 55.75 and 87.5 MHz the field strength level should not exceed the equivalent of -104 dBm within a 12.5 kHz channel.

4.6 There may also be additional national co-ordination restrictions that apply, e.g. for systems operating within the UHF1 Band (these need to be notified to us so that we may co-ordinate them with other UHF1 systems).

4.7 Please note that it may not always be possible to operate all base stations within an area defined system at the maximum licensable power, e.g. 50 watts ERP, where this could breach a national or international co-ordination requirement.

4.8 Any potential national co-ordination interference breach may require the licensee to negotiate with the impacted licensee(s). If successful, the relevant licence(s) may need to be varied so as to take into account the impact of the negotiated change(s). NB: proposed changes may need to be ratified by us.

[5] The equivalent field strengths are detailed within the Technical Frequency Assignment Criteria document.

International co-ordination

5.1 International co-ordination is required for two main reasons. These are:

- to protect our neighbours' systems from harmful interference from proposed UK base station and mobile assignments; and
- to protect the receivers of proposed UK assignments (base stations and mobiles) from harmful interference from our neighbours' systems.

5.2 The protection of our neighbours' systems can be assumed when the predicted impact of the proposed system meets the requirements of a relevant MoU and / or Agreement. In such cases, successful international co-ordination may be assumed.

5.3 A summary of the applicable MoUs and Agreements to Business Radio spectrum can be found in Annex 4 of the Technical Frequency Assignment Criteria document (OfW164). Please note that the Harmonised Co-ordination Methodology (HCM) Agreement (formerly the Berlin and Vienna Agreements) is generally used in the absence of a formal international agreement. See: http://hcm.bundesnetzagentur.de/vertrag/englisch/e_pdf05.zip

5.4 Please note that international co-ordination coverage predictions generally use a 50% location and typically 10%-time propagation model. For Business Radio the model used is P1546-3. This means that a predicted international co-ordination interference boundary will usually extend further than a national co-ordination prediction boundary that uses a 50% location and 50%-time model.

5.5 International co-ordination may need to be sought if the predicted interference level breaches the requirements of the relevant MoU(s) and / or Agreement(s). Please contact us if you are unsure.

5.6 In addition to making outgoing interference predictions, our spectrum management software also identifies areas within and around the UK where international co-ordination is sought automatically, e.g. the Channel Islands, Northern Ireland, and the North Sea. This is to minimise the possibility of harmful interference occurring to UK low-power on-site systems from our neighbours' high-power wide-area systems.

5.7 It should therefore not be assumed that the protection of our neighbours' systems will automatically result in our own systems being protected. This is because our neighbours' systems may:

- have a significantly higher ERP than the proposed UK system (resulting in a proportionately higher level of incoming interference); and / or
- use a channel with different frequency pairing arrangements.

5.8 The international co-ordination process consists of:

- an exchange of data between the impacted Administrations;
- an impact analysis of the proposed system; and
- a formal response, e.g. co-ordinated without conditions, co-ordinated with conditions, or co-ordination failed.

5.9 Please note that the international co-ordination process takes typically 45 days. This duration may need to be extended if, for example:

- the channel(s) that we seek to be co-ordinated are already being used by our neighbours;
- the requested technical characteristics are considered excessive or incorrect. For example:
  - the ERP is too high for the requested coverage radius[6];
  - a non-directional antenna may be being used un-necessarily;
  - a down-fire antenna is being used for a coverage radius greater than 3 kms or has a tilt angle other than -90 degrees.

5.10 Please see Section 6 for ways in which you could reduce the potential level of interference to an adjacent user and therefore increase the probability of an international co-ordination request being successful.

5.11 Please note that all international co-ordination requests must be conducted through us (Ofcom) and the relevant neighbouring Administration(s).

[6] NB: the example ERP and antenna height combinations associated within the Technically Assigned licence fees may have a much greater coverage radius when the antenna is located on high ground.

How to reduce potential interference to and from adjacent users

6.1 It is a licensing condition for Technically Assigned, Area Defined, and Simple licences that the use of radio equipment must not cause or contribute to undue[7] interference to the authorised use of other radio equipment.

6.2 The probability of a licence application being successful is increased where the proposed system meets the user's coverage are requirements and keeps potential undue interference levels to adjacent users to a minimum.

6.3 Although an excellent service radius may be attained, it is not always in an applicant's best interest to seek a high-gain non-directional antenna, at the highest antenna height, on the highest hill, with the highest licensable ERP. This is because the proposed system may:

- contribute to a very high level of interference to adjacent users; and
- suffer a very high level of interference from adjacent users.

6.4 This effect is demonstrated using a simple radio horizon prediction formula. This uses the height in metres of an antenna above mean sea level (amsl) to predict the theoretical maximum coverage range of the antenna.

6.5 The simple radio horizon formula is: 3.569 x SQRT[8](Antenna Height in metres amsl)

Example 1: 3.569 x SQRT(20m) = 15.961km

Example 2: 3.569 x SQRT(20m Mast Ht + 80m Ground Ht) = 35.691km

Note 1: the formula assumes that the earth is spherical and smooth, e.g. no hills.

6.6 The radio horizon formula shows that:

- increasing a transmitter's radiated power will not extend the boundary but will increase the signal strength at the boundary; and
- increasing the antenna height will increase the distance from which interference may be received;
    - higher power mobile[9] stations may then be required to overcome the level of interference received by the base station.

NB: using a directional antenna will reduce the incoming and outgoing interference levels in any direction of un-wanted coverage, e.g. from sources of interference.

[7] The expression "Undue Interference" shall have the meaning given by Section 115 of the Communications Act 2003.
[8] SQRT = square root.
[9] NB: the higher power mobiles are then more likely to interfere with the base stations of neighbouring systems.

6.7 Designing a system appropriately is therefore especially important when it will be located adjacent to one of our European neighbours because this should maximise the probability of achieving successful international co-ordination. NB: successful international co-ordination is required before the licence is issued. It is also required before an assignment may be placed on the ITU Master Frequency Register (MFR).

6.8 Altering the following components of your system may prove helpful when attempting to reduce potential interference to and from adjacent users:

- antenna height;
- antenna gains and effective radiated powers;
- directional antennas;
- antenna down-tilt (electrical and /or mechanical);
- down-fire antenna;
- dual-antenna working;
- terrain shielding;
- channel access codes (e.g. CTCSS, DCS, RAN, and Colour Codes);
- time division multiple access (TDMA);
- alternative frequency division multiple access (FDMA) arrangements.

6.9 The impact of selecting a suitable antenna height was demonstrated in the previous section. It showed that the using the maximum height possible might not always be the best solution because of the potential increase in outgoing and incoming interference as the height of the antenna increases. Where possible[10], the antenna height should be a balance between achieving the required service coverage area and minimising potential interference to and from adjacent systems; especially those of our European neighbours.

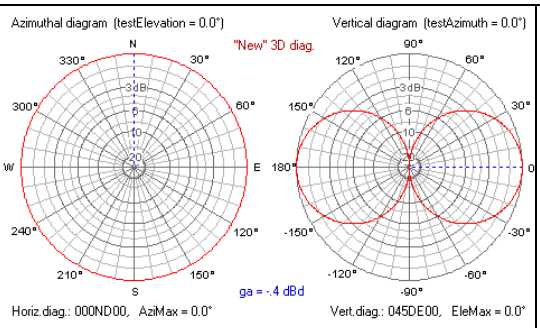
6.10 The transmission and reception of signals vary in direct proportion to the gain of an antenna. For example: an antenna with a 3dB gain will transmit and receive signals at double the strength of an antenna with no gain; a 6dB gain antenna will result in four times the signal strength; etc. Using a high-gain base station antenna can be useful because it will amplify your transmitter's power and amplify the signals received from your mobiles. NB: the licensed effective radiated power (ERP) will be fixed so care must be taken to ensure that the transmitter power and antenna gain combination[11] does not exceed the licensed value.

6.11 Unfortunately, with antenna gains you do not get something for nothing. This is because an increase in gain towards, say, the horizon results in an automatic

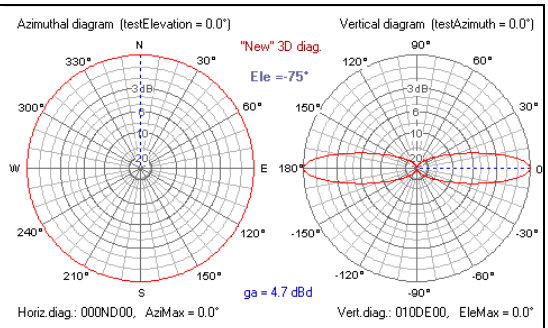
[10] It may not always be possible to select the optimum antenna height when it is located at a major radio site. The antenna height may be dictated by the site owner.

[11] The ERP is typically (e.g. ignoring the antenna cable loss) equal to the transmitter power multiplied by the antenna gain, e.g. a transmitter output power of 5 watts (7 dBW) with an antenna gain of 4 (6dB) would result in an ERP of 20 watts (13dBW). Likewise, a transmitter output power of 10 watts (10 dBW) with an antenna gain of 2 (3dB) would result in an ERP of 20 watts (13dBW).

decrease in gain towards the ground. So, using a high gain, e.g. 6dB, base station antenna mounted on a hill top may therefore increase the un-wanted levels of interference received from neighbouring systems whilst reducing the wanted levels of signal received from your own mobiles operating at the base of the hill. Please see the diagrams below. (NB: the two diagrams below should, ideally, show the 6dB vertical pattern extending beyond the 0dB pattern by an extra 50 per cent.)



Non-directional antenna with 0dB gain

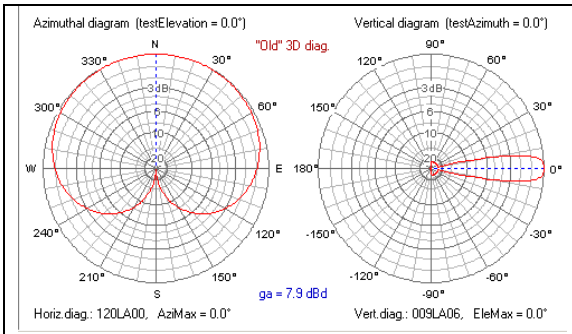


Non-directional antenna with 6dB gain

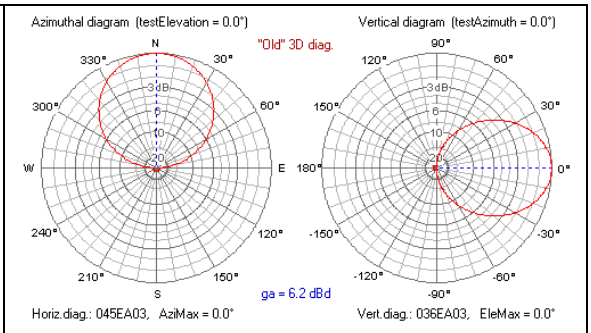
6.12 Directional antennas may, depending on their direction, be used to:

- concentrate the radiated power to within the wanted coverage area;
- reduce the impact of incoming interference from an adjacent system; and
- reduce interference to an adjacent system.

6.13 There are several types of directional antenna. The diagram below shows the horizontal and vertical coverage patterns of example cardioid and elliptical directional antennas. The cardioid antenna type may be directed so as to obtain an almost all-around coverage pattern but with a signal coverage notch in the direction of, perhaps, a strong source of interference. The elliptical antenna type may be directed to ensure that a maximum signal is transmitted to, and received from, the mobiles in a specific area, e.g. when the base station is located at the edge of the required service area.

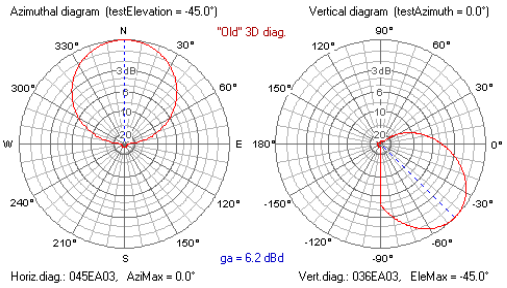


Cardioid directional.



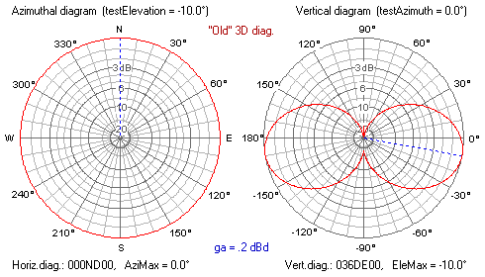
Elliptical directional antenna

6.14 A directional antenna may be mounted so its main beam points below the horizon. This is called mechanical down-tilt. Down-tilt can combine the advantage and potential disadvantage of antennas with gain to good effect, e.g. a high-gain base station directional antenna on a hilltop pointed at -45 degrees downwards to the base of the hill will increase the signal strength / reception in the wanted service area whilst reducing the interference to and from adjacent systems towards the horizon.



Elliptical directional antenna with -45 degrees of mechanical down-tilt adjustment

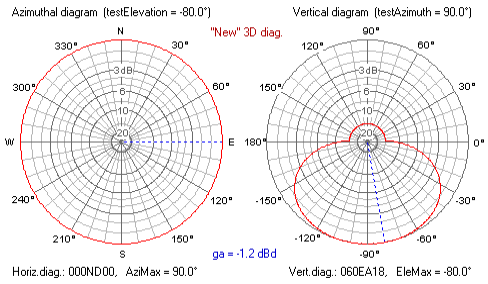
6.15 Where the antenna is located in the centre of the service area it might be better to use a non-directional antenna with electrical down-tilt. These antennas can also combine the advantage and potential disadvantage of antennas with gain. Unlike mechanical tilt antennas, the maximum electrical tilt angle is typically -20 degrees.



Non-directional antenna with -10 degrees of down-tilt.

6.16 Down-fire antennas are not the same as down-tilt antennas. Down-fire antennas are specifically designed to be mounted on a mast so that their main beam points directly down[12] towards the ground. The coverage pattern of a down-fire antenna is simulated in the diagram below. These antennas may be used when coverage is required primarily within a tall building. Down-fire antennas may be the best solution for on-site and small area systems because they also have the advantage of having a typical gain of -20dB (i.e. 1/100th) towards the horizon. (NB: there may be delays in us processing licence requests for down-fire antennas that do not have a tilt angle of -90 degrees because down-fire antennas are normally assumed to point directly towards the ground.)

[12] Down-fire antennas mounted close to the ground may point directly upwards, i.e. +90 degrees tilt.



Down-fire antenna with 6dBd Gain [simulated pattern]

6.17 Sometimes it may be necessary to, perhaps, protect an adjacent system from interference whilst maintaining or enhancing a base station's general reception capability. Dual-antenna working enables a system to achieve this. In this example, a directional antenna with a cardioid pattern could be used as the transmitter's antenna whilst a high-gain non-directional antenna could be used for the receiver's antenna.

6.18 Terrain shielding[13] can be used to enable the same radio channel to be re-used relatively closely to another system. A simple situation would be where the antennas of the two base stations that need to operate on the same channel are mounted on opposite sides of a range of hills rather than their both being mounted on the hilltops.

6.19 In some areas it may be either requested or necessary for a radio channel to have shared use[14]. The use of channel access codes (e.g. CTCSS, DCS, RAN, and Colour Codes) enables multiple users to share a channel without them constantly hearing the communications of the other users. Whilst this sharing methodology theoretically improves spectrum efficiency, it has the disadvantage that it increases potential interference[15] because the channel cannot be used by one user when another user is using it.

6.20 There is an option to licence some channels on a time division multiple access (TDMA) basis. DMR uses TDMA to achieve 6.25 kHz efficiency within a 12.5 kHz channel using two timeslots, typically within an onsite installation.

6.21 Frequency division multiple access (FDMA) is the methodology used by analogue radio systems and by a version of digital private mobile radio. We offer the option of licensing new 6.25 kHz channels for digital systems. We also offer the option to vary an existing 12.5 kHz channel system licence to use the corresponding 2 x 6.25 kHz channels. This change may then enable an existing user to operate two 6.25 kHz radio systems within the original 12.5 kHz channel. Alternatively, two geographically adjacent interfering users could agree to change their existing 12.5 kHz systems so that one uses the upper 6.25 kHz channel and the other uses the lower 6.25 kHz channel.

[13] Some microwave frequency systems can use the blocking effect of just a building to re-use a radio channel.
[14] A channel licensed for shared use has a lower licence fee than a channel licensed for exclusive use.
[15] Some radios have a Busy Light to show when an operator with a different CTCSS tone, etc, is using the channel.

Further information

7.1 The Business Radio Technical Frequency Assignment Criteria is available at:

http://licensing.ofcom.org.uk/binaries/spectrum/business-radio/technical-information/tfac/ofw164.pdf

7.2 National & International Co-ordination policy enquiries for Business Radio and Maritime should be sent to:

Spectrum.licensing@ofcom.org.uk