OfW 49
Fixed Point-to-Point and Point-to-Multipoint Scanning Telemetry Radio Services Operating in the Frequency Ranges 457.5 to 458.5 MHz paired with 463.0 to 464.0 MHz

Published: May 2017
Version: 3.0

Foreword

The Wireless Telegraphy Act 2006 request that only radio apparatus that the Office of Communications (Ofcom) has authorised a licence for can be installed and used in the United Kingdom. This is under the condition that the radio equipment meets certain minimum standards set in the Interface Requirement 2037 (IR 2037).

This document details the technical frequency assignment criteria and principles that Ofcom has employed in the selected frequencies for use by compliant fixed terrestrial (point-to-point and point-to-multipoint) analogue radio equipment operating in the specified band or frequency range. It is further used for the basis of assessing both 1) new link applications and 2) treating technical reconfiguration of links on application form OfW 113 for scanning telemetry links.

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Section 1

Contents

Section 1

General

1.1 Introduction

This document outlines the technical frequency assignment criteria and principles that Ofcom will employ when selecting frequencies for fixed terrestrial (point-to-point and point-to-multipoint) analogue and digital radio services operating in the frequency band 457.5 to 458.5 MHz paired with 464.0 to 465.0 MHz.

Please refer to section 5 for the applied channel plan.

1.2 Licensee's responsibility

The establishment, use or installation of transmitting or receiving apparatus is subject to the issue of a licence by Ofcom. The licensee must ensure that equipment conforms with and is kept to the requirements referenced in UK IR 2037.

1.3 Minimum path length policy

Please see section 4.5.

1.4 References

Ref. No:	Title	Author	Year
1	Void		
2	Radio Interface Requirements 2037 – Scanning telemetry and telecontrol Systems operating in the frequency band 457.5 to 465.0 MHz in which spectrum managed by Ofcom. (EC Notification Number:2001/130/UK)	Ofcom	2001
3	The Future of UHF Scanning telemetry and telecontrol Frequency Assignments - A report for DTI, Joint Radio Committee (JRC) and Technical Advisory Group (TAG)	Ofcom	January 1989

Section 2

Channel Information

2.1 Adaptable cellular plan

The Adaptable Cellular Plan (Adaptable Channel Plan) was devised as a means of maximising the use of the scanning telemetry and telecontrol band and providing a defined planning and frequency co-ordinating environment for the major utilities of scanning telemetry and telecontrol; namely the Gas, Electricity and Water industries. A full description and discussion of the Adaptable Cellular Plan is given in the reference [3].

The UHF scanning telemetry and band comprises of 80 channels, 72 of which are reserved for use with the Adaptable Cellular Plan. The 72 channels are arranged on a twelve cell, six channels per cell, regular frequency re-use plan. Each of the three utilities has access to two exclusive channels per cell. Eight channels (T73 to T80) are reserved for other users of scanning telemetry services and these are not subject to the Adaptable Cellular Plan.

The use of alternative planning and frequency co-ordination strategies by one or more of the aforementioned utilities, within their own allotted channels is permitted by Ofcom, providing that prior agreement is achieved and its effectiveness over the present arrangement can be adequately demonstrated.

The basic parameters of the plan, are:

- system availability approaching 99·9%;
- four classes of outstation, based upon their data transmission speeds and C/I ratio (see table 5).
- cell radii of 25 km, but outstations with path lengths of up to 30 km are allowed in the first instance, with longer paths permitted on a case-by-case basis.
- 6 channels per cell, giving 2 channels per utility;
- 12 cells per cluster, giving a co-channel re-use distance of 150 km; and
- potential channel re-uses of 23 times across the UK.

The distribution of channels between the three major utility operators of scanning telemetry systems on a per cell basis is shown in Table 1 below:

Cell	Gas		Electricity		Water	
	Ch.1	Ch.2	Ch.1	Ch.2	Ch.1	Ch.2
A	57	59	3	12	44	47
B	69	65	32	6	21	36
C	48	50	29	40	31	56
D	49	51	13	24	14	16
E	64	66	27	7	30	37
F	60	62	41	25	35	45
G	70	72	10	11	19	17
H	61	63	9	34	38	46
J	52	54	23	28	5	15
K	67	58	2	33	1	39
L	68	71	8	26	20	43
M	53	55	4	42	18	22

Table 1: Distribution of channels between the three major utility operators

The cellular re-use strategy is illustrated in figure 1 and the cell centres are listed in Annex F.

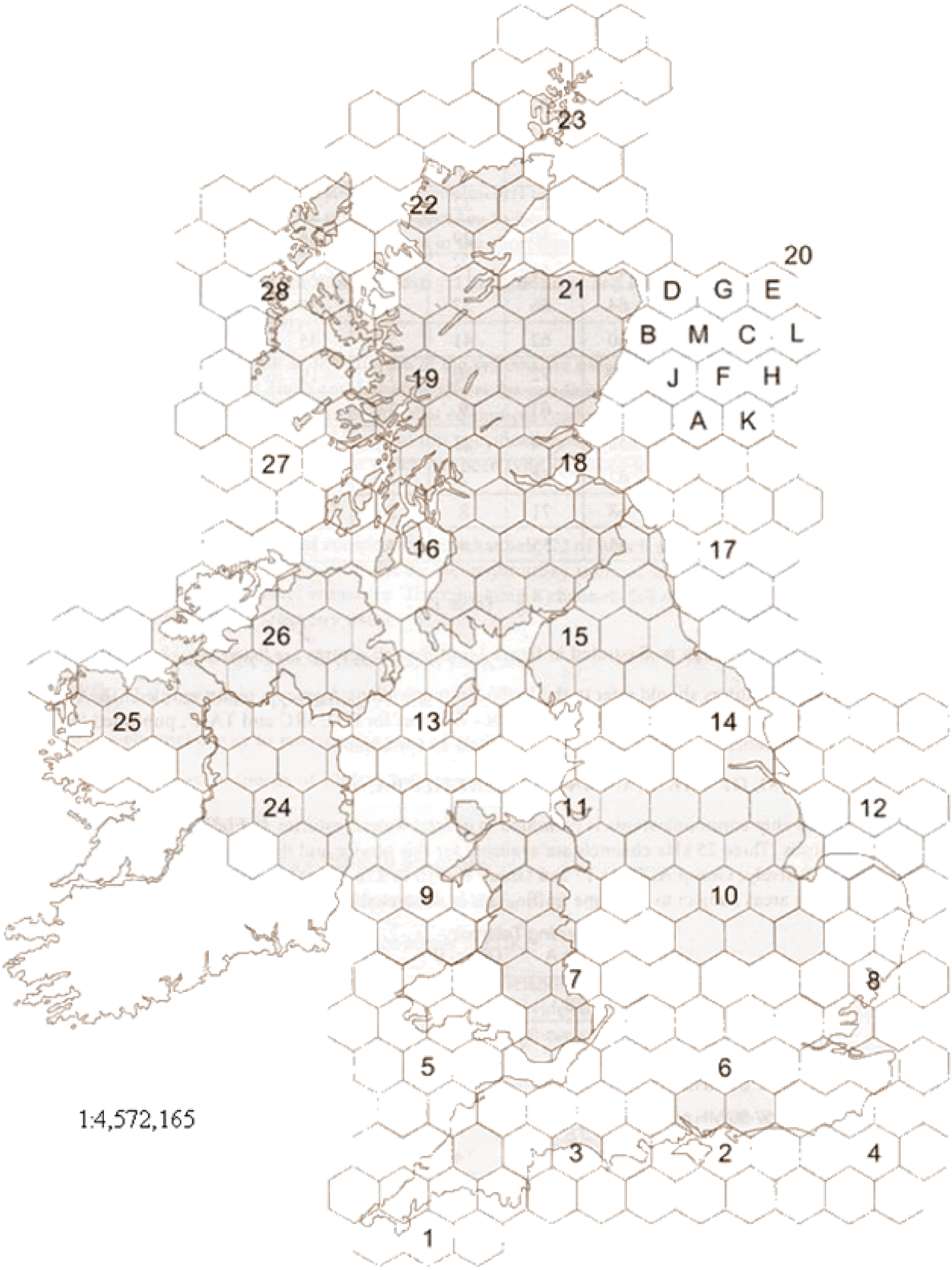


Figure 1: UK Cellular Plan for Scanning Telemetry and Telecontrol Services for the Utilities.

2.2 Maritime use of the Scanning Telemetry and Telecontrol band

The use of on-ship communications is permitted in coastal waters, estuaries and tidal rivers for maritime safety purposes. Three 25 kHz channels are available for this service and these encompass the following channels inclusively; T2 to T7. Consequently, these channels may not be assigned in areas subject to maritime traffic. Table 3 below shows the maritime channels in relation to the standard 12.5 kHz channel plan. See clause 4.2 for further details.

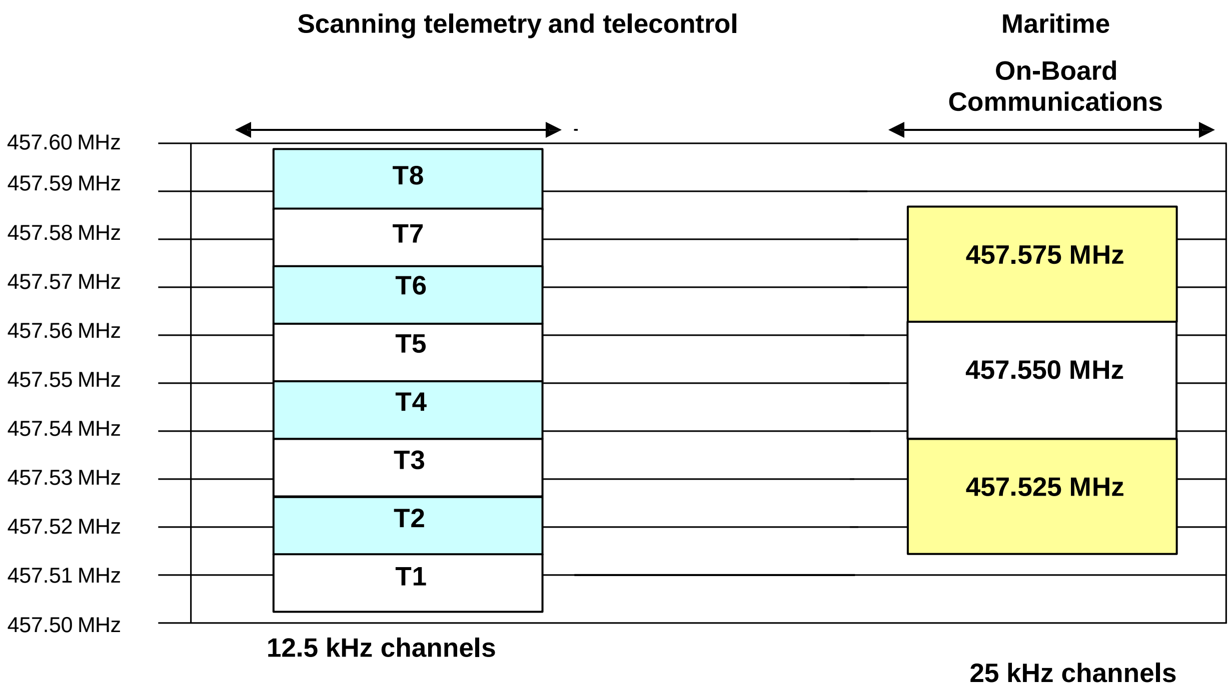


Table 3: 25 kHz Maritime channels in relation to the 12.5 kHz channel plan

Notes: * New maritime channels (UK, as defined by Ofcom)

New maritime channels (International, as defined by the ITU-R)

Section 3

Transmitting and Receiving Installations

3.1 General

The installations shall be in accordance with good engineering practice and conform to the advice within this document.

3.2 Antennas

The primary concern is for the transmitting antenna of a station, since radio emissions have the greatest potential to affect other users. In principle, it will be possible to use any antenna, or configuration of antennas for receive purposes without needing type approval, providing it can be co-ordinated with both co-channel and adjacent channel users, and meets the cross-polar rejection requirement. This should also extend to the use of more complex arrangements, such as passive or active cancellation techniques for the rejection of unwanted co-channel signals. The receive antenna configuration and its radiation pattern will however need to be registered with Ofcom, and acceptance for registration will still depend on successful frequency co-ordination with other co-channel systems. Note that frequency assignments will be made on the assumption that all antennas comply with the parameters described in the clauses below.

3.2.1 Antenna directivity

The co-polarised and cross-polarised directivity of an individual antenna installed at the licensed premises shall be such that the effective isotropic gain in the horizontal plane (0° elevation) at any azimuth does not exceed the value specified in reference [2].

3.2.2 Directional antenna arrays

Complex directional arrays of type approved antennas will be considered on a case-by-case basis.

3.2.3 Antenna nulling techniques

Active and passive antenna nulling techniques and their arrays will be considered on a case-by-case basis.

3.2.4 Antenna discrimination

When assigning frequencies, which are in use in the same geographical area, due consideration shall be taken of the antenna discrimination available where this is deemed possible.

3.2.5 Antenna polarisation

The emissions' polarisation plane will be specified by Ofcom for each radio link.

It will normally be vertical or horizontal linear polarisation.

The antenna alignment surface will be as precise as possible to the true vertical or true horizontal.

The misalignment will be limited to 1.5°.

3.2.6 Mixed polarisation systems

The use of vertical transmit and horizontal receive polarisation at the scanner for the purpose of improving system resilience is permitted. The use of mixed polarisation receive antenna systems at the scanner for unusual circumstances, e.g. due to re-direction of outstations, is permitted. A typical example would be the normal system being vertically polarised, perhaps a more distant, possibly re-directed, outstation being ‘pulled-in’ by means of a horizontally polarised, with say twelve element, Yagi antenna. Such scenarios will be considered on a case-by-case basis.

3.2.6.1 Horizontal polarisation

The use of horizontal polarisation can be of benefit in a number of circumstances; whether this is for receive purposes only, where separate transmit and receive antennas are used at all sites in the system, or for combined transmit and receive where shared antennas are used. The former would result in a mixed polarisation scheme.

The use of horizontal polarisation can give between 6 dB and 15 dB polar discrimination protection against the interfering signal. Operators in the south east of England have found this to be particularly beneficial. However, the longer the path length of the interfering signal, the more likely it is to suffer greater depolarisation and hence the lower protection figure may apply. However, care needs to be exercised in areas of flat terrain as excessive ground reflections may occur. Such scenarios will be considered on a case-by-case basis.

3.2.6.2 Choice of outstation antenna

A 12-element Yagi is the minimum specification outstation antenna from the viewpoint of frequency management, spectrum conservation and good engineering.

Other antennas may be considered where appropriate and their possible use is discussed in section 6.

Ofcom will encourage any operator to use the higher performance antennas, such as an 18 element Yagi antenna with a forward gain of 16·7 dBi. These antennas will be particularly useful for re-directed outstations.

3.2.7 Specification Limits

It is assumed for planning purposes that the antenna meets the minimum requirements specified in Table 4 below.

Antenna	Type	Limits
Base Station	Omni-directional	The radiation pattern when measured in azimuth shall not vary by more than ± 1.5 dB for horizontally and vertically polarised antennas.
Base Station	Sector coverage	See Figure 2
Outstation	Directional	See Figures 3 and 4

Table 4: Antenna Radiation Pattern Envelope Limits

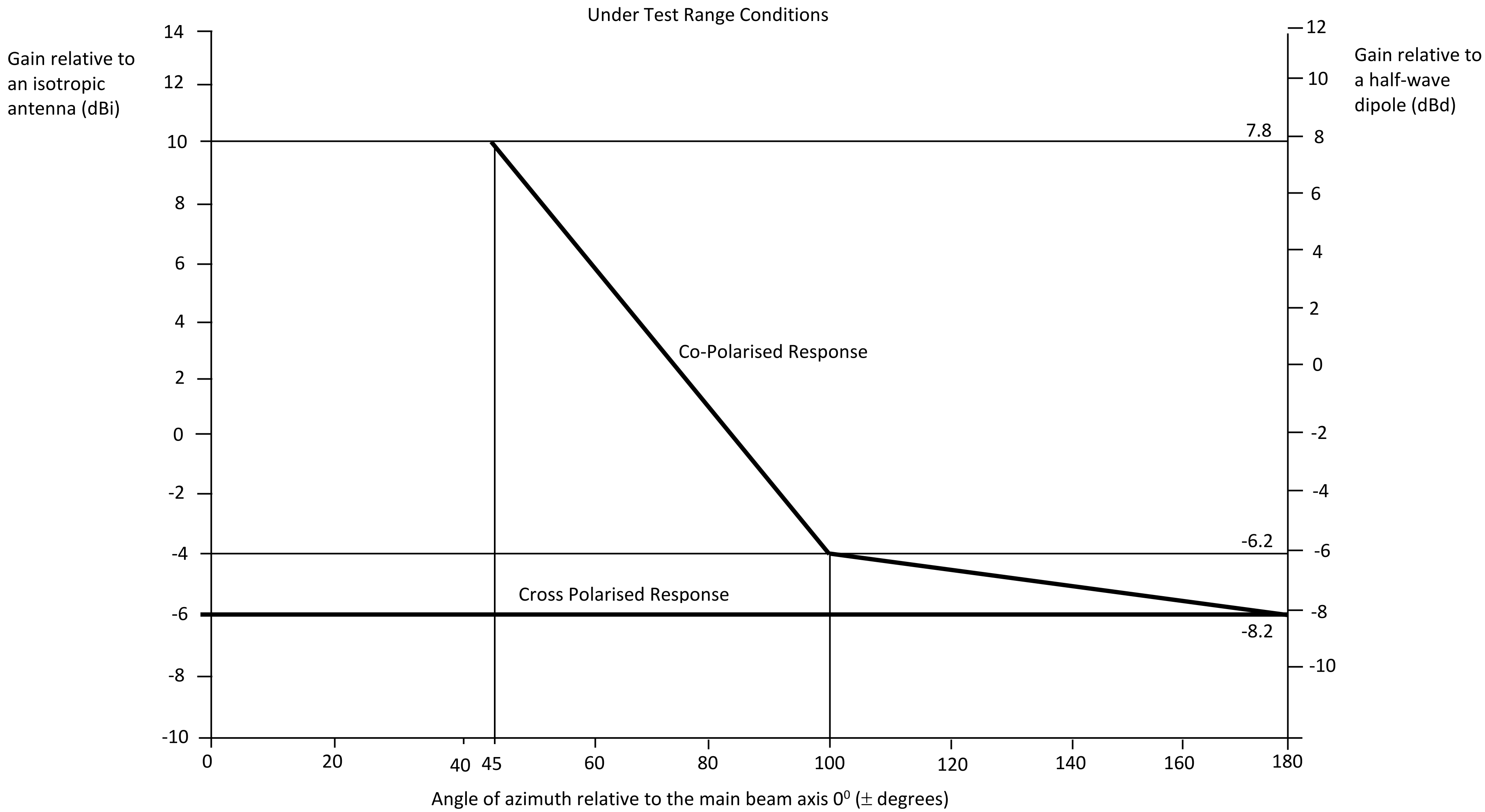


Figure 2: Sector Antenna Radiation Pattern Envelope for Base Stations

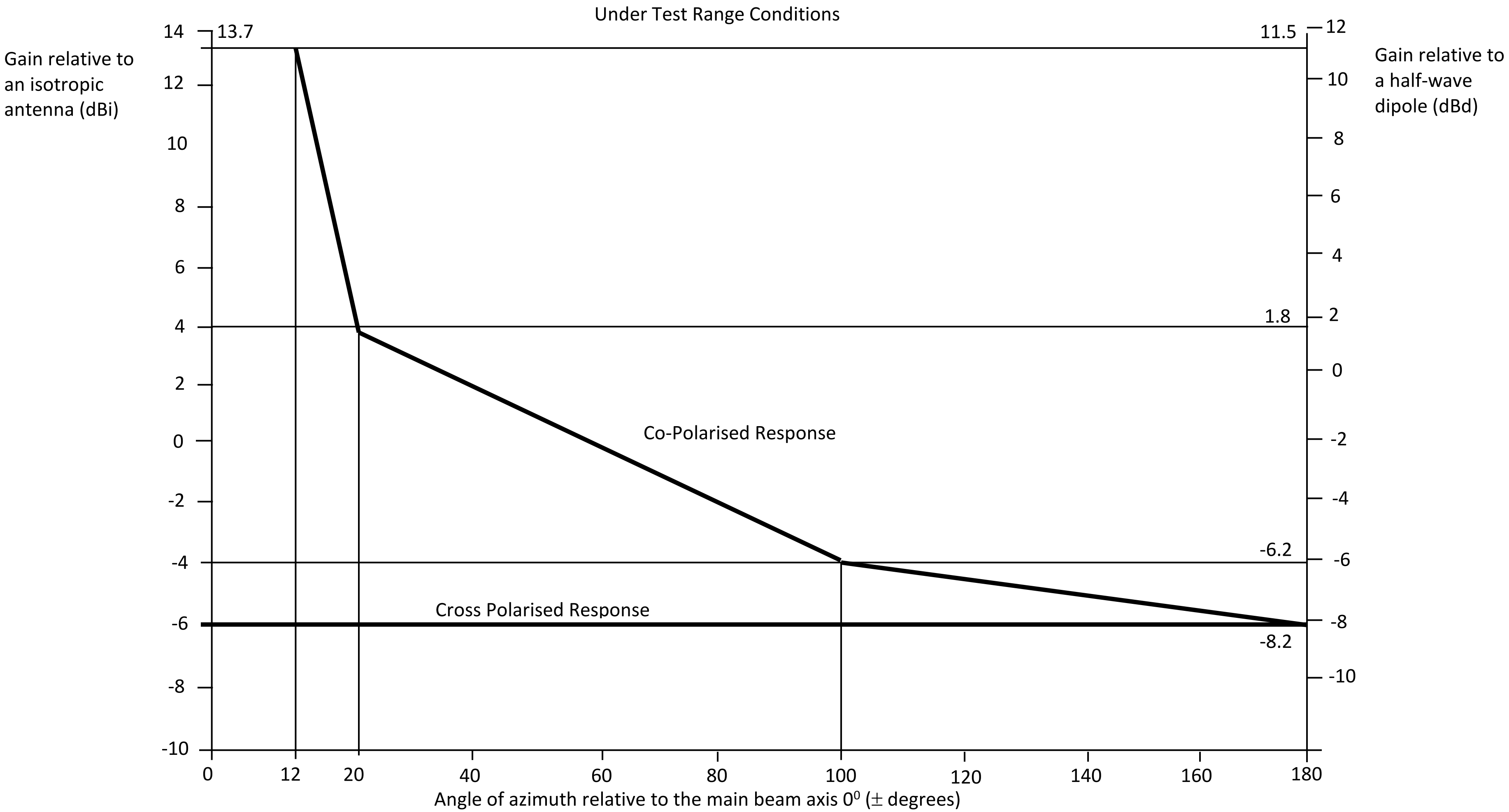


Figure 3: Antenna Radiation Pattern Envelope for Outstations – High Performance Antenna

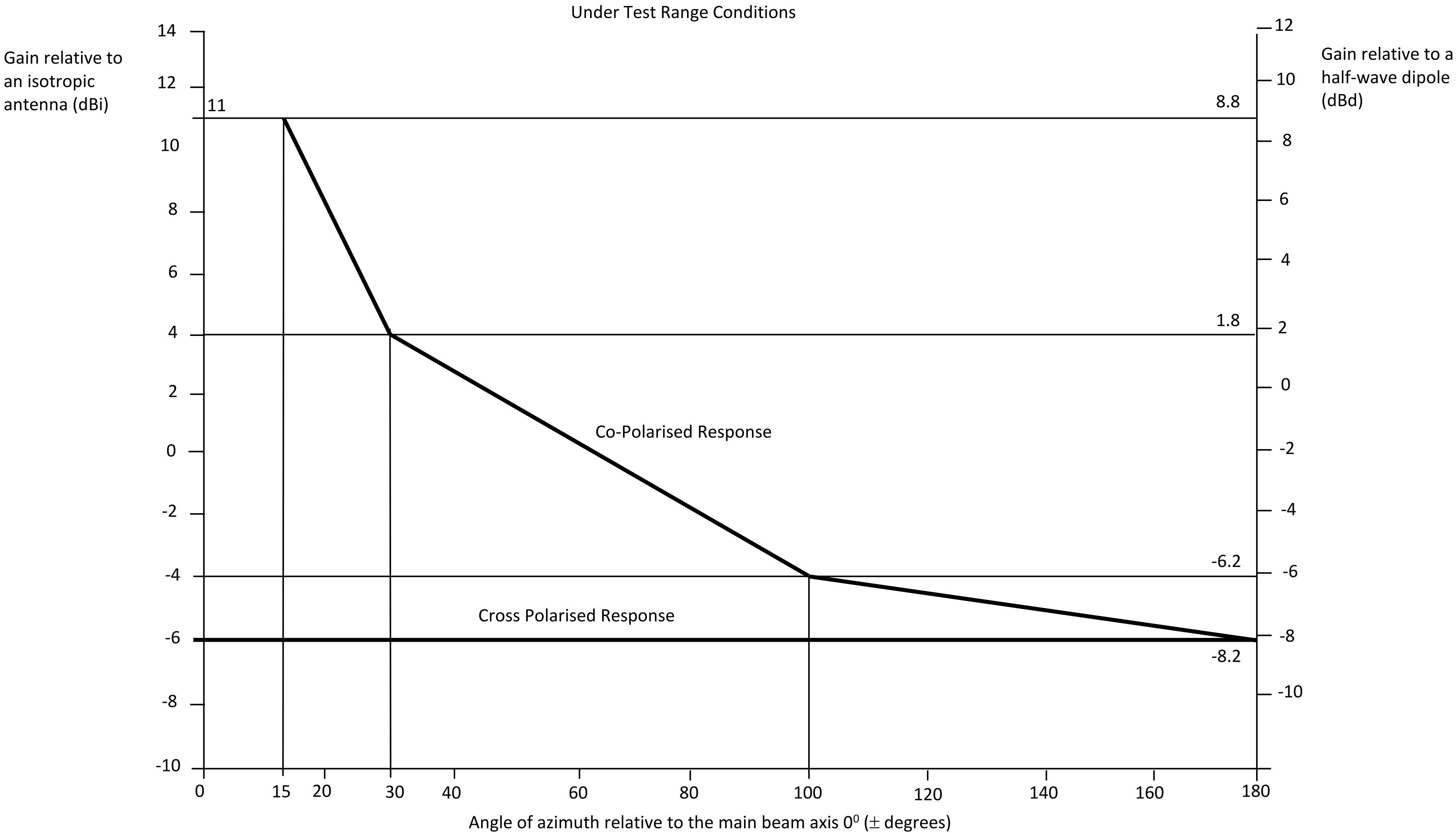


Figure 4: Antenna Radiation Pattern Envelope for Outstations – standard antenna

Section 4

Principles of Assignment and EIRP Derivation

4.1 Background

In the interest of economy of use of the radio frequency spectrum and of limiting interference between different radio transmissions, it is the responsibility of Ofcom to decide the frequency assignment, the limits of EIRP and other engineering characteristics to be permitted under the licence for each separate or group of radio installations.

Factors, which may affect the most suitable frequency, include the antenna polarisation, antenna heights, and the end-to-end circuit loss of potential interference paths, together with the Adaptable Channel Plan. An assessment may also include site inter-modulation products etc, before the final frequency assignment is decided. Furthermore, when assigning frequencies in the same geographical area, due consideration is given to available antenna discrimination when this is deemed possible.

4.2 Frequency channelling

The bands 457·5 to 458·5 MHz and 463·0 to 464·0 MHz may be considered as a lower half band "L" and an upper half band "H" respectively.

A frequency assignment will generally comprise of a channel comprising a pair of transmit frequencies. One frequency chosen from the "L" half band will be assigned to the base station (scanner) and the corresponding frequency from the "H" half band to the outstation.

The frequency difference between two adjacent channels in both the "L" and "H" half bands will be 12·5 kHz and the difference between a pair of corresponding "L" and "H" channels will be 5·5 MHz (See Annex A).

Wherever possible frequency re-use will be employed. In the case of channels T1 to T72, this will be in accordance with the Adaptable Cellular Plan where possible. Please refer to Table 1.

A total of 15 channels have been identified as nominally interference free on account of their offset from adjacent continental cellular radio channels. Where feasible, the scanners in interference prone areas will be assigned on these channels. However, there can be no guarantee that any channel will remain free from continental interference in the future.

These channels are;

2, 7, 10, 15, 18, 23, 26, 31, 34, 39, 42, 47, 58, 63 and 74.

Channels shared with the Maritime Service will not be assigned in coastal areas and estuaries. These channels are shown in Table 3.

4.3 Co-channel interference limits

Ofcom will, as far as possible, assign frequencies on the basis that a wanted Carrier to Co-Channel Interference ratio (C/I) from table 5 relating to the applicable class of outstation . Which in normal circumstances, for a single unwanted source at the receiver input, should not exceed -144 dBW for 99·9% of the time.

For co-ordination purposes, the EIRP is that radiated in the horizontal plane (0° elevation).

It is important that the wanted Carrier to Co-Channel Interference (C/I) ratio between the existing co-channel operators and the applicant's systems should be maintained. The applicant's EIRP's should not degrade the co-channel operators' C/I ratios, however it may be that an acceptable degradation could be negotiated with the co-channel operator(s) which will permit increased EIRP's for the applicant. It will be the applicant's responsibility to demonstrate that a satisfactory agreement has been reached with the co-channel operator(s).

Outstation Class	Data Rate (kBit/s)	Sensitivity 10^{-2} (dBm)	Unfaded Signal (dBm)	Faded signal (dBm)	C/I ratio (dB)
1	9.6	-110	-92	-102	22
2	16	-105	-87	-97	27
3	38	-98	-80	-90	34
4	>38	-93	-75	-85	39

Table 5: Outstation class, Receiver parameters and C/I ratio

a. Channel selection and assignment

For applicants, other than the Gas, Electricity and Water Industries, the choice of frequency to be assigned to the system(s) will depend on the ability of Ofcom to co-ordinate a channel, selected from within channels T73 to T80, with existing co-channel operators. In the case of a multi-site scheme, the re-use of a chosen frequency within the scheme may be necessary.

In the case of the Gas, Electricity and Water Industries, the assignment will generally be in accordance with the Adaptable Cellular Plan. These channel allocations are shown in table 1. Where it is not possible to select a channel from table 1 which is appropriate to both the cell and the applicant's industry, (which may be due either to existing assignments or maritime operations, or where it is required to import channels to satisfy increased demand for services), a channel will need to be selected by one of the following criteria:

- Where there is a high density of scanning stations and it is either inappropriate, or not possible, to use an adjacent cell channel, then a channel can be selected from either the first or second tier non-adjacent cells. The selection criteria are shown in Annexes E, C, and D for the Gas, Electricity and Water Industries respectively. For instance, if the home cell is 'A', the first tier channels for the gas industry will be T48, T50, T65 and T69, the second tier channels will be T53, T55, T61, T63, T64 and T66.
- Where the density of existing scanning stations is low, or where the proposed site is on, or adjacent to, a coastal area, then it may very well be possible to import a channel from an adjacent sea-bound cell. However, the importing may result in the sterilisation of the adjacent donor cell, thus preventing the full capability of the Adaptable Channel Plan being realised in that area.

With the above selection processes, the use of a channel will generally be at a lower EIRP than usual because of the reduced co-channel frequency re-use distance. The use of imported channels may require both the adoption of a polarisation orthogonal to that used in the channel's home cell and directional scanner antennas. If either channel selection process fails to identify a suitable channel, then it may be possible to assign one from another industry's group of channels, providing this can be successfully negotiated with the donor industry. In all cases, the choice of channel must be co-ordinated with existing co-channel systems.

b. Link length policy

In the interests of spectrum efficiency, Ofcom will generally consider only those outstations, whether standard, non-standard or relay, which are grouped within a 30 km radius of the associated base station. Outstations greater than 30 km from the base station will only be considered on a case-by-case basis. This provision is to enable those outstations whose path lengths cannot readily be kept below 30 km, due to either practical or external constraints, or any procedure that has been adopted to ameliorate the effects of continental interference. Such outstations will need to be successfully frequency co- ordinated with other users and must comply with the planning assumptions stated within this Technical

Frequency Assignment Criteria document.

c. Equivalent isotropically radiated power (EIRP)

The maximum value of EIRP will be a condition of the licence. In no circumstances will Ofcom issue a licence for any system which requires an EIRP in excess of 250 W (24 dBW).

d. Total path loss

The total path loss is the sum of the free space propagation, ground terrain obstruction and building and vegetation clutter losses. In general, computer based prediction methods use the first two; however, some models also predict clutter losses as well. The terrain obstruction loss may be zero for some paths, this may also be the case for clutter loss. The losses may alternatively be manually calculated. The various elements of the path loss are shown in figure 5.

Total path loss = free space path loss + terrain obstruction loss + building and vegetation clutter loss

(The free space loss is that which corresponds to a first Fresnel zone clearance of 0·6, using an earth curvature factor of K=4/3).

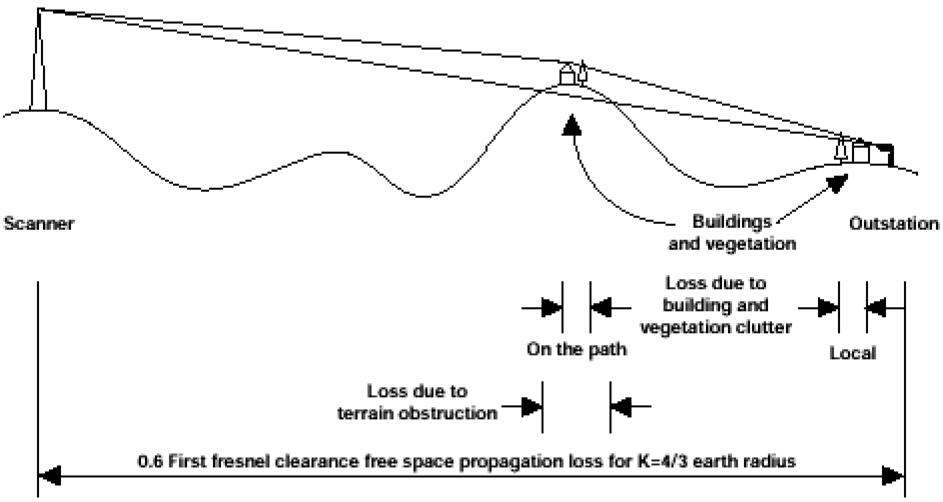


Figure 5: Losses along a path

The total path loss for assignment purposes may not exceed 143 dB under any circumstances. If it does so, the value used for assignment purposes will be restricted to 143 dB.

i. Clutter loss

Clutter losses comprise of the following components:

- The loss due to the effects of buildings and vegetation on top of a terrain obstruction along the path.
- The loss due to buildings and vegetation in the immediate locality of the outstation. The clutter loss near an outstation may comprise of one or both of the above two components as illustrated in Figure 5.

In order to encourage operators to minimise excessive local clutter, the specification limit for clutter loss shall be 20 dB, although losses up to, but not exceeding, 30 dB will be considered on a case-by-case basis.

Where clutter losses exceed 20 dB, supporting documentation will be required which shall indicate the cause of the excess clutter and confirm that all reasonable attempts have been made to minimise local clutter effects.

For existing systems, this limitation will only apply when the inclusion of additional outstations require an increase in the scanner EIRP. This limitation will apply to all new systems.

The clutter loss may be estimated by a database, calculated by a computer prediction model in conjunction with a terrain height database. It may also be determined by the actual measurement of the end-to-end circuit loss. This measured value will include further losses which will be comprised of the difference between the computer generated path profile and the actual path profile together with antenna radiation pattern anomalies created by its support structure. Experience indicates that clutter losses of up to 20 dB are relatively common, and up to 30 dB is sometimes unavoidable.

Any outstation whose measured path loss includes more than 20 dB of clutter ought to be re-engineered, where practicable, so as to reduce the clutter loss. This could be achieved by increasing antenna height and / or changing its spatial location on the site. There may be occasions when this is not possible, in which case the outstation may suffer poorer performance if the EIRP necessary to overcome the clutter loss cannot be successfully co-ordinated with existing co-channel systems. It will be the clutter losses in the locality of the outstation which are most likely to be reduced by the re-engineering of the outstation. For practical assigning purposes, clutter loss is defined as the difference between the Ofcom predicted and operator measured path losses (the path loss being extracted from the measured end-to-end circuit loss).

4.8 End-to-end circuit loss

In order to optimise frequency re-use, it is necessary to keep scanner and outstation EIRP's to the minimum compatible with achieving the system performance objective. This has in the past been achieved by limiting the total path loss. However, this does not take into account factors such as the antenna characteristics, or feeder loss, which could lead to significant increases in EIRP levels.

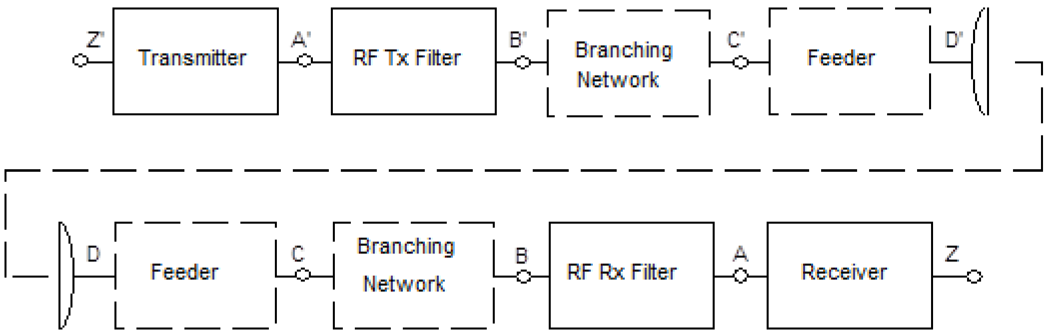


Figure 6 – System Block Diagram

With reference to figure 6, the end-to-end circuit loss comprises of the sum of all losses and gains between the transmitting station transmitter output port (C') and the receiving station receiver input port[1] (C), inclusive of both stations' antenna radiation pattern in the direction under consideration.

Where:

The antenna gain is that gain along the direction of the path, as defined by the radiation patterns.

EECL = TPL + (SFL + SOL – SAG) + (OFL + OOL - OAG)

[1]The receiver input port shall include any antenna combination or branching elements which may be used between the antenna feeder connections and the receiver unit input connection.

EECL = Scanner to outstation end-to-end circuit loss (dB).

TPL = Total path loss to the outstation (dB).

SFL, OFL = Scanner and outstation feeder losses respectively (dB).

SOL, OOL = Scanner and outstation other[2] losses respectively (dB)

SAG, OAG = Scanner and outstation antenna gain respectively (dBi).

Parameter	Value	Comments
Sc Ant Gain	8.1	*dBi {6 dBd colinear}*
Sc Losses	3.0	*dB {Feeder, feeder tail and connectors}*
Sc Rx Level		*dBW {Duplicated scanner receivers with a common antenna – see table 5}*
O/S Ant Gain	14.1	*dBi {12 element yagi (12 dBd)}*
O/S Losses	-	*dB {see table below}*
O/S Rx Level		*dBW {Non-duplicated outstation receivers – see table 5}*

Outstation	Free Space Loss	Obstruction Loss	Clutter Loss	Total Path Loss	Outstation Losses	End to end Circuit Loss
OS08	98.9	0.0	11.2	110.1	3.0	93.9
OS02	103.8	0.0	8.3	112.1	2.0	94.9
OS09	104.9	0.5	9.7	115.1	2.0	97.9
OS10	107.4	0.0	9.7	117.1	2.0	99.9
OS04	104.0	1.8	11.6	117.4	2.0	100.2
OS11	101.0	0.0	16.1	117.1	3.0	100.9
OS01	110.5	2.4	5.2	118.1	2.0	100.9
OS06	103.1	0.0	18.0	121.1	3.0	104.9
OS03	107.9	2.0	13.2	123.1	2.0	105.9
OS07	105.0	0.0	18.1	123.1	2.0	105.9
OS05	107.9	1.2	16.0	125.1	2.0	107.9
OS13	108.1	0.8	16.2	125.1	3.0	108.9
OS14	104.2	1.2	26.7	132.1	3.0	115.9
OS12	107.2	3.0	24.9	135.1	2.0	117.9

[2] Other losses are namely, connector and feeder tail losses etc.

Parameter	Calculated Value	Comments
Mean EECL	104.0	*Mean of all end-to-end circuit losses.*
Standard Deviation (SD)	6.8	*Standard Deviation (total population) of all end-to-end circuit losses.*
1.6*SD + Mean	114.9	*Maximum value of end-to-end circuit loss for assignment purpose.*

Table 6: A Worked Example for Determining the Assignment Path

Parameter	Value	Unit
Scanner ‘other’ loss (Connectors etc.)	1	dB
Scanner feeder loss (Antenna at 50m agl assumed)	3	dB
Scanner antenna gain (Omni-directional assumed)	2	dBi
Maximum overall loss	143	dB
Outstation antenna gain (12 element Yagi assumed)	14	dBi
Outstation feeder loss (Antenna at 8m agl assumed)	2	dB
Outstation ‘other’ loss (Connectors etc)	1	dB
Maximum end-to-end circuit loss	134	dB

Table 7: Typical values of components

The reference values chosen are from typical systems and are based on those used in reference [3].

The values are not limiting values, except that the total end-to-end circuit loss shall not exceed 134 dB and the total path loss shall not exceed 143 dB.

4.9 Assigning path

The method for determining the assigning path and hence the maximum outstation EIRP is described below. The Standard Deviation of the scanner’s own family of outstation end-to-end circuit losses, multiplied by 1·6, will be used to provide an offset value. This offset value is then added to the mean end-to-end circuit loss to enable the maximum assignable end-to-end circuit loss ($EECL_{max}$) for the group of outstations to be determined. The assigning path defines the $EECL_{max}$ which will be allowed for that particular system.

The assigning path is that path whose end-to-end circuit loss (EECL) does not exceed the calculated maximum outstation permissible value $EECL_{max}$ for that system. Those paths whose actual EECL exceeds $EECL_{max}$ will be assigned EIRPs corresponding to $EECL_{max}$. The $EECL_{max}$ is defined thus:

Where:

The above criteria will apply to existing schemes when an alteration to the system results in an increase of scanner EIRP.

σ_{EECL} = The standard deviation of the end-to-end circuit losses (dB).

X_{EECL} = The average end-to-end circuit loss for the outstations (dB).

n = The number of outstations attached to the scanner.

$EECL_{max}$ = The maximum end-to-end circuit loss for the outstations (dB).

In the worked example shown in Table 8, two outstations are excluded from having their desired EIRP. However, if the OS14 outstation end-to-end circuit loss, by means of a better feeder, can be reduced by 2 dB to 113·9 dB, only one outstation will be excluded. If the

$$EECL_{max} = 1.6\sigma_{EECL} + \bar{x}_{EECL} \qquad \bar{x}_{EECL} = \frac{\sum_{i=1}^{n} EECL_i}{n} \qquad \sigma_{EECL} = \sqrt{\frac{\left(n.\sum_{i=1}^{n} EECL_i^2\right) - \left(\sum_{i=1}^{n} EECL_i\right)^2}{n^2}}$$

OS14 outstation end-to-end circuit loss is reduced by 5 dB to 110·9 dB (3 dB total path loss and 2 dB feeder loss) and the OS12 outstation end-to-end circuit loss is reduced by 6 dB to 111·9 dB (5 dB total path loss and 1 dB feeder loss), then no outstations are denied their desired EIRP. Reduction of the end-to-end circuit loss by means of an appropriately engineered system is the key to maximising the number of outstations which can be assigned their required EIRP. In a well-engineered system this usually includes all the outstations.

4.10 Path profile

To determine the maximum radiated power for both base station and associated outstations, Ofcom will require a suitably scaled path profile corresponding to an effective earth radius to real earth radius of K = 4/3. The profile shall show the path having the assigning end-to-end circuit loss as defined in clause 4.8. Details of terrain features such as vegetation, buildings, etc, must be clearly identified along with their relative positions and heights.

4.10.1 Receiver input port signal level

Scanning telemetry systems shall be so designed that the receiver input port level will be in line with the level for the applicable outstation class from table 5 for both unprotected equipment and duplicated stations utilising individual receive antennas, and -5 dB higher than these values for those operators using duplicated receivers with a common antenna. Outstations with end-to-end circuit losses that are less than the calculated maximum end to end circuit loss will benefit from a higher received signal at the receiver input port. A scanner receiver input port level of up to, but not exceeding, -103 dBW may be permitted in special circumstances. These will be considered on a case-by-case basis, the actual value being determined by the received level of continental interference and by what other ameliorating measures have been adopted by the operator.

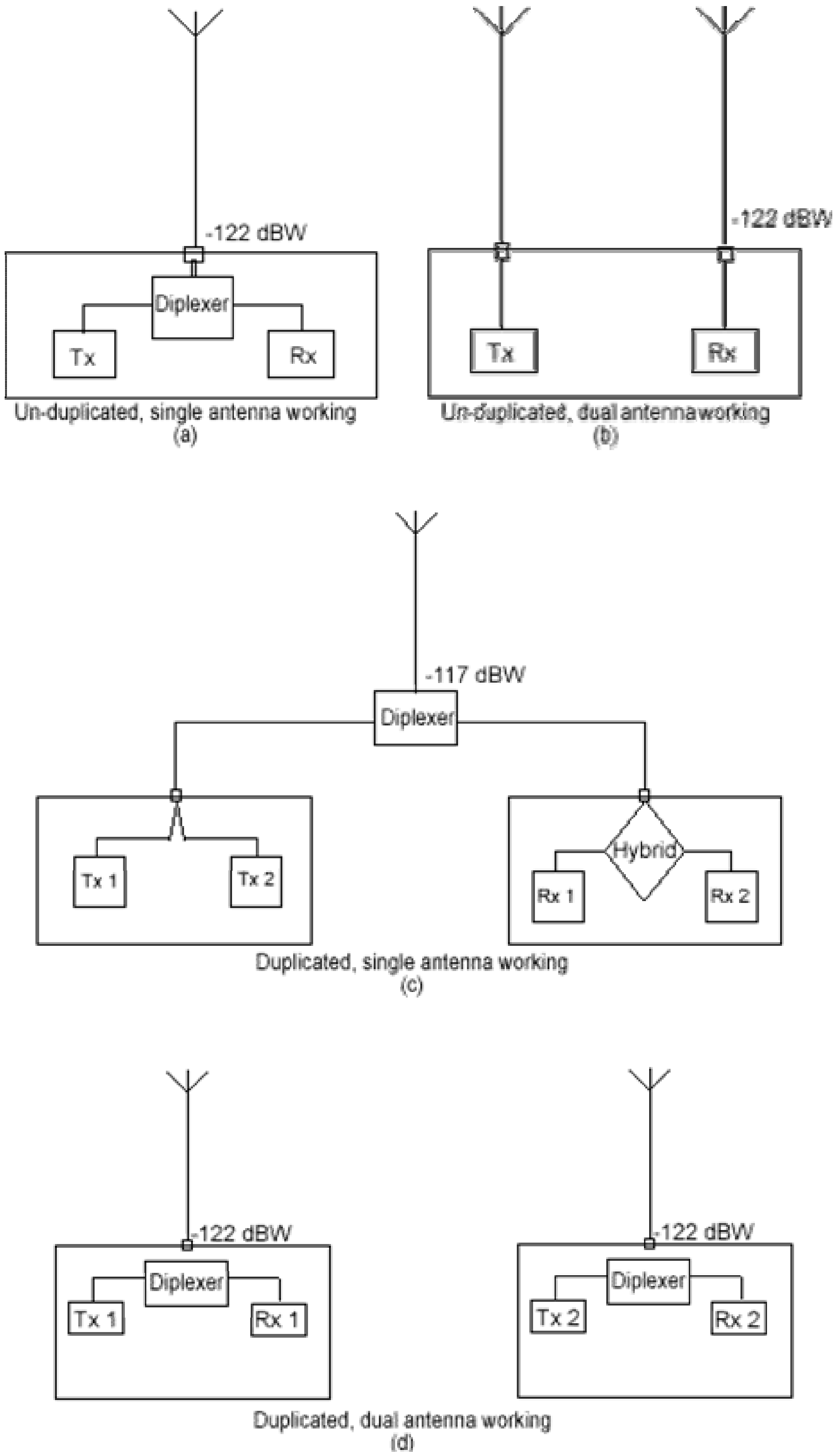
New schemes to be installed in parts of the UK that are susceptible to interference, for example, south east of England, may be assigned higher receive signal levels than those specified in table 5 in the first instance.

In general, operators will be dissuaded from simply seeking EIRP increases and encouraged to implement more appropriate methods of engineering their system. Increased receiver input port levels will only be assigned upon the operator providing adequate evidence of the duration and magnitude of the received continental interfering signal levels, together with a statement of what other ameliorating measures the user intends to adopt to assist in combating this interference. The new levels assigned will be chosen so as to overcome the continental interference in conjunction with other practicable changes that will make the system more resilient. It may be that they will be allowed greater increases of scanner receiver input port level, and hence EIRP, for a short period of time during periods of severe interference or while other improvements are being implemented. It is accepted that there may be occasions when increased scanner receiver input port levels, and hence EIRP's, may be the only practicable solution.

Note: The use of these higher EIRP's will be subject to satisfactory co-channel frequency coordination. This may require the operator, requesting these increased levels, to negotiate with the co-channel users and possibly paying for the modification of the other user's system so as to prevent it from suffering interference as a consequence of the operator's increased EIRPs.

The application of the receiver input port levels within a system is shown in Figure 7. These are examples of the configurations most commonly employed.

Scanner and Outstation Configurations



Note: The receiver levels in the diagrams above are for Outstation Class 1, for other Outstation classes these values will be different, refer to table 5 for more details.

Figure 7

4.11 Calculation of equivalent isotropically radiated power (EIRP)

The maximum system EIRP will be calculated using the greatest total path loss permitted by the limiting end-to-end circuit loss determined by the method described below. The end to end circuit loss (EECL) comprises the total path loss + feeder losses + other losses – antenna gains in the direction under consideration. The free space and terrain obstruction loss value may be obtained by computer prediction, which may include a generalised figure for building / vegetation clutter loss.

Alternatively, the EECL may be directly measured. This measured value will include a further additional loss which will be composed of the difference between the computer-generated path profile and the actual path profile together with antenna radiation pattern anomalies created by its support structure, as well as all those parameters previously defined for the EECL. It is assumed that the operator has already satisfied himself that the installations are fault free and that the measurements are taken in a prescribed manner.

When measurements are taken, it is usually the EECL that is measured and hence these values may be used directly. However, they will be compared with the predicted EECLs to examine the extent of the clutter loss. If this exceeds 20 dB, Ofcom will investigate the application more closely; this may involve a site visit. The assigning process can then continue when the above investigation has taken place, as is current practice for the path loss.

The method for determining the maximum system EIRPs now fully characterises a scanning telemetry system and thus ensures that no parameter need be excluded when applying the limiting rule. This gives the operator more flexibility in 'fine tuning' their system to bring all, or most, of the outstations within the assigning rule.

Calculation of the permitted maximum EIRP will be based on the appropriate receiver input port level, as defined in clause 4.10.1, and the EECL, as defined in clause 4.8, for both the base station and -outstations and the appropriate loss to scanner or loss to outstation as shown below:

$Scanner\ \{EECL_{wc} \le EECL_{max}\}$	$LTO = EECL - SFL - SOL + SAG$	$EIRP_{Scanner} = RIL + LTO$
$Scanner\ \{EECL_{wc} > EECL_{max}\}$	$LTO = EECL_{max} - SFL - SOL + SAG$	$EIRP_{Scanner} = RIL + LTO$
$Outstation\ \{EECL \le EECL_{max}\}$	$LTS = EECL - OFL - OOL + OAG$	$EIRP_{Outstation} = RIL + LTS$
$Outstation\ \{EECL > EECL_{max}\}$	$LTS = EECL_{max} - OFL - OOL + OAG$	$EIRP_{Outstation} = RIL + LTS$

Where:

$EECL_{wc} =$ Worst case outstation $EECL$ (dB)

$LTO =$ Loss to outstation (dB).

$LTS =$ Loss to scanner (dB).

$RIL =$ Receiver input port level (dBW).

The maximum assignable EIRP for a given scanner and its family of outstation(s) is that EIRP determined by clause 4.6.

The minimum assignable EIRP will normally not be less than -20 dBW, although lower EIRPs can be assigned.

Parameter	Value (dBW)	
Scanner EIRP	-2	
Outstation	**EIRP (dBW)**	
	Desired	**Assigned**
OS08	-12.0	-12.0
OS02	-10.0	-10.0
OS09	-7.0	-7.0
OS10	-5.0	-5.0
OS04	-4.7	-4.7
OS11	-5.0	-5.0
OS01	-4.0	-4.0
OS06	-1.0	-1.0
OS03	1.0	1.0
OS07	1.0	1.0
OS05	3.0	3.0
OS13	3.0	3.0
OS14	10.0	9.0
OS12	13.0	10.0

Table 8: The application of EIRP to the example shown in Table 7

Where no measured end-to-end circuit or path losses are provided, then the clutter losses will not be known and the assignment will be based on computer predicted end-to-end circuit losses only. Some computer models may estimate the prospective clutter losses, in which case an improved assignment will follow. This does not preclude a user from applying for a re-assignment using measured values at a later date once his system has been commissioned; or from seeking a temporary channel to permit a survey of preferred receive signal levels for a new scanner in advance of the full application

Under normal circumstances, the EIRP that a scanner or outstation will be assigned will be limited to a minimum of -20 dBW, even though the calculated EIRP may be lower. There may be occasions where the assigned EIRP will be less than -20 dBW.

The EIRP of the system will be calculated for each outstation and the scanner in the normal manner; in that the outstation EIRP is set so as to give the correct receiver input port level at the scanner, except that the maximum assignable EIRP is set by the method described below.

- The scanner EIRP is determined from the 'loss to outstation value (LTO) and the outstation receiver input port level, as defined above.
- The outstation EIRP is determined from the 'loss to scanner value (LTS) and the scanner receiver -input port level (RIL), as defined above.
- It must be noted that when the end-to-end circuit loss (EECL) for a scanner-outstation pair exceeds the calculated maximum end-to-end circuit loss ($EECL_{max}$) value, then this value is substituted for the measured, or predicted, EECL in the modified loss- to

-scanner and loss- to- outstation formulae. It is this substitution which limits the EIRP which may be assigned to outstations with large EECLs, relative to the remainder of the outstations.

In the example in table 6, this results in outstations OS12 and OS14 being restricted to EECL of 114·9 dB for assignment purposes, rather than their actual end-to-end circuit loss of 117·9 and 115·9 dB. This $EECL_{max}$ for the family of outstations results in loss- to -scanner values of 127 and 126 dB for OS12 and OS14 respectively and a loss- to- outstation value of 120 dB.

Section 5

Other Telemetry Services

It is considered that there are six basic classes of scanning telemetry and telecontrol system. These are:

- Systems with standard outstations only.
- Systems with both standard and non-standard outstations.
- Systems with only non-standard outstations.
- Single hop relay systems for circumnavigating severe obstructions.
- Single standard outstation scanning telemetry systems for obstructed paths.
- Multi-hop single frequency relay systems.

The following special systems fall within one of the above categories and consequently this governs their method of assignment.

5.1 Relay outstations

Ofcom will permit the use of relay outstations as a means of communicating with other outstations that are difficult to reach. This technique is already used by some non-utility operators. In effect, a relay outstation becomes a secondary scanner to communicate with one or more other outstations, which cannot be reached from the main scanner. The relay outstation will onward route the transmission using either the parent scanners transmit frequency or an alternative channel. Such relay outstations may only be used where they form an extension to a main telemetry scheme. The relay outstation will utilise antennas designated for outstation or scanner sector use and the antenna height above ground may not exceed 15 metres. The calculated EIRP will in many cases be below -20 dBW, but, where possible, a minimum EIRP of -20 dBW may be assigned. The relay outstation shall not be more than 30 km from the parent scanner.

The assigning path is determined in accordance with clauses 4.9. Non-standard outstations, as described in clause 5.4, are included in the calculations used to determine the assigning path. The calculation of the permitted maximum EIRP for the system shall be in accordance with clauses 4.6 and 4.11, except that the maximum assignable EIRP of the relay outstation and its corresponding target outstations, regardless of whether the target outstations are standard or non-standard, shall not exceed 0 dBW.

Relay outstations are not intended as an alternative to the establishment of a main scanning site, but to give access to isolated outstations where the establishment of a new main scanner site is not practicable.

Such relay outstations, together, with their target outstations, would have to be successfully frequency co-ordinated with all co-channel systems before an assignment could be made.

5.2 Regulated on-site and local area telemetry and telecontrol services

Ofcom will permit the use of regulated scanning telemetry and telecontrol services for on-site and local area schemes. Major user groups may reserve one or more of their allocated channels for such a service if considered appropriate. Service areas of up to 1 km are envisaged. The antenna height above ground shall normally not exceed 15 metres, however a height greater than 15 metres will be considered on a case-by-case basis. Where non-standard outstations are employed, they will be assigned according to clause 5.4. Such systems shall utilise suitable antenna systems and EIRP so as to confine their service area to the boundary of the site, or the extent of the local area under consideration, and to restrict their interference potential to wide area schemes. In any case, the EIRP shall not exceed 0 dBW.

5.3 Secondary scanner receive-only stations

Ofcom will permit the use of secondary scanner receive only stations as a means of maintaining communications to those outstations effected by the sectorisation of the scanner reception coverage area as a means of combating continental interference. It is assumed that the scanner transmit antenna remains Omni-directional. This is described in more detail in clause 6.3.

Secondary scanner receiver stations will be permitted, where these form an extension to the main scanning system. They will typically be used after sectoring the main scanner receiver coverage area.

5.4 Non-standard outstations

The establishment of a non-standard outstation utilising an antenna other than a standard or high performance type will be considered on a case-by-case basis.

The height of the antenna of a non-standard outstation shall not exceed 10 metres above ground level (agl). However, they may not necessarily be assigned with the applicable C/I ratio from table 5.

They are not intended as an alternative to the establishment of a standard outstation, but to give a new class of outstation for use in those circumstance where the installation of a standard antenna is not practicable and / or safe. Where possible, the use of a directional antenna will be encouraged. The method of assignment is governed by the class of system in which they are installed.

5.4.1 Systems with some non-standard outstations

These are normal scanning systems, which communicate with standard outstations, but into which some non-standard outstations are to be introduced. The assigned EIRPs are determined in accordance with clause 4.9, except that the non-standard outstations are excluded from the calculations used to determine the EIRPs. The assigned EIRPs are determined only by the standard outstations of the host system. The calculation of the permitted EIRPs for the system shall be in accordance with clause 5.8, except that the maximum assignable EIRPs for the non-standard outstations shall not exceed 0 dBW.

5.4.2 Systems which contain only non-standard outstations

These are considered as local area scanning systems, which are dedicated to addressing only non-standard outstations. The assigning EIRPs are determined in accordance with clauses 4.9. Non-standard outstations are included in the calculations used to determine the assigned EIRPs. The calculation of the maximum permitted EIRPs for the system shall be in accordance with clause 4.9, except that the maximum assignable EIRPs for the scanner and the non-standard outstations shall not exceed 0 dBW.

5.5 Simplex systems

These systems are currently operated by non-utility users and are assigned within channels T73 to T80. ‘Outward’ and ‘Return’ frequencies could be assigned to separate users. In some cases, such systems may be restricted to low power on-site or local area applications. Since such systems are currently operated by non-utility users and are assigned within channels T73 to T80, the major benefit will be to such users. However, if national licence holders require such systems within their own channel allocations, then the technique could be applied providing successful co-ordination can be achieved.

Simplex systems will be permitted and will be assigned in accordance with clauses 4.9 or 5.4, and clause 4.6 depending upon the type of outstations employed.

These are intended for telemetry or telecontrol services and data distribution or gathering networks.

The un-used frequency of the two-frequency pair may be assigned to another user if appropriate.

5.6 Multi-hop single-frequency relay stations

Such systems will be permitted where it can be demonstrated that the requirement cannot be met within the 458·5 – 459·5 MHz deregulated telemetry and telecontrol band. The assigned EIRPs will be governed by the path lengths required, subject to the rules pertaining to standard and non-standard outstations as appropriate. It is envisaged that such systems may very well be met by store and forward techniques using a single frequency. In order to achieve a successful co-ordination with co-channel systems, such relay stations may not necessarily be assigned with a C/I ratio of 22 dB. Where the operational and legal safety procedures impose constraints on the installation and servicing personnel by virtue of the location of the radio equipment and antennas, the operator may request the use of standardised EIRP values. Where the operator is subject to these constraints, Ofcom may consider the use of standardised EIRP values providing successful co-ordination can be achieved.

5.7 Systems utilising a single standard outstation

It is envisaged that such systems will be permitted where there is either a significant terrain obstruction to be overcome or that the benefits of the 460 MHz band propagation characteristics are necessary. Such systems will be assigned in accordance with clauses 4.6 and 4.9.

Some of these systems are currently operated by non-utility users and are assigned channels from T73 to T80. ‘Outward’ and ‘Return’ frequencies could be assigned to separate users where single frequency working is required. In some cases such systems may be restricted to low power on-site or local area applications. Since such systems are currently operated by non-utility users and are assigned within channels T73 to T80, the major benefit of this will be to such users. However, if national licence holders require such systems within their own channel allocations, the technique could be applied providing successful co-ordination can be achieved.

Section 6

Continental Interference to UK Scanning Telemetry Systems

As the UK UHF bands are frequency reversed relative to those in Europe, users of scanning telemetry systems in the south east of England, as well as along the whole UK east coast, are vulnerable to interference from European radio communications. At times this may be significant and protracted.

A variety of measures can be adopted which will permit operators of scanning telemetry systems to ameliorate this problem**.** These remedial measures can only be adopted provided that Ofcom has both granted consent to such solutions and that they can be co-ordinated with other co-channel users. Ofcom is willing to discuss any problems with affected, or potentially affected users of scanning telemetry and telecontrol and determine what can be done to ameliorate their difficulties. This will include the use of one or more of the following remedial measures which will be considered by Ofcom on a case-by-case basis.

6.1 Horizontal polarisation

The use of horizontal polarisation can be of benefit in a number of circumstances: whether this is for receive purposes only, where separate transmit and receive antennas are used at all sites in the system, or for combined transmit and receive where shared antennas are used. The former would result in a mixed polarisation scheme.

6.2 An alternative channel

It may be possible to assign either an alternative channel that may be nominally free of continental interference (i.e. at an acceptable level). In either case, the operator should be satisfied that the said alternative channel, is free from continental interference. There can be no guarantee that any channel will remain free from continental interference in the future.

6.3 Sectoring scanner coverage areas, using a directional antenna or either passive or adaptive cancelling

Sectoring the scanner coverage area, using a directional antenna for either passive or adaptive cancelling antenna arrays may provide a solution for some operators. This may be for either receive purposes only, where separate transmit and receive antennas are used, or for combined transmit and receive where a shared antenna is used.

This technique may result in some outstations being displaced from their original parent scanner. These displaced outstations will either be re-directed to a more distant scanner or they will access a secondary scanner receive only station.

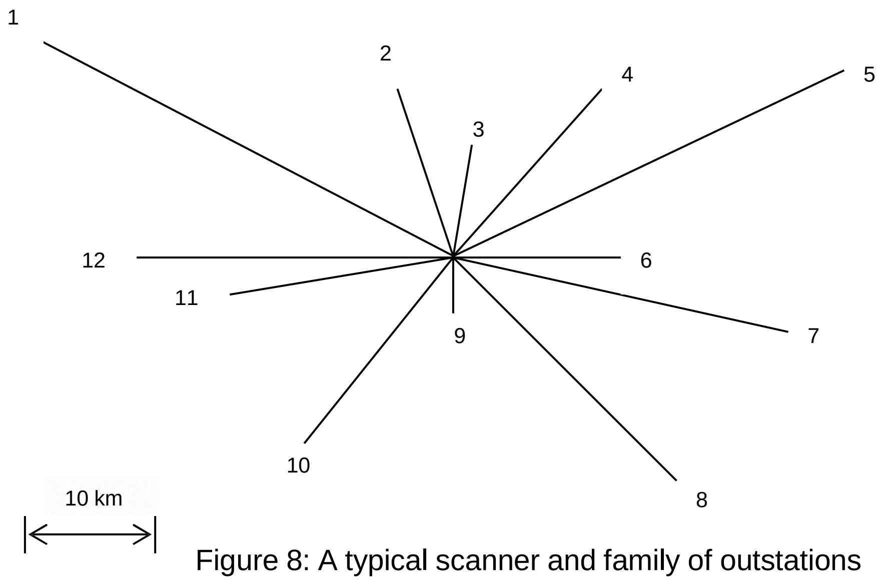


Figure 8: A typical scanner and family of outstations

After sectorisation some outstations may need to be re-directed to more distant scanners, the system may now look as shown in Figure 8.

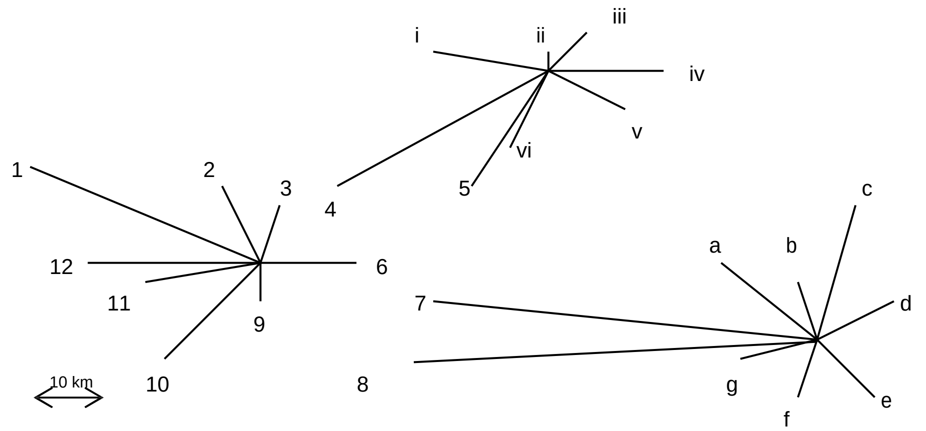


Figure 9: The same scanner-outstation family employing sectorisation techniques

In this solution, outstations 4, 5, 7 and 8 have been re-directed to alternative scanners. The rear lobe of the sector antenna installed at the scanner covers outstation 6. For some scanners such a solution may prove adequate However, there may very well be those where re-direction to more distant scanners is not viable.

An alternative approach may be to establish a secondary scanner receive only station at another site. This would enable the displaced outstations to be re-directed to an alternative scanner receiver site which would be located at a more convenient distance from the epicentre of the outstation geographic distribution. It may be that there would be a suitable communications site conveniently located for the purpose.

After sectorisation some outstations may need to be re-directed to more distant scanners. This system may now look as shown in Figure 9.

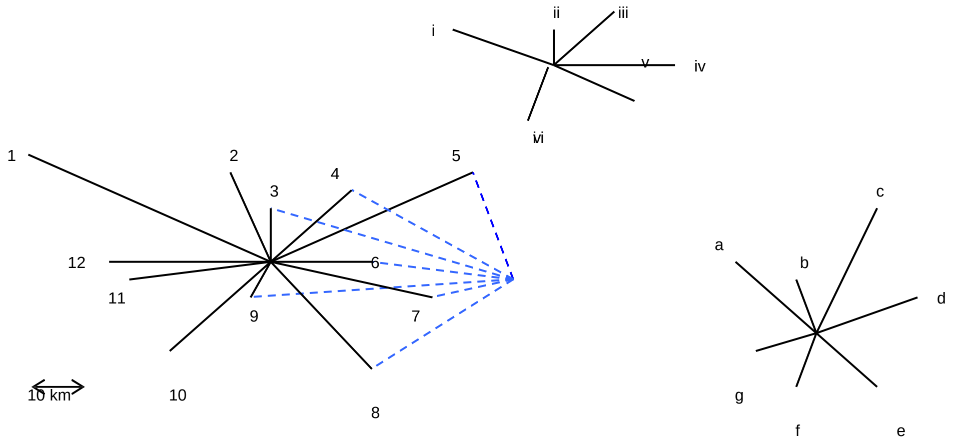


Figure 10: The same scanner-outstation family employing sectorisation and secondary receiver techniques

The above shows how such a scanner and its family of outstations would look if a secondary scanner receive-only station were employed. Outstations 3, 4, 5, 6, 7, 8 and 9 have been re-directed to the secondary receive only scanner. The dashed lines indicate the outstation receive path and the solid lines the corresponding transmit path. The use of such an arrangement will be managed by the operators' control software. Unlike mobile systems, no voting is necessary since each outstation will reply either to the main scanner or its secondary receive site. For some operators, such a configuration will not be practicable and hence the establishment of an additional main scanner will be required.

6.4 Antenna arrays.

The use of two or more antennas combined into an array may provide a solution for some operators.

6.5 Increased median signal level at the receiver input port of up to -103 dBW

The operator may wish to use an increased median signal level at the receiver input port of up to, but not exceeding, -103 dBW as a means of overcoming continental interference. The choice of median signal level at the receiver input port will be based on the known, i.e. measured, level of received continental interference at the scanner site in question.

Rather than requesting an increase in ERIP, operators will be expected to consider other measures. Where an increase is unavoidable, its level should be minimised by the incorporation of applicable measures.

6.6 Other solutions which can be accepted within the terms of this specification

There may be solutions not addressed within this document that can provide a solution to ameliorate the effects of continental interference. Ofcom is willing to discuss other possible solutions with the operator and, where acceptable and subject to frequency co-ordination, such measures may be used.

Annex A: Transmit Frequencies for Scanning Telemetry and Telecontrol

The following table shows the transmit frequencies for the scanning telemetry and telecontrol radio services operating in the band 457·5 to 464·0 MHz.

Channels	Scanner	Outstations
1	457.50625	463.00625
2	457.51875	463.01875
3	457.53125	463.03125
4	457.54375	463.04375
5	457.55625	463.05625
6	457.56875	463.06875
7	457.58125	463.08125
8	457.59375	463.09375
9	457.60625	463.10625
10	457.61875	463.11875
11	457.63125	463.13125
12	457.64375	463.14375
13	457.65625	463.15625
14	457.66875	463.16875
15	457.68125	463.18125
16	457.69375	463.19375
17	457.70625	463.20625
18	457.71875	463.21875
19	457.73125	463.23125
20	457.74375	463.24375
21	457.75625	463.25625
22	457.76875	463.26875
23	457.78125	463.28125
24	457.79375	463.29375
25	457.80625	463.30625
26	457.81875	463.31875
27	457.83125	463.33125
28	457.84375	463.34375
29	457.85625	463.35625

30	457.86875	463.36875
31	457.88125	463.38125
32	457.89375	463.39375
33	457.90625	463.40625
34	457.91875	463.41875
35	457.93125	463.43125
36	457.94375	463.44375
37	457.95625	463.45625
38	457.96875	463.46875
39	457.98125	463.48125
40	458.99375	463.49375
41	458.00625	463.50625
42	458.01875	463.51875
43	458.03125	463.53125
44	458.04375	463.54375
45	458.05625	463.55625
46	458.06875	463.56875
47	458.08125	463.58125
48	458.09375	463.59375
49	458.10625	463.60625
50	458.11875	463.61875
51	458.13125	463.63125
52	458.14375	463.64375
53	458.15625	463.65625
54	458.16875	463.66875
55	458.18125	463.68125
56	458.19375	463.69375
57	458.20625	463.70625
58	458.21875	463.71875
59	458.23125	463.73125
60	458.24375	463.74375
61	458.25625	463.75625
62	458.26875	463.76875
63	458.28125	463.78125
64	458.29375	463.79375
65	458.30625	463.80625

66	458.31875	463.81875
67	458.33125	463.83125
68	458.34375	463.84375
69	458.35625	463.85625
70	458.36875	463.86875
71	458.38125	463.88125
72	458.39375	463.89375
73	458.40625	463.90625
74	458.41875	463.91875
75	458.43125	463.93125
76	458.44375	463.94375
77	458.45625	463.95625
78	458.46875	463.96875
79	458.48125	463.98125
80	458.49375	463.99375

The Industry for which the channel is nominated is shown using the following colour code:

Electricity
Gas
Water
Other

Annex B: Adaptable Cellular Plan Channel Sets

Cell	Gas		Electricity		Water	
	Ch. 1	Ch. 2	Ch. 1	Ch. 2	Ch. 1	Ch. 2
A	T57	T59	T3	T12	T44	T47
B	T69	T65	T32	T6	T21	T36
C	T48	T50	T29	T40	T31	T56
D	T49	T51	T13	T24	T14	T16
E	T64	T66	T27	T7	T30	T37
F	T60	T62	T41	T25	T35	T45
G	T70	T72	T10	T11	T19	T17
H	T61	T63	T9	T34	T38	T46
J	T52	T54	T23	T28	T5	T15
K	T67	T58	T2	T33	T1	T39
L	T68	T71	T8	T26	T30	T43
M	T53	T55	T4	T42	T18	T22

Annex C: Adaptable Channel Plan Non-Adjacent Cell Channel Look-Up Table for the Electricity Industry

Home Cell	Home Cell Channels	First Tier Non-Adjacent Cells	First Tier Channels	Second Tier Non-Adjacent Cells	Second Tier Channels
A	T3	B	T32	E	T27
	T12		T6		T7
		C	T29	H	T9
			T40		T34
				M	T4
					T42
B	T32	A	T3	G	T10
	T6		T12		T11
		C	T29	F	T41
			T40		T25
				L	T8
					T26
C	T29	A	T3	D	T13
	T40		T12		T24
		B	T32	J	T23
			T6		T28
				K	T2
					T33
D	T13	E	T27	C	T29
	T24		T7		T40
		F	T41	J	T23
			T25		T28
				K	T2
					T33
E	T27	D	T13	A	T3
	T7		T24		T12
		F	T41	H	T9
			T25		T34
				M	T4
					T42
F	T41	D	T13	B	T32
	T25		T24		T6
		E	T27	G	T10
			T7		T11

				L	T8
					T26
G	T10	H	T9	B	T32
	T11		T34		T6
		J	T23	F	T41
			T28		T25
				L	T8
					T26
H	T9	G	T10	A	T3
	T34		T11		T12
		J	T23	E	T27
			T28		T7
				M	T4
					T42
J	T23	G	T10	C	T29
	T28		T11		T40
		H	T9	D	T13
			T34		T24
				K	T2
					T33
K	T2	L	T8	C	T29
	T33		T26		T40
		M	T4	D	T13
			T42		T24
				J	T23
					T28
L	T8	K	T2	B	T32
	T26		T33		T6
		M	T4	F	T41
			T42		T25
				G	T10
					T11
M	T4	K	T2	A	T3
	T42		T33		T12
		L	T8	E	T27
			T26		T7
				H	T9
					T34

Annex D: Adaptable Channel Plan Non-Adjacent Cell Channel Look-Up Table for the Water Industry

Home Cell	Home Cell Channels	First Tier Non-Adjacent Cells	First Tier Channels	Second Tier Non-Adjacent Cells	Second Tier Channels
A	T44	B	T21	E	T30
	T47		T36		T37
		C	T31	H	T38
			T56		T46
				M	T18
					T22
B	T21	A	T44	G	T19
	T36		T47		T17
		C	T31	F	T35
			T56		T45
				L	T30
					T43
C	T31	A	T44	D	T14
	T56		T47		T16
		B	T21	J	T5
			T36		T15
				K	T1
					T39
D	T14	E	T30	C	T31
	T16		T37		T56
		F	T35	J	T5
			T45		T15
				K	T1
					T39
E	T30	D	T14	A	T44
	T37		T16		T47
		F	T35	H	T38
			T45		T46
				M	T18
					T22
F	T35	D	T14	B	T21
	T45		T16		T36
		E	T30	G	T19
			T37		T17

				L	T30
					T43
G	T19	H	T38	B	T21
	T17		T46		T36
		J	T5	F	T35
			T15		T45
				L	T30
					T43
H	T38	G	T19	A	T44
	T46		T17		T47
		J	T5	E	T30
			T15		T37
				M	T18
					T22
J	T5	G	T19	C	T31
	T15		T17		T56
		H	T38	D	T14
			T46		T16
				K	T1
					T39
K	T1	L	T30	C	T31
	T39		T43		T56
		M	T18	D	T14
			T22		T16
				J	T5
					T15
L	T30	K	T1	B	T21
	T43		T39		T36
		M	T18	F	T35
			T22		T45
				G	T19
					T17
M	T18	K	T1	A	T44
	T22		T39		T47
		L	T30	E	T30
			T43		T37
				H	T38
					T46

Annex E: Adaptable Channel Plan Non-Adjacent Cell Channel Look-Up Table for the Gas Industry

Home Cell	Home Cell Channels	First Tier Non-Adjacent Cells	First Tier Channels	Second Tier Non-Adjacent Cells	Second Tier Channels
A	T57	B	T69	E	T64
	T59		T65		T66
		C	T48	H	T61
			T50		T63
				M	T53
					T55
B	T69	A	T57	G	T70
	T65		T59		T72
		C	T48	F	T60
			T50		T62
				L	T68
					T71
C	T48	A	T57	D	T49
	T50		T59		T51
		B	T69	J	T52
			T65		T54
				K	T67
					T58
D	T49	E	T64	C	T48
	T51		T66		T50
		F	T60	J	T52
			T62		T54
				K	T67
					T58
E	T64	D	T49	A	T57
	T66		T51		T59
		F	T60	H	T61
			T62		T63
				M	T53
					T55
F	T60	D	T49	B	T69
	T62		T51		T65
		E	T64	G	T70
			T66		T72
				L	T68

					T71
G	T70	H	T61	B	T69
	T72		T63		T65
		J	T52	F	T60
			T54		T62
				L	T68
					T71
H	T61	G	T70	A	T57
	T63		T72		T59
		J	T52	E	T64
			T54		T66
				M	T53
					T55
J	T52	G	T70	C	T48
	T54		T72		T50
		H	T61	D	T49
			T63		T51
				K	T67
					T58
K	T67	L	T68	C	T48
	T58		T71		T50
		M	T53	D	T49
			T55		T51
				J	T52
					T54
L	T68	K	T67	B	T69
	T71		T58		T65
		M	T53	F	T60
			T55		T62
				G	T70
					T72
M	T53	K	T67	A	T57
	T55		T58		T59
		L	T68	E	T64
			T71		T66
				H	T61
					T63

Annex F: Adaptable Cellular Plan Cell Centre National and Irish Grid Reference Co-Ordinates

Cluster /Cell	NGR	Cluster /Cell	NGR	Cluster /Cell	NGR
1A	XW834750	5A	SR834250	9A	SM834750
1B	SW401500	5B	SM401000	9B	SG401500
1C	SX268500	5C	SN268000	9C	SH268500
1D	SW618875	5D	SM618375	9D	SG618875
1E	SX484875	5E	SN484375	9E	SH484875
1F	SX051125	5F	SS051625	9F	SH051125
1G	SX051875	5G	SN051375	9G	SH051875
1H	SX484125	5H	SS484625	9H	SH484125
1J	SW618125	5J	SR618625	9J	SG618125
1K	XX268750	5K	SS268250	9K	SN268750
1L	SX701500	5L	SN701000	9L	SH701500
1M	SW834500	5M	SM834000	9M	SG834500
2A	XZ433750	6A	SU433250	10A	SP433750
2B	SZ000500	6B	SP000000	10B	SK000500
2C	SZ866500	6C	SP866000	10C	SK866500
2D	SZ216875	6D	SP216375	10D	SK216875
2E	TV082875	6E	TL082375	10E	TF082875
2F	SZ649125	6F	SU649625	10F	SK649125
2G	SZ649875	6G	SP649375	10G	SK649875
2H	TV082125	6H	TQ082625	10H	TF082125
2J	SZ216125	6J	SU216625	10J	SK216125
2K	XZ866750	6K	SU866250	10K	SP866750
2L	TV299500	6L	TL299000	10L	TF299500
2M	SZ433500	6M	SP433000	10M	SK433500
3A	SY134500	7A	SO134000	11A	SJ134500
3B	SS701250	7B	SN701750	11B	SC701250
3C	ST567250	7C	SO567750	11C	SD567250
3D	SS917625	7D	SH917125	11D	SC917625
3E	ST783625	7E	SJ783125	11E	SD783625
3F	SY350875	7F	SO350375	11F	SJ350375
3G	ST350625	7G	SJ350125	11G	SD350625
3H	SY783875	7H	SO783375	11H	SJ783875
3J	SX917875	7J	SN917375	11J	SH917875
3K	SY567500	7K	SO567000	11K	SJ567500
3L	SU000250	7L	SP000750	11L	SE000250

3M	ST134250	7M	SO134750	11M	SD134250
4A	TV732500	8A	TL732000	12A	TF732500
4B	TQ299250	8B	TL299750	12B	TA299250
4C	TR165250	8C	TM165750	12C	TB165250
4D	TQ515625	8D	TF515125	12D	TA515625
4E	TR381625	8E	TG381125	12E	TB381625
4F	TV948875	8F	TL948375	12F	TF948875
4G	TQ948625	8G	TF948125	12G	TA948625
4H	TW381875	8H	TM381375	12H	TG381875
4J	TV515875	8J	TL515375	12J	TF5I1875
4K	TW165500	8K	TM165000	12K	TG165500
4L	TR598250	8L	TM598750	12L	TB598250
4M	TQ732250	8M	TL327750	12M	TA732250
13A	SB834250	17A	NZ433750	21A	NJ134000
13B	NW401000	17B	NU000500	21B	NB701750
13C	NX268000	17C	NU866500	12C	NJ567750
13D	NW618375	17D	NU216875	21D	NC917125
13E	NX484375	17E	MQ082875	21E	ND783125
13F	SC051625	17F	NU649125	21F	NJ350375
13G	NX051375	17G	NU649875	21G	ND350125
13H	SC484625	17H	MQ082125	21H	NJ783375
13J	SB618625	17J	NU216125	21J	NH917375
13K	SC268250	17K	NZ866750	21K	NJ567000
13L	NX701000	17L	MQ299500	21L	NK000750
13M	NW834000	17M	NU433500	21M	NJ134750
14A	SE6433250	18A	NT134500	22A	NB834750
14B	NZ000000	18B	NN701250	22B	NB401500
14C	NZ866000	18C	NO567250	22C	NC268500
14D	NZ216375	18D	NN917625	22D	NB618875
14E	MV082375	18E	NO783625	22E	NC484875
14F	SE649625	18F	NT350875	22F	NC051125
14G	NZ649375	18G	NO350625	22G	NC051875
14H	TA082625	18H	NT783875	22H	NC484125
14J	SE216625	18J	NS917875	22J	NB618125
14K	SE866250	18K	NT567500	22K	NH268750
14L	MV299000	18L	NP000250	22L	NC701500
14M	NZ433000	18M	NO134250	22M	NB834500
15A	NY134000	19A	NM834250	23A	ND134500
15B	NX701750	19B	NG401000	23B	HC701250

15C	NY567750	19C	NH268000	23C	HD567250
15D	NS917125	19D	NG618375	23D	HC917625
15E	NT783125	19E	NH484375	23E	HD783625
15F	NY350375	19F	NN051625	23F	ND350875
15G	NT350125	19G	NH051375	23G	HD350625
15H	NY783375	19H	NN484625	23H	ND783875
15J	NX917375	19J	NM618625	23J	NC917875
15K	NY567000	19K	NN268250	23K	ND567500
15L	NZ000750	19L	NH701000	23L	HE000250
15M	NY134750	19M	NG834000	23M	HD134250
16A	NW834750	20A	NP433250	24E	NW184375
16B	NR401500	20B	NK000000	27C	NL066250
16C	NS268500	20C	NK866000	27E	NM183265
16D	NR618875	20D	NK216375	27G	NL049625
16E	NS484875	20E	MF082375	27H	NR183875
16F	NS051125	20F	NP649625	27L	NM400250
16G	NS051875	20G	NK649375	28A	NF033000
16H	NS484125	20H	ML082625	28C	NF067752
16J	NR618125	20J	NP216625	28E	NB184128
16K	NX268750	20K	NP866250	28F	NF051375
16L	NS701500	20L	MF299000	28H	NG184375
16M	NR834500	20M	NK433000	28K	NF067000
				28L	NG401752
13B	J302441	26C	C807150	26H	J055795
13D	J486833	26D	C129467	26J	H193721
25L	H003329	26E	C991542	26K	H871403
26A	H440366	26F	H624758	26L	D238187
26B	B945075	26G	C560504	26M	C376112

Document History

Version	Date	Changes
1.0	Sept 2004	Rebranded to Ofcom Style
2.0	Jan 2015	Updated to incorporate VNS2111 and RA386
2.1	Aug 2015	Editorial corrections
3.0	May 2017	Removal of interleaved channel options and update to allow for different digital modulations.

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