OfW 590

Technical Frequency Assignment Criteria for Shared Access Radio Services

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Forward

The Wireless Telegraphy Act 2006 requires that only radio equipment that the Office of Communications (Ofcom) has granted a licence to, unless licence exempt, can be installed and used in the United Kingdom. This is under the condition that the radio equipment meets certain minimum requirements set in the appropriate Interface Requirement.

- IR2103 (Shared Access Low Power)
- IR2104 (Shared Access Medium Power)

This document details the technical frequency assignment criteria and the principles that Ofcom will employ in the frequency bands for use by Shared Access systems.

This Technical Frequency Assignment Criteria (TFAC) is subject to revision. A further revision is expected to be published in 2025, when the remainder of the decisions made in the July 2024 Statement will be implemented in the licensing tool and 2320-2340 MHz will become available for Shared Access deployments.

Operators and manufacturers can obtain the latest copy of this document from the Ofcom website. If you do not have access to the internet, you can request a printed copy to be posted to you from Spectrum Licensing, contact details are below.

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Introduction

Shared Access products are part of a framework[1] enabling shared use of spectrum. This product provides a simple method for users to access spectrum which could support the rollout of a wide range of local wireless connectivity applications.

Spectrum Bands available for Shared Access are listed below:

Band	Channel Bandwidths Available
1.8 GHz band FDD band: Lower Duplex 1.7817 – 1.785 GHz (terminal transmit) Upper Duplex 1.8767 – 1.880 GHz (base station transmit)	2 x 3.3 MHz
2.3 GHz band TDD band: 2.39 – 2.4 GHz	10 MHz
3.8-4.2 GHz band TDD band: 3.805 – 4.195 MHz	10 MHz, 20 MHz, 30 MHz, 40 MHz, 50 MHz, 60 MHz, 80 MHz and 100 MHz
26 GHz band TDD band: 24.25 – 26.5 GHz	50 MHz, 100 MHz and 200 MHz

A common authorisation approach applies for access to any of these bands. Potential applicants will apply to Ofcom for a licence for a specific location. For each licence application, we will assess interference to and from other licensees[2] in the band, based on our coordination parameters and methodology outlined in this document. Assignments will be made on a first come, first served basis with regards to other users in the band.

There are two types of licence to cater for different types of potential uses:

- **Low Power licence** for local connectivity (per area licence). This would allow users to deploy as many base stations as they like within a 50-metre radius circle without further authorisation from Ofcom. Licensees can apply for multiple licence areas if the required coverage area is larger than the coverage area defined by a single licence.
- **Medium Power licence** for longer range connectivity (per base station licence). Given the higher transmit power and larger potential interference area, we will authorise medium power base stations on a per base station basis.
- Usage will be designated for indoor or outdoor use. “Indoor” means a location inside a premises in which the shielding will provide additional attenuation and therefore protection against harmful interference to wireless telegraphy equipment. For the low power licence,

[1] https://www.ofcom.org.uk/spectrum/frequencies/shared-access

[2] Self-interference for Shared Access stations isn’t taken account of within the technical assignment process. A Licensee is determined by the organisation name and organisation code used by the Ofcom Licensing Systems

where a user can deploy multiple base stations using a single licence, an indoor-only licence requires all base station and fixed terminal deployments to be indoors, whereas an outdoor licence allows base stations and fixed terminals to be deployed both outdoors and indoors.

The 2.3 GHz band and 26 GHz band are currently only available for low power indoor use.

1.8 GHz band and 3.8-4.2 GHz band Medium Power licences are available as standard for use outside Greater London. Applications inside Greater London will be considered as exceptions and will only be permitted if the application passes the 'premises sterilisation' test, as outlined in the Shared Access Licence Guidance document.

Ofcom has defined "Greater London" as the geographical boundary for Greater London defined in the September 2023 Statement: "Enabling mmWave spectrum for new uses".[3] [4]

Some applications outside Greater London will also be considered as exceptions, as defined below.

1.8 GHz band Medium Power licences are available as standard elsewhere when applications use an antenna height of 10 m Above Ground Level (AGL) or less. Applications for antenna heights greater than 10 m AGL will be considered as exceptions and will only be permitted if the application passes the 'premises sterilisation' test, as outlined in the Shared Access Licence Guidance document.

3.8-4.2 GHz band Medium Power licences with an antenna height of greater than 10 m AGL are available as standard when the application is in a Rural location. Applications for antenna heights greater than 10 m AGL in Urban locations will be considered as exceptions, and will only be permitted if the application passes the 'premises sterilisation' test as outlined in the Shared Access Licence Guidance document. Applications for antenna heights of 10 m AGL or less are available as standard in both Urban and Rural locations (except for applications in Greater London, as explained previously).

Ofcom has defined "Rural" for the purposes of these licences as:

a) any location in England or Wales in an ONS 2011 Census Output Area which falls into categories D1, D2, E1, E2, F1 or F2 (i.e. "town and fringe", "villages" and "hamlets and isolated dwellings");[5]
b) any location in Scotland which falls into categories 3-8 based on the Scottish Government's 8-fold Urban Rural Classification; (i.e. any area outside a settlement of over 3,000 people);[6] and,
c) any location in Northern Ireland which falls into bands E-H of the Northern Ireland Statistics and Research Agency's Statistical Classification and Delineation of Settlements bands (i.e. any area outside a settlement of over 2,500 people);[7] and,

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[3] Geographical boundaries of the 'Spectrum Access High Density 26 GHz' licences and the 'Spectrum Access High Density 40 GHz' licences (ofcom.org.uk)
[4] Shapefiles of final geographical boundaries of the 'Spectrum Access High Density 26 GHz' licences and the 'Spectrum Access High Density 40 GHz' licences (ofcom.org.uk)
[5] Office of National Statistics, *2011 Rural/Urban Classification (RUC2011)*, https://www.ons.gov.uk/methodology/geography/geographicalproducts/ruralurbanclassifications/2011ruralurbanclassification
[6] Scottish Government, *Scottish Government Urban Rural Classification*, https://www.gov.scot/Topics/Statistics/About/Methodology/UrbanRuralClassification
[7] Northern Ireland Statistics and Research Agency, *Urban-Rural Classification*, https://www.nisra.gov.uk/support/geography/urban-rural-classification

d) in addition, any location which falls outside of the ONS 2011 Census Output Area, the Scottish Government's 8-fold Urban Rural Classification, and the Northern Ireland Statistics and Research Agency's Statistical Classification and Delineation of Settlements bands, but which is within the limit of the UK's territorial seas, will be considered as rural.[8]

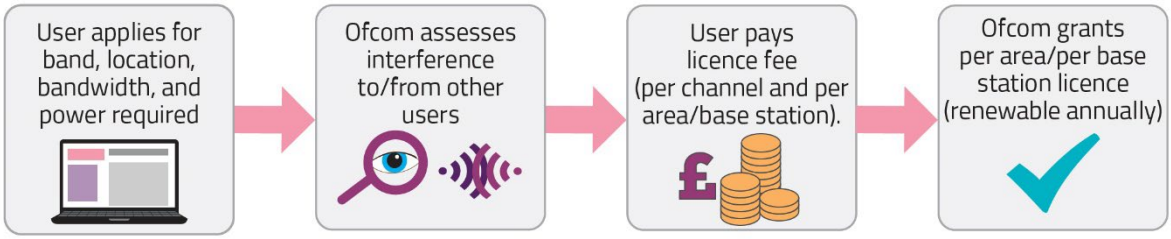
For the purposes of these licences, "Urban" is defined as any location which is not Rural.

The licence terms and conditions will have a requirement for equipment to start transmitting within six months of the licence being issued and continue to be operational afterwards. If spectrum is not used in this timeframe, Ofcom may revoke the licence with one month's notice.

[8] For more information, see the UK Government website: https://www.gov.uk/guidance/uk-maritime-limits-and-law-of-the-sea. The UK Hydrographic Office also produces a map showing the limits of the UK's territorial seas, for reference: https://data.admiralty.co.uk/portal/apps/sites/#/marine-data-portal

Application Process

High level process for new applications:



Frequency Assignment

Each base station will be assessed against a series of checks that cover:

a) exclusion zone checks;
b) separation distance checks;
c) inter-service technical coordination (coordination between Shared Access deployments and Fixed Links, Permanent Earth Stations & UK Broadband);
d) intra-service technical coordination (coordination with other Shared Access deployments, noting self-interference is ignored);
e) national coordination (coordination between Shared Access deployments and MOD); and,
f) international coordination/MoU[9] checks.

After the above checks have been completed, any remaining frequencies that are available will follow the assignment process given in the paragraph below, excluding any channels outside of tuning range (if provided).

Note: There is only a single channel in the 1.8 GHz band and currently in the 2.3 GHz band. In the 3.8-4.2 GHz band where possible the channel assignment will be top down. In the 26 GHz band where possible the channel assignment will be bottom up.

Exclusion zone checks

Shared Access base stations are not licenced in the Isle of Man and Channel Islands.

1.8 GHz band and 3.8-4.2 GHz band Medium Power Shared Access base stations inside Greater London will be considered as exceptions. Outside Greater London, 1.8 GHz band Medium Power Shared Access base stations with antenna height greater than 10 m AGL will be considered as exceptions, and 3.8-4.2 GHz band Medium Power Shared Access base stations with antenna height of greater than 10 m AGL located in Urban locations will be considered as exceptions.[10]

Shared Access base stations in the 26 GHz band will initially be excluded from areas within 1 km of Harwell Earth Exploration Satellite Service earth station, Oxfordshire.

Separation distance checks

A summary table of the separation distance checks is given in Annex A1 – “Separation distances”.

[9] Memorandum of understanding
[10] See Section “Introduction” for more details

3.8-4.2 GHz band Shared Access licences

If an existing Fixed Link is within 500 m of the of the proposed Shared Access base station location, frequencies with a frequency offset of less than 2.5 times bandwidth[11] from the existing Fixed Link's allocation will be excluded from the available frequencies for assignment.[12]

26 GHz band Shared Access licences

If an existing indoor Low Power Shared Access deployment is within 100 m of the of the proposed Shared Access base station location, frequencies with a frequency offset of less than 2.5 times bandwidth with the existing Shared Access allocation will be excluded from the available frequencies for assignment.

Inter-service technical coordination

There is a set coordination area per station type.[13] All station types of other licensees within these areas will be assessed in turn, while stations outside these areas will not be assessed.

There are no other licensed services in the 1.8 GHz or 2.3 GHz bands, so there is no need for inter-service technical coordination.

No inter-service technical coordination is done for 26 GHz band Low Power indoor licences.

Propagation model ITU-R P.452-10 will be used for the interference to noise (I/N) or threshold to interference (T/I) calculation. Terrain and clutter maps of 50-metre resolution are used as part of the path loss model.

For inter-service technical coordination (coordination between Shared Access deployments and Fixed Links, Permanent Earth Stations & UK Broadband), the interference analysis calculation will be based on the protection criteria test(s) defined below. The technical parameters for the Shared Access deployments are based on the parameters given in Section "Technical Frequency Assignment Data". The technical parameters for the other users are present in our licensing tool.

[11] Throughout this document, "2.5 times bandwidth" refers to any case where the frequency offset between victim and interferer centre frequencies, denoted f_V and f_I respectively, meets the condition $|f_V - f_I| = 2.5 \cdot (B_V + B_I)$, where B_V and B_I denote the bandwidths of the victim and interferer carriers respectively.

[12] In the case of 3.8-4.2 GHz shared access licensees using narrower carrier bandwidths (e.g. 20 MHz) and depending on the performance of the base station receiver, there exists a theoretical risk of a fixed link transmitter causing blocking at a shared access base station receiver at frequency separations larger than 2.5 times bandwidth. However, as this is extremely unlikely to occur in practice, this will not be assessed in the coordination, and instead resolved through local level interference management measures.

[13] See Annex A2 – "Coordination distances"

Fixed Links	Permanent Earth Station (PES) *(for RSA for ROES, we only apply Test 2)*	UK Broadband deployments *(3.8-4.2 GHz band only)*	Low Power Shared Access deployments	Medium Power Shared Access deployments
Test 1: Ensure the equipment specific protection ratio is met, assuming 50% of time and the RSL specified in TFAC OFW446	Test 1: I/N = 0dB and for 0.005% of time	Test 1: W/U = 27dB and for 50% of time, assuming RSL = 75dBm	Test 1 for 3.8-4.2 GHz band: I/N = −5 dB and for 20% of time, assuming NF = 13 dB	Test 1 for 3.8-4.2 GHz band: I/N = −6 dB and for 20% of time, assuming NF = 10 dB
Test 2: Ensure the equipment specific protection ratio is met, assuming time % = (100 – link availability) and the RSL specified in TFAC OFW446 + fade margin	Test 2: I/N = -10dB and for 20% of time	Test 2: W/U = 6.5dB and for 0.001% of time, assuming RSL = -75dBm		

RSL = Receive Sensitivity Level, T/I = Threshold to Interference, I/N = Interference to Noise, NF = Noise Factor

The noise power (N) value in the interference to noise (I/N) is thermal noise (kTB)[14] plus the equipment noise figure (NF):

$$N\ (dBm) = 10 \times \log10(kTB) + NF + 30$$

Considerations for Low Power Shared Access licences

Low Power Shared Access licences are granted on a per area basis. The technical coordination procedures for Low Power Shared Access applications use the licence coordinates provided by the licensee.

The EIRP used for coordination is the maximum allowed EIRP per base station, with the addition of 2 dB.[15] This is to account for the base station being located anywhere within the circulate licence area with radius 50 m.

Similarly, the I/N protection criteria is increased by 1 dB compared to the Medium Power protection criteria, to account for 50 m radius licence area.

[14] kTB is the total thermal noise power (kTB) in Watts, it is a function of three quantities, (i) Boltzmann's constant "k" in Joules/˚K, (ii) temperature "T" is 290˚Kelvin, and (iii) the overall bandwidth "B" (Hz) of the channel

[15] For clarity, the EIRP (or TRP for 26 GHz) used for coordination of Medium Power Shared Access is that provided by the applicant, as shown in Section "Technical Frequency Assignment Data".

Shared Access transmit and receive mask for inter-service technical coordination

1.8 GHz band and 2.3 GHz band

There are no other services in the 1.8 GHz or 2.3 GHz bands, so there is no need for inter service technical coordination.

3.8-4.2 GHz band

Base station Transmit (Tx) mask for all channel bandwidth sizes[16]:

Offset from centre operational frequency (MHz)	Channel bandwidth (MHz)							
	10	20	30	40	50	60	80	100
	Tx mask, relative emission level (dBc)							
−2.5xBW	-50	-47	-45.2	-44	-43	-42.2	-41	-40
−BW/2−5	-50	-47	-45.2	-44	-43	-42.2	-41	-40
−BW/2−5	-42	-39	-37.2	-36	-35	-34.2	-33	-32
−BW/2	-42	-39	-37.2	-36	-35	-34.2	-33	-32
−BW/2	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
BW/2	0	0	0	0	0	0	0	0
BW/2	-42	-39	-37.2	-36	-35	-34.2	-33	-32
BW/2+5	-42	-39	-37.2	-36	-35	-34.2	-33	-32
BW/2+5	-50	-47	-45.2	-44	-43	-42.2	-41	-40
2.5xBW	-50	-47	-45.2	-44	-43	-42.2	-41	-40

BW = Channel bandwidth (MHz)
Relative emission level gives the emissions at the specified frequency offset relative to the wanted channel power

[16] The licencing software assumes perfect relative emission level beyond the defined frequency offset, i.e. −∞ for a frequency offset of more than 2.5xBW in this case.

Base station Receive (Rx) mask for all channel bandwidth sizes[17] [18]:

Offset from centre operational frequency (MHz)	Channel bandwidth (MHz)							
	10	20	30	40	50	60	80	100
	Rx mask, selectivity (dBc)							
–2.5xBW	-51.2	-48.2	-46.5	-45.2	-44.2	-43.5	-42.2	-41.2
–BW/2–5	-51.2	-48.2	-46.5	-45.2	-44.2	-43.5	-42.2	-41.2
–BW/2–5	-42.2	-39.2	-37.5	-36.2	-35.2	-34.5	-33.2	-32.2
–BW/2	-42.2	-39.2	-37.5	-36.2	-35.2	-34.5	-33.2	-32.2
–BW/2	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
BW/2	0	0	0	0	0	0	0	0
BW/2	-42.2	-39.2	-37.5	-36.2	-35.2	-34.5	-33.2	-32.2
BW/2+5	-42.2	-39.2	-37.5	-36.2	-35.2	-34.5	-33.2	-32.2
BW/2+5	-51.2	-48.2	-46.5	-45.2	-44.2	-43.5	-42.2	-41.2
2.5xBW	-51.2	-48.2	-46.5	-45.2	-44.2	-43.5	-42.2	-41.2

BW = Channel bandwidth (MHz)

26 GHz Band

No inter-service technical coordination is done for 26 GHz band Low Power indoor licences.

Inter-service interference calculation

Protection of Fixed Links and UK Broadband receivers

This section captures the methodology used for the assessment of the following interference scenarios:

[17] 3GPP TS 38.104 specifies the Adjacent Channel Selectivity (ACS) test requirement and in-band blocking test requirement for local area (low power) and medium range (medium power) base stations. Using these requirements, with noise figure assumptions of 13 dB and 10 dB for low power and medium power base stations respectively, the relative selectivity levels for the 1st adjacent and further adjacent channels can be calculated. Note: For wanted carrier bandwidths wider than 20 MHz, 3GPP TS 38.104 defines the 2nd adjacent channel (where the in-band blocking test requirement begins to apply) as starting 20 MHz from the wanted carrier band edge, whereas for carrier bandwidths of 20 MHz or less the 2nd adjacent channel is defined as starting 5 MHz from the wanted carrier band edge. However, we have decided to apply the in-band blocking requirement as starting 5 MHz from the wanted carrier band edge for all carrier bandwidths, reflecting the behaviour of the operating band unwanted emissions limits used to define the BS Tx mask.

[18] The licencing software assumes perfect relative selectivity beyond the defined frequency offset, i.e. −∞ a for frequency offset of more than 2.5xBW in this case.

a) Shared Access base station Tx (interferer) to Fixed Link station Rx (victim);

i) Calculations are performed when the frequency offset between the Fixed Link station's centre frequency and the new Shared Access allocation's centre frequency is less than 2.5 times bandwidth;

ii) Fixed Link stations with larger frequency offset will not be assessed.

b) Shared Access base station Tx (interferer) to UK Broadband base station Rx (victim).

iii) Calculations are performed when the frequency offset between the UK Broadband base station's centre frequency and the new Shared Access allocation's centre frequency is less than 2.5 times bandwidth;

iv) UK Broadband base stations with larger frequency offset will not be assessed.

For the 26 GHz band no technical coordination is carried out.

Threshold to interference calculation is described below in equation below:

$$\frac{T}{I} = \left(T - \frac{W}{U}\right) - P_t + G_r + L_{fixed} - L_{prop} - F_{WCR} - NFD - A_d - BEL$$

where:

$\frac{T}{I}$ is the threshold-to-interference ratio at the victim receiver in dB

T is the receiver sensitivity level (RSL) in

$\frac{W}{U}$ is the wanted to unwanted ratio in dB

P_t is the transmit power (EIRP) of the interfering system in dBm

G_r is the gain of the victim receiver towards the interfering system in dBi

L_{fixed} is the combined feeder and other losses of the receiver in dB

L_{prop} is the propagation loss between the interfering system and the victim receiver in dB (P.452)

F_{WCR} is the worst case reduction factor which removes 12 dB for the interference budget (26 GHz only where the interfering signal is Shared Access transmitter to Fixed Link receiver)

NFD is the net filter discrimination in dB[19]

A_d is the antenna discrimination for the interfering system towards the victim receiver in dB

BEL is the additional attenuation for outgoing and incoming signals (indoor use only) in dB

The interfering signal must be less than or equal to $T - \frac{W}{U}$.

Wanted-to-Unwanted ($\frac{W}{U}$) ratios are evaluated at each receiver in the co-ordination zone.

The $\frac{W}{U}$ test must be satisfied at all assessed receivers in the co-ordination zone for a deployment to proceed. In practical terms this means that the unwanted signal level must be less than the interference threshold at the victim receiver. Interference calculations take account of antenna

[19] See Annex A3 – "Net Frequency Discrimination"

discrimination at both ends of the interference path, losses on the path and any Net Filter Discrimination available.

Fixed Link $\frac{W}{U}$ ratio requirements are defined in OfW 446: Technical Frequency Assignment Criteria for Fixed Point-to-Point Radio Services with Digital Modulation (ofcom.org.uk). Fixed Link equipment specific $\frac{W}{U}$ ratio requirements data can be found in the published Equipment Reference Codes list (XLSX, 406.1 kb, ofcom.org.uk).

UK Broadband $\frac{W}{U}$ ratio requirements are defined in the protection criteria test(s) table above.

G_r (gain of the victim receiver towards the interfering system in dB) is calculated by determining the angle of arrival of the interfering signal to the victim receiver, and applying the victim antenna radiation pattern to the peak gain.

Fixed Link antenna patterns are available on the Ofcom website: Fixed terrestrial links (ofcom.org.uk).

A_d (antenna discrimination of the interfering system towards the victim receiver in dB) is calculated by determining the angle of transmission of the interfering signal towards the victim receiver.

For 3.8-4.2 GHz band Shared Access base stations, a 0 dBi omnidirectional antenna pattern is assumed.

For indoor Shared Access deployments an attenuation (BEL) of 12 dB is added to the calculation for the outgoing signal.

Protection of Permanent Earth Station (PES) and Shared Access receivers

This section captures the methodology used for the assessment of the following interference scenarios:

c) Shared Access base station Tx (interferer) to PES Rx (victim);

   i) Calculations are performed when the frequency offset between the PES's centre frequency and the new Shared Access allocation's centre frequency is less than 2.5 times bandwidth;
   ii) PES with larger frequency offset will not be assessed.

d) Fixed Link station Tx (interferer) to Shared Access base station Rx (victim);

   i) Calculations are performed when the frequency offset between the new Shared Access base stations' centre frequency and the Fixed Link station's centre frequency is less than 2.5 times bandwidth;
   ii) Fixed Link stations with larger frequency offset will not be assessed.

e) UK Broadband base station Tx (interferer) to Shared Access base station Rx (victim);

   i) Calculations are performed when the frequency offset between the new Shared Access base stations' centre frequency and the UK Broadband base station's centre frequency is less than 2.5 times bandwidth;
   ii) UK Broadband base stations with larger frequency offset will not be assessed.

Interference to noise calculation is described below in equation below.

$$\frac{I}{N} = \left(P_t + \mathrm{G_r} + L_f - L_{prop} - NFD - A_d - BEL\right) - N$$

where:

$\frac{I}{N}$ is the interference-to-noise ratio at the victim receiver in dB

P_t is the transmit power (EIRP) of the interfering system in dBm

G_r is the gain of the victim receiver towards the interfering system in dBi

L_f is the combined feeder and other losses of the receiver in dB

L_{prop} is the propagation loss between the interfering system and the victim receiver in dB (P.452)

NFD is the net filter discrimination in dB[20]

A_d is the antenna discrimination for the interfering system towards the victim receiver in dB

BEL is the additional attenuation for outgoing and incoming signals (indoor use only) in dB

N is the Noise power

Interference-to-Noise ($\frac{I}{N}$) ratios are evaluated at each receiver in the co-ordination zone.

The $\frac{I}{N}$ test must be satisfied at all assessed receivers in the co-ordination zone for a deployment to proceed. In practical terms this means that the unwanted signal level must be less than the interference threshold at the victim receiver. Interference calculations take account of antenna discrimination at both ends of the interference path, losses on the path and any Net Filter Discrimination available.

G_r (gain of the victim receiver towards the interfering system in dB) is calculated by determining the angle of arrival of the interfering signal to the victim receiver, and applying the victim antenna radiation pattern to the peak gain.

PES antenna patterns are based on the technical parameters present in our licensing tool, modelled using ITU-R Recommendation S.580 or ITU-R Recommendation S.465.[21] [22]

For protection of 3.8-4.2 GHz band low power Shared Access base stations, a 0 dBi omnidirectional antenna pattern is assumed.

For protection of 3.8-4.2 GHz band medium power Shared Access base stations, an omnidirectional antenna pattern is assumed, using the antenna gain as defined by the applicant (0-16 dBi max range).

A_d (antenna discrimination of the interfering system towards the victim receiver in dB) is calculated by determining the angle of transmission of the interfering signal towards the victim receiver.

For 3.8-4.2 GHz band Shared Access base stations, a 0 dBi omnidirectional antenna pattern is assumed.

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[20] See Annex A3 – "Net Frequency Discrimination"

[21] S.465: Reference radiation pattern of earth station antennas in the fixed-satellite service for use in coordination and interference assessment in the frequency range from 2 to 31 GHz (itu.int)

[22] S.580: Radiation diagrams for use as design objectives for antennas of earth stations operating with geostationary satellites (itu.int)

For indoor Shared Access deployments an attenuation (BEL) of 12 dB is added to the calculation for the outgoing signal (when Shared Access is the interferer) and the ingoing signal (when Shared Access is the victim).

Intra-service technical coordination

There is a set coordination area per station type.[23] All stations of other licensees within these areas will be assessed in turn, while stations outside these areas will not be assessed.

No intra-service technical coordination is done for 26 GHz band Low Power indoor licences.

Propagation model ITU-R P.452-10 for 20% of time will be used for the I/N calculation. Terrain and clutter maps of 50-metre resolution are used as part of the path loss model.

For intra-service technical coordination, the interference analysis calculation will be based on the protection criteria test defined below. The technical parameters for the Shared Access deployments are based on the parameters given in Section "Technical Frequency Assignment Data".

Low Power Shared Access base station	Medium Power Shared Access base station
Test 1 for 1.8 GHz band and 2.3 GHz band: I/N = 1 dB and for 20% of time, assuming NF = 13 dB	Test 1 for 1.8 GHz band and 2.3 GHz band: I/N = 0 dB and for 20% of time, assuming NF = 10 dB
Test 1 for 3.8-4.2 GHz band: I/N = −5 dB and for 20% of time, assuming NF = 13 dB	Test 1 for 3.8-4.2 GHz band: I/N = −6 dB and for 20% of time, assuming NF = 10 dB

The noise power (N) value in the interference to noise (I/N) is thermal noise (kTB)[24] plus the equipment noise factor (NF):

$$N\ (dBm) = 10 \times \log10(kTB) + NF + 30$$

1.8 GHz band is FDD with the base station as transmit (Tx) on Upper Duplex and receive (Rx) on Lower Duplex. The licensing tool will model a virtual terminal at the base station location, it will be 2 m above ground, Tx on Lower Duplex and Rx on Upper Duplex for interference calculation.

Considerations for Low Power Shared Access licences

Low Power Shared Access licences are granted on a per area basis. The technical coordination procedures for Low Power Shared Access applications use the licence coordinates provided by the licensee.

The EIRP used for coordination is the maximum allowed EIRP per base station, with the addition of 2 dB.[25] This is to account for the base station being located anywhere within the circulate licence area with radius 50 m.

[23] See Annex A2 – "Coordination distances"

[24] kTB is the total thermal noise power (kTB) in Watts, it is a function of three quantities, (i) Boltzmann's constant "k" in Joules/˚K, (ii) temperature "T" is 290˚Kelvin, and (iii) the overall bandwidth "B" (Hz) of the channel

[25] For clarity, the EIRP (or TRP for 26 GHz) used for coordination of Medium Power Shared Access is that provided by the applicant, as shown in Section "Technical Frequency Assignment Data".

Similarly, the I/N protection criteria is increased by 1 dB compared to the Medium Power protection criteria, to account for 50 m radius licence area.

Shared Access transmit and receive mask for intra-service technical coordination

1.8 GHz band and 2.3 GHz band

A transmit and receive mask will not be used as there is only a single channel.

3.8-4.2 GHz band

Base station Tx mask and Rx mask for all channel bandwidth sizes[26]:

Offset from centre operational frequency (MHz)	Tx mask, relative emission level / Rx mask, relative selectivity (dBc)
-BW/2	0
0	0
BW/2	0

BW = Channel bandwidth (MHz)

26 GHz Band

No intra-service technical coordination is done for 26 GHz band Low Power indoor licences.

Interference calculation

Protection of Shared Access receivers

This section captures the methodology used for the assessment of the following interference scenarios:

f) Shared Access base station Tx (interferer) to Shared Access base station Rx (victim), co-channel[27] only.

i) Calculations are performed when the Shared Access base station (victim) carrier and the Shared Access base station (interferer) carrier are co-channel;

ii) When the Shared Access base station (victim) carrier and the Shared Access base station (interferer) carrier are not co-channel, interference will not be assessed.

[26] Our policy is that the NFD calculation should be based on the full (i.e. 2.5xBW) Tx and Rx masks. However, since we only coordinate in the co-channel case (i.e. when an interferer's assigned channel has some overlap with the victim's channel), in practice the NFD calculation gives the same result when using a perfect Tx and Rx masks (given here) compared to using the full Tx and Rx masks. Therefore, for simplicity, we have made the decision to implement perfect Tx and Rx masks in our licencing software. The licencing software assumes perfect relative emission level and perfect relative selectivity beyond the defined frequency offset, i.e. $-\infty$ for a frequency offset of more than BW/2 in this case.

[27] Throughout this document, "co-channel" refers to any case where the victim carrier and interferer carrier overlap (partially or fully), i.e. the frequency offset between victim and interferer centre frequencies, denoted f_V and f_I respectively, meets the condition $|f_V - f_I| < 0.5 \cdot (B_V + B_I)$, where B_V and B_I denote the bandwidths of the wanted and unwanted carriers respectively.

The potential Shared Access application will be tested as both the interferer and as the victim.

For the 26 GHz band no technical coordination is carried out.

Interference to noise calculation is described below in equation below.

$$\frac{I}{N} = \left(P_t + G_r + L_f - L_{prop} - NFD - A_d - BEL\right) - N$$

where

$\frac{I}{N}$ is the interference-to-noise ratio at the victim receiver in dB

P_t is the transmit power (EIRP) of the interfering system in dBm

G_r is the gain of the victim receiver towards the interfering system in dBi

L_f is the combined feeder and other losses of the receiver in dB

L_{prop} is the propagation loss between the interfering system and the victim receiver in dB (P.452)

NFD is the net filter discrimination in dB[28]

A_d is the antenna discrimination for the interfering system towards the victim receiver in dB

BEL is the additional attenuation for outgoing and incoming signals (indoor use only) in dB

N is the Noise power

Interference-to-Noise ($\frac{I}{N}$) ratios are evaluated at each receiver in the co-ordination zone.

The $\frac{I}{N}$ test must be satisfied at all assessed receivers in the co-ordination zone for a deployment to proceed. In practical terms this means that the unwanted signal level must be less than the interference threshold at the victim receiver. Interference calculations take account of antenna discrimination at both ends of the interference path, losses on the path and any Net Filter Discrimination available.

G_r (gain of the victim receiver towards the interfering system in dB) is calculated by determining the angle of arrival of the interfering signal to the victim receiver, and applying the victim antenna radiation pattern to the peak gain.

For protection of 1.8 GHz band low and medium power Shared Access base stations, 2.3 GHz band low power Shared Access base stations and 3.8-4.2 GHz low power Shared Access base stations, a 0 dBi omnidirection antenna pattern is assumed.

For protection of 3.8-4.2 GHz band medium power Shared Access base stations, a 0 dBi omnidirectional antenna pattern is assumed and the antenna gain as defined by the applicant (0-16 dBi max range).

A_d (antenna discrimination of the interfering system towards the victim receiver in dB) is calculated by determining the angle of transmission of the interfering signal towards the victim receiver.

[28] See Annex A3 – "Net Frequency Discrimination"

For 1.8 GHz band low and medium power Shared Access base stations, 2.3 GHz band low power Shared Access base stations and 3.8-4.2 GHz band low and medium power Shared Access base stations, a 0 dBi omnidirectional antenna pattern is assumed.

For indoor Shared Access deployments an attenuation (BEL) of 12 dB is added to the calculation for the outgoing signal (when the indoor Shared Access deployment is the interferer) and the ingoing signal (when the indoor Shared Access deployment is the victim).

National Coordination

The 3.8-4.2 GHz band will be coordinated with the MOD sites at GCHQ Bude and RAF Menwith Hill. A site protection threshold of -69 dBm / 5 MHz at 18 m AGL shall apply. Any station that would breach this threshold at these sites will be rejected.

International Coordination / MoU check

1.8 GHz band

Coordination check will be carried out for medium power licences in the 1.8 GHz band. Ofcom will either pass or fail the assignment if it breaches the limits in tables below:

Countries	Medium power threshold	Propagation model parameters
From the UK (England, Scotland, Northern Ireland) to France	37dBµV/m/3.3 MHz at 3m AGL for all points on the coastline of France	ITU-R P.1546-5 50% of time and 50% of locations
From the UK (England, Scotland, Northern Ireland) to the Republic of Ireland	37dBµV/m/3.3 MHz at 3m AGL for all points at the border or coastline of the Republic of Ireland	ITU-R P.1546-5 50% of time and 50% of locations
From the UK (England, Scotland, Northern Ireland) to the Isle of Man	37dBµV/m/3.3 MHz at 3m AGL for all points at the border or coastline of the neighbouring country	ITU-R P.1546-5 50% of time and 50% of locations

2.3 GHz band, 3.8-4.2 GHz band and 26 GHz band

No international coordination is done for 2.3 GHz band, 3.8-4.2 GHz band or 26 GHz band licences.

Technical Frequency Assignment Data

The following table outlines the technical data that is required to process the application.

Information type required for Technical Assignment / Coordination	Required from applicant	1.8 GHz (1781.7 – 1785 MHz/ 1876.7 – 1880 MHz)	2.3 GHz (2.39 – 2.40 GHz)	3.8-4.2 GHz (3.805 – 4.195 GHz)	26 GHz (24.25 – 27.5 GHz)
Licence Product	Yes	Low Power, or Medium Power	Low Power (only)	Low Power, or Medium Power	Low Power (only)
Station Coordinate	Yes	NGR or Latitude, Longitude	NGR or Latitude, Longitude	NGR or Latitude, Longitude	NGR or Latitude, Longitude
Antenna Location	Yes	Indoor, Outdoor	Indoor (only)	Indoor, Outdoor	Indoor (only)
Antenna Type	No	Omni	Omni	Omni	*N/A*
Low Power Transmit Antenna Gain[29]	No	0 dBi used for coordination	0 dBi used for coordination	0 dBi used for coordination	*N/A*
Low Power Receive Antenna Gain[30]	No	0 dBi used for coordination	0 dBi used for coordination	0 dBi used for coordination	*N/A*

[29] An omnidirectional antenna pattern is assumed in coordination, with transmit antenna gain accounted for in the transmit power (EIRP)
[30] An omnidirectional antenna pattern is assumed in coordination

Information type required for Technical Assignment / Coordination	Required from applicant	1.8 GHz (1781.7 – 1785 MHz/ 1876.7 – 1880 MHz)	2.3 GHz (2.39 – 2.40 GHz)	3.8-4.2 GHz (3.805 – 4.195 GHz)	26 GHz (24.25 – 27.5 GHz)
Medium Power Transmit Antenna Gain[31]	Yes	0 dBi used for coordination	*N/A*	0 dBi used for coordination	*N/A*
Medium Power Receive Antenna Gain[32]	Yes	0 dBi used for coordination	*N/A*	As per application 0-16 dBi max range	*N/A*
Medium Power Application Location: Rural or Urban	Yes	Yes	*N/A*	Yes	*N/A*
Low Power Indoor Base Station Antenna Height AGL	No	5 m height used for coordination purpose	5 m height used for coordination purpose	5 m height used for coordination purpose	*N/A*
Low Power Outdoor Base Station Antenna Height AGL	Yes	As per application 0-10 m max range	*N/A*	As per application 0-10 m max range	*N/A*
Medium Power Indoor Base Station Antenna Height AGL	Yes	As per application	*N/A*	As per application	*N/A*

[31] An omnidirectional antenna pattern is assumed in coordination, with transmit antenna gain accounted for in the transmit power (EIRP)
[32] An omnidirectional antenna pattern is assumed is coordination, with receive antenna gain as defined by the applicant accounted for in 3.8-4.2 GHz band medium power Shared Access base stations

Information type required for Technical Assignment / Coordination	Required from applicant	1.8 GHz (1781.7 – 1785 MHz/ 1876.7 – 1880 MHz)	2.3 GHz (2.39 – 2.40 GHz)	3.8-4.2 GHz (3.805 – 4.195 GHz)	26 GHz (24.25 – 27.5 GHz)
Medium Power Outdoor Base Station Antenna Height AGL	Yes	As per application 0-10 m max range *Note: Applications for antenna heights greater than 10 m AGL will be considered as exceptions*	*N/A*	As per application *Note: Applications for antenna heights greater than 10 m AGL in urban locations will be considered as exceptions*	*N/A*
Terminal Antenna Height AGL, used for the purpose of intra-service coordination	No	2m	*N/A*	*N/A*	*N/A*
Bandwidth	Yes	*N/A* *There is only a single bandwidth available, 2x3.3 MHz FDD channel, in the 1.8 GHz band*	*N/A* *There is only a single bandwidth available, 10 MHz TDD channel, in the 2.3 GHz band*	10, 20, 30, 40, 50, 60, 80 and 100 MHz channels	50, 100 and 200 MHz channels
Equipment tuning range	No	*N/A*	*N/A*	Start and end frequency in MHz	Start and end frequency in MHz
Low Power EIRP[33]	No	24 dBm / 3 MHz + 2 dB	24 dBm / 10 MHz + 2 dB	24 dBm per carrier + 2 dB for carriers ≤ 20 MHz; 18 dBm / 5 MHz + 2 dB for carriers > 20 MHz	*N/A*

[33] As described in the "Frequency Assignment: inter-service technical coordination" and "Frequency Assignment: intra-service technical coordination" Sections of this document, the EIRP used for coordination of Low Power Shared Access licences is the maximum allowed EIRP per base station, with the addition of 2 dB.

Information type required for Technical Assignment / Coordination	Required from applicant	1.8 GHz (1781.7 – 1785 MHz/ 1876.7 – 1880 MHz)	2.3 GHz (2.39 – 2.40 GHz)	3.8-4.2 GHz (3.805 – 4.195 GHz)	26 GHz (24.25 – 27.5 GHz)
Low Power TRP[34]	No	*N/A*	*N/A*	*N/A*	25 dBm / 200 MHz + 2 dB
Medium Power EIRP	Yes	As per application 42 dBm / 3 MHz max	*N/A*	As per application 42 dBm per carrier max for carriers ≤ 20 MHz; 36 dBm / 5 MHz max for carriers > 20 MHz	*N/A*
Medium Power TRP	No	*N/A*	*N/A*	*N/A*	*N/A*

[34] As described in the "Frequency Assignment: inter-service technical coordination" and "Frequency Assignment: intra-service technical coordination" Sections of this document, the TRP used for coordination of Low Power Shared Access licences is the maximum allowed TRP per base station, with the addition of 2 dB.

Channel Plan Design

The 1.8 GHz band has a single 2 x 3.3 MHz channel, which is lower duplex (terminal transmit) 1.7817 – 1.785 GHz and upper duplex (base station transmit) 1.8767 – 1.880 GHz.

The 2.3 GHz band has a single 10 MHz channel centred on 2.395 GHz.

Our channel plan for 3.8-4.2 GHz is below. In the case of the larger bandwidths, we will have channels that overlap with a 10 MHz offset. Whilst multiple overlapping channels will not be usable within the same area, this approach will give us the most flexibility when assigning frequencies to be able to avoid those frequencies used by earth stations, fixed links or UK Broadband base stations within a given area. We do not allocate spectrum in the bottom and top 5 MHz blocks of the band, therefore the actual available band is 3.805 – 4.195 GHz.

f_n is the centre frequency (MHz) of a radio-frequency channel in the band; and individual channel frequencies are expressed by the following relationships:

a) For systems with a carrier spacing of 10 MHz:
   $f_n = 3805 + ((2n-1)/2)*10$ MHz
   where n = 1, …39

b) For systems with a carrier spacing of 20 MHz:
   $f_n = 3805 + ((2n-1)/2)*20$ MHz
   where n = 1, …19

c) For systems with a carrier spacing of 30 MHz:
   $f_n = 3805 + ((2n-1)/2)*30$ MHz
   where n = 1, …13

d) For systems with a carrier spacing of 40 MHz (overlapping channel arrangement with a 10 MHz step):
   $f_n = 3825 + (n-1)*10$ MHz
   where n = 1, …36

e) For systems with a carrier spacing of 50 MHz (overlapping channel arrangement with a 10 MHz step):
   $f_n = 3830 + (n-1)*10$ MHz
   where n = 1, …35

f) For systems with a carrier spacing of 60 MHz (overlapping channel arrangement with a 10 MHz step):
   $f_n = 3835 + (n-1)*10$ MHz
   where n = 1, …34

g) For systems with a carrier spacing of 80 MHz (overlapping channel arrangement with a 10 MHz step):
   $f_n = 3845 + (n-1)*10$ MHz
   where n = 1, …32

h) For systems with a carrier spacing of 100 MHz (overlapping channel arrangement with a 10 MHz step):
   $f_n = 3855 + (n-1)*10$ MHz
   where n = 1, …30

Our channel plan for 26 GHz (24.25 – 26.5 GHz) is provided below. [35]

f_n is the centre frequency (MHz) of a radio-frequency channel in the band; and Individual channel frequencies are expressed by the following relationships:

a) For systems with a carrier spacing of 50 MHz:
   $f_n = 24225 + (n)*50$ MHz
   where n = 1, …45

b) For systems with a carrier spacing of 100 MHz:
   $f_n = 24250 + (n)*100$ MHz
   where n = 1, …22

c) For systems with a carrier spacing of 200 MHz:
   $f_n = 24200 + (n)*200$ MHz
   where n = 1, …11

[35] 24.25 GHz – 24.45 GHz (200 MHz) is closed for Ministry of Defence (MOD) use, this means the first: 5x50 MHz, 2x100 MHz, 1x200 MHz, 1x400 MHz, 1x800 MHz are not available for Shared Access.

Band Specific Issues

Band specific issues are listed below:

Band	Description
1.8 GHz band	As there is a single bandwidth available in this band, all base stations are treated as co-channel assuming the carrier power is spread across a 3 MHz bandwidth, even if they are using only a portion of the available bandwidth; Not available in Isle of Man or Channel Islands; It's possible that users of the shared spectrum could experience periodic interference from MoD use of this band in some locations. This could happen near three specific sites: RAF Colerne in Wiltshire, RAF Oakhanger in Hampshire, and RAF Menwith Hill in North Yorkshire. We consider the risk of interference to be very low.
2.3 GHz band	This band is currently only available for low power indoor use; Not available in Isle of Man or Channel Islands; and Users of this band should be aware that the band is shared by amateur radio users. These uses are mainly temporary, and we expect the risk of interference to be very small. However, it is possible that Shared Access licence users in this band could experience interference from amateur radio users, as Ofcom does not coordinate these. If you do receive interference to your licensed equipment, you can report this to Ofcom – although it should be noted that Ofcom cannot guarantee spectrum will always be free of interference.
3.8 – 4.2 GHz band	Not available in Isle of Man or Channel Islands
26 GHz band	This band is currently only available for low power indoor use; Not available in Isle of Man or Channel Islands;

Supplementary Notes

Maximum power of Radio Equipment outside the Permitted Frequency Channel

1.8 GHz band

When transmitting, the Licensee must transmit within the limits set out below.

Frequency offset from the lower frequency of the band edge	Maximum mean EIRP density
-6.2 to -3.2 MHz	-55 dBm / kHz
-3.2 to 0 MHz	-45 + 10 x (Δ_{FL}*+ 0.2)/3 dBm / kHz
Frequency offset from the upper frequency of the band edge	**Maximum mean EIRP density**
0 to 0.05 MHz	-23 – 60 x Δ_{FH}* dBm / kHz
0.05 to 0.1 MHz	-26 – 153.3 x (Δ_{FH}* - 0.05) dBm / kHz
0.1 to 2.8 MHz	-45 - 10 x (Δ_{FH}* + 0.2)/3 dBm / kHz
2.8 to 5.8 MHz	-55 dBm / kHz

ΔFL in MHz is the offset from the lower edge of the permitted frequency band at 1876.7 MHz (it has values in the range -3.2 to 0 MHz)
ΔFH in MHz is the offset from the upper edge of the permitted frequency band at 1880 MHz (it has values in the range 0 to 2.8 MHz)

2.3 GHz band

When transmitting, the Licensee must transmit within the limits set out below.

Frequency offset from the Permitted Channel edge	Power
-5 to 0 MHz offset from lower Permitted Channel edge **0 to 5 MHz offset from upper Permitted Channel edge**	(PMax – 40) dBm / 5 MHz EIRP per antenna
-10 to -5 MHz offset from lower Permitted Channel edge **5 to 10 MHz offset from upper Permitted Channel edge**	(PMax – 43) dBm / 5 MHz EIRP per antenna
< -10 MHz offset from lower Permitted Channel edge **> 10 MHz offset from upper Permitted Channel edge**	(PMax – 43) dBm / 5 MHz EIRP per antenna

In addition, the EIRP emanating from the Radio Equipment transmissions at any frequency outside the Permitted Channel shall not exceed the following additional requirements:

Frequency	Power
2400-2403 MHz	(PMax – 40) dBm / 5 MHz EIRP per antenna

Frequency	Power
Above 2403 MHz*	−17 dBm / 5 MHz EIRP**

*The limit defined above 2403 MHz given here takes precedence over the limits defined previously
**The maximum mean power relates to the EIRP of a specific piece of Radio Equipment irrespective of the number of transmit antennas.

The licensee's base stations must transmit within the limits of transmission Frame Structure A, except for indoor base stations. If indoor base stations cause undue interference to the licensee in the 2350-2390 MHz band, we reserve the right to require the indoor base stations to transmit within the limits of transmission Frame Structure A.

Frame Structure A means:

- timeslots (or subframes) 0, 2 to 5 and 7 to 9 must be allocated to Downlink (D) or Uplink (U) transmissions as indicated or may be left with no transmissions;
- the Licensee must ensure that the special subframe (S) in timeslots 1 and 6 has a structure that is compatible with TD-LTE special subframe configuration 6, also known as 9:3:2;
- all timeslots must be 1 millisecond in duration and the frame must start at a common reference time so that frames are aligned with licensee(s) that hold a Spectrum Access licence in 2350-2390MHz and transmissions synchronised; and
- TD-LTE frame configuration 2 (3:1) is compatible with this frame structure. Other technologies are permitted provided that the requirements are met.

Frame Structure A

DL/UL ratio	Subframe number									
	0	1	2	3	4	5	6	7	8	9
3:1	D	S	U	D	D	D	S	U	D	D

3.8–4.2 GHz band

When transmitting, the Licensee must transmit within the limits set out below.

Frequency offset from the Permitted Channel edge	Power
-5 to 0 MHz offset from lower channel edge **0 to 5 MHz offset from upper channel edge**	(PMax – 40) dBm / 5 MHz EIRP per antenna
-10 to -5 MHz offset from lower channel edge **5 to 10 MHz offset from upper channel edge**	(PMax – 43) dBm / 5 MHz EIRP per antenna
Out of channel baseline power limit (BS) **< -10 MHz offset from lower channel edge** **> 10 MHz offset from upper channel edge**	(PMax – 43) dBm / 5 MHz EIRP per antenna

In addition, the EIRP emanating from the Radio Equipment transmissions at any frequency outside the Permitted Frequency Channel shall not exceed the following additional band edge requirements:

Frequency	Power
3795 MHz – 3800 MHz **4200 MHz – 4205 MHz**	(PMax – 40) dBm / 5 MHz EIRP per antenna
3760 MHz - 3795 MHz **4205 MHz – 4240 MHz**	(PMax – 43) dBm / 5 MHz EIRP per antenna
Below 3760 MHz **Above 4240 MHz**	-2 dBm / 5 MHz EIRP per antenna

26 GHz band

When transmitting, the Licensee must transmit within the limits set out below.

Frequency offset from the lower and upper frequency of the channel edge	Maximum base station power (TRP)
Up to 50 MHz	12 dBm / 50 MHz
Beyond 50 MHz	4 dBm / 50 MHz
Within the frequency band 23.6 – 24 GHz	-39 dBW / 200 MHz
	Maximum terminal station power (TRP)
Within the frequency band 23.6 – 24 GHz	-35 dBW / 200 MHz

A1 Separation distances

Separation distance for the 3.8-4.2 GHz band and 26 GHz band, are summarised below:

New user	Existing user	
	Low power (indoor)	Fixed Links
3.8-4.2 GHz band Low and Medium Power base stations	*N/A*	500 m
26 GHz Low Power (Indoor)	100 m	*N/A*

A2 Coordination distances

Ofcom's licensing tool will apply band-specific coordination distances for candidate transmitting stations. The table below provides coordination distance per band and product type.

Band	1.8 GHz		2.3 GHz	3.8-4.2 GHz	
Service	Shared Access Low Power	Shared Access Medium Power	Shared Access Low Power	Shared Access Low Power	Shared Access Medium Power
Coordination Radius with Fixed Links, PES and UK Broadband (inter service)	N/A	N/A	N/A	287 km	287 km
Coordination Radius with other Shared Access Low Power	20 km	115 km	20 km	20 km	115 km
Coordination Radius with other Shared Access Medium Power	115 km	115 km	N/A	115 km	115 km

A3 Net Frequency Discrimination

Calculation of Net Frequency Discrimination

The Net Filter Discrimination, or NFD, available between victim and interfering stations is used to adjust the predicted interfering signal level incident to the victim receiver, accounting for the frequency offset between the unwanted and wanted system, the Tx mask of the unwanted system and the Rx mask of the wanted system.

For Fixed Links, ETSI Out-of-Band masks are used to characterise the unwanted signal and the wanted receiver mask is derived using the 'conservative' method set out in ETSI TR 101 854. Default masks are employed in cases where legacy equipment cannot be mapped to the modern ETSI Standard.

For PES, the wanted receiver mask is as agreed by the FSS earth station operator, the satellite operators' requirements and Ofcom, with the mask for each licence given in our licencing tool.

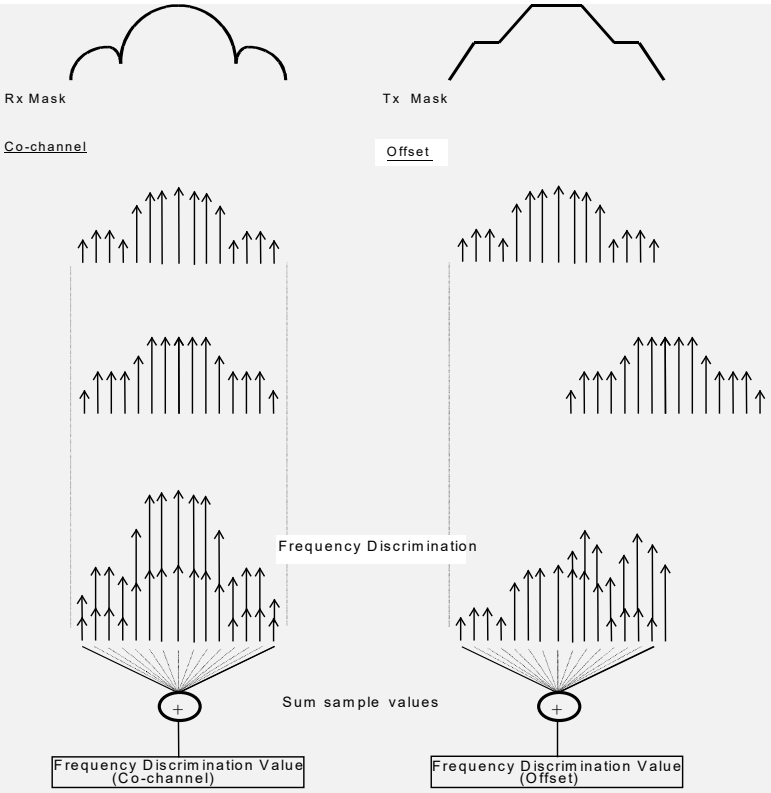
For UK Broadband, the Out of Block emission requirements defined in UK Broadband's 3.9 GHz Spectrum Access Licence are used to characterise the unwanted signal, and the wanted receiver mask is also derived from these Out of Block emission requirements.

For Shared Access, the unwanted signal and receiver masks are defined in the "Frequency Assignment: inter-service technical coordination" and "Frequency Assignment: intra-service technical coordination" Sections of this document.

The two masks are sampled 'on the fly' and the NFD calculated using equation below:

$$NFD = 10\log\left[\frac{\sum_{i=0}^{i=n-1} 10^{\left(\frac{U_i+W_i}{10}\right)}}{\sum_{i=0}^{i=n-1} 10^{\left(\frac{U_{i(offset)}+W_i}{10}\right)}}\right] (\text{dB})$$

Where U_i and W_i are values sampled from the unwanted and wanted signal masks set co-frequency, U_i are samples from the unwanted mask offset in frequency from the victim receiver and n is the number of samples taken from the wanted and unwanted masks. The process is illustrated in NFD concept below:



The maximum value for NFD, termed NFD_{max} given by equation below:

$$NFD_{max} = \frac{W}{U} + 40(\text{dB})$$

This facilitates a lower bound for $\frac{W}{U} = 40$ dB.

A4 Document history

Version	Date	Changes
1.0	9 December 2019	Published
1.1	16 April 2020	Edited section 3 and 4 for EIRP clarification
1.2	16 September 2022	Amending the out-of-band emissions as per our statement to implement the harmonised limits and removing the 1 km exclusion zones around Jodrell Bank and Cambridge radio astronomy sites.
2.0	2 December 2024	Document refresh for clarity and completion. Technical updates accounting for those decisions made in the July 2024 Statement which are being implemented immediately as described in December 2024 Statement https://www.ofcom.org.uk/siteassets/resources/documents/consultations/category-1-10-weeks/consultation-supporting-increased-use-of-shared-spectrum/associated-documents/statement-enhancing-the-shared-access-framework.pdf