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COMPARISON OF THE SUBDIVISION AND INTERLEAVED METHODS CONCERNING THE ARRANGEMENT OF CHANNEL PATTERNS WITHIN A FREQUENCY RANGE

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1 INTRODUCTION

Ever since channel pattern arrangements have been developed for the radio relay service, the question has been constantly raised which method should be used for the arrangement of a channel pattern within a particular frequency range.
Within the framework of efforts to harmonise radio relay patterns on CEPT level, there have always been discussions whether one of the two methods has considerable advantages over the other.

This study is aimed at indicating the advantages and disadvantages of the subdivision and interleaved methods from the viewpoint of technology, frequency economy and coordination in order to enable an objective and factual assessment of this persistently recurring problem.

However, this study has not been elaborated with a view to strictly separating both methods or even excluding one method as being completely unsuitable for the arrangement of channel patterns.
This study has rather been prepared to aid on a *single-case basis* in the decision which method of pattern arrangement provides for crucial advantages over the other as a result of certain prerequisites.

However, the selection criteria may thus not be generalised as the prerequisites for selecting one method might vary considerably depending on the frequency range so that in a *particular case* the other method could offer significant advantages.

When standardising channel patterns, it may even be necessary to use both methods in a given frequency range as can be seen in current ITU-R and CEPT Recommendations (**Table 1**).

Recommendation	Channel Spacing	Method
ITU-R Rec. 636 (15 GHz)	28 MHz / 14 MHz 28 MHz / 7 MHz	Interleaved Subdivision
ITU-R Rec. 595 (18 GHz)	110 MHz / 55 MHz 110 MHz / 27.5 MHz	Interleaved Interleaved
CEPT Rec. T/R 13-02 Annex A (23 GHz)	112 MHz / 56 MHz 112 MHz / 28 MHz 112 MHz / 14 MHz 112 MHz / 7 MHz 112 MHz / 3.5 MHz	Interleaved Interleaved Subdivision Subdivision Interleaved
CEPT Rec. T/R 13-02 Annex B (26 GHz)	all	Subdivision

Table 1: Examples of methods of channel pattern arrangements outlined in ITU-R and CEPT Recommendations

2 DEFINITION OF THE SUBDIVISION AND INTERLEAVED ARRANGEMENTS OF CHANNEL PATTERNS

The subdivision and interleaved arrangements of channel patterns are illustrated and defined in **Annexes 1** and **2**.

Subdivision (**Annex 1**): The "channel corner frequency" of a pattern having a larger channel spacing always is the "channel corner frequency" of a pattern with a smaller channel spacing, too.

Interleaved (**Annex 2**): The channel center frequency of a pattern having a larger channel spacing always is the channel center frequency of a pattern with a smaller channel spacing, too.

The channel spacing of the patterns varies by the factor 2^n (n = 1, 2, 3, ...). Therefore, patterns with a channel spacing of for example 3.5 MHz, 7 MHz, 14 MHz and 28 MHz are studied.

3 NUMBER OF CHANNELS IN A FREQUENCY RANGE

The number of channels which can be made available in a frequency range with a given channel spacing largely depends on the *minimum guard band necessary*, and of the *position of the frequencies* resulting from the "homogeneous pattern". In each *single case* it should be determined whether:

* the number of lower capacity channels possible would be reduced or increased by use of one or other of the arrangement methods; this is influenced by whether the higher capacity channels fully occupy the frequency range availability, and if not, where the higher capacity channels lie in the available frequency range.

* a band which is being used by two (or more) operators who are using equipment with different spacing could be divided more efficiently using one arrangement method or the other; this would require the determination of the spectral decoupling between the equipments used by the two operators, as explained later in this document.

3.1 Primary considerations in choosing channel arrangement

3.1.1 Alignment of patterns

In all cases the most important consideration is how the basic pattern aligns with the available frequency range (see **Annex 3**), which will constrain the number of lower capacity channels which could be accommodated into the plan.

a) If the widest channels align such that there is little or no spare spectrum at either end of the plan, then it will be possible to maximise the number of lower capacity channels by the use of channel subdivision (**Annex 3**, Case 1), whilst the interleaved pattern would not be able to accommodate as many lower capacity channels.

b) If, however, there is a greater amount of spare spectrum at either end, it would be possible to assign an additional low capacity channel at each end of the plan by using the interleaved arrangement, so that the interleaved plan offers more channels than the subdivision plan (**Annex 3**, Case 2).

c) In other case it might be found that the alignment of the basic pattern relative to the available band is such that the higher capacity plan is significantly offset so that the spare spectrum is mostly to one end of the band. In this case (**Annex 3**, Case 3), there would usually be no difference between the two methods.

3.1.2 Usage of the band

The other primary consideration in choosing between channel subdivision and the interleaved method is whether the band is going to be used by more than one operator, or by equipments with different channel widths, which may influence how the band can best be divided.

Whilst both arrangements can accommodate a variation in equipment types and operators, the manner in which the spectrum is going to be assigned (for example as a block allocation from the outset, or on an individual link by link basis as required) might influence the choice towards one method or the other.

The need to coordinate high, medium and low bandwidth equipments into the same band, with the minimum wastage of spectrum is very important.

For parallel point to point links the use of channel subdivision might appear to be the better option for mixing system capacities, since gabs in the plan can be avoided (or filled at a later date) more easily than with an interleaved plan.

However for a network of single links operating in all directions, the differing spectral decoupling gained from an interleaved pattern might prove to be better. This could be determined on case-by-case basis.

Consequently, each band should be considered on its own merits, taking account of the amount to which the spectrum will be divided up, and what systems will use it.

3.2 Other considerations in choosing channel arrangement

If the primary factors given in section 3.1 above do not lead to a decision between the two methodologies, there are a number of lesser factors which could be considered.

* The use of a subdivision method normally produces a channel plan with aligned channel edges. From a spectrum management aspect it is usually easier to visualise and remember a plan for which there is the same guard band at the channel edge irrespective of the channel width.

* The use of interleaved channel arrangements results in common centre frequencies, whereas each centre frequency for a subdivision arrangement has to be uniquely calculated.

It is, however recognised that the importance of these factors is subjective, and they could both be viewed as being trivial.

4 SPECTRAL DECOUPLING

When determining the adjacent channel spacing within a pattern, a compromise must be reached between the highest number of channels possible and the highest possible degree of adjacent channel decoupling. The "Interference Reduction Factor" (IRF) is introduced as a value of the spectral decoupling between 2 channels.
The IRF depends on the frequency separation and the characteristics of the apparatus (bit rate, type of modulation, filter selection).

The value of the IRF is of crucial importance when determining, for example, under which conditions several operators can - independently and only separated by the frequency separation - operate radio relay systems within the same geographical area without causing mutual harmful interference.

4.1 Spectral decoupling between channels of one pattern

This interference scenario is illustrated in lines 1A, 1B, 2A and 2B of **Annex 4**.
In terms of the resulting frequency separations and the spectral decoupling between the channels there are no differences between the subdivision and interleaved arrangement methods.

4.2 Spectral decoupling between channels of two patterns

This interference scenario is illustrated in

- lines 1A --> 1B and 1B --> 1A concerning the subdivision arrangement and in
- lines 2A --> 2B and 2B --> 2A concerning the interleaved arrangement of **Annex 4**. The channel spacing of the two patterns varies by a factor of 2.

Annex 5 contains the interference scenario when the channel spacing of the two patterns varies by a factor of 4.

The frequency separations between the channels of the two patterns vary according to the arrangement of the pattern. Thus, the IRF in the case of the subdivision arrangement differ from the IRF regarding the interleaved arrangement.

5 EXAMPLE OF SPECTRAL DECOUPLING

In this paragraph, the information provided with respect to spectral decoupling (section 4) is now supplemented by IRF values.

The IRF values were determined on the basis of studies compiled by a company concerning one group of systems, only.

System A:	8 * 2 Mbit/s;	channel spacing:	14.0 MHz
System B:	4 * 2 Mbit/s;	channel spacing:	7.0 MHz
System C:	2 * 2 Mbit/s;	channel spacing:	3.5 MHz

The modulation scheme 4 FSK was applied to all three systems. The IRF values are listed in **Annexes 6** and **7**.

6 RESULTS TAKEN FROM THE EXAMPLE

6.1 Applicability of the test result

In the example, 4 FSK-modulated radio relay systems with relatively low transmission rates (up to 8 * 2 Mbit/s) taken from only one group of systems were tested. Nowadays, such systems are typically used in frequency ranges above approximately 13 GHz. They are basically suitable for the band re-use in the co-channel mode. To what extent the results taken from this example are applicable to comparable radio relay systems has to be studied in further detail (if necessary, in coordination with ETSI TM 4).

Moreover, the conditions in the following cases need also be tested:

* high-level modulated radio relay systems (e.g. 64 QAM),
* radio relay systems with high transmission rates (e.g. 155 Mbit/s),
* multi-carrier systems,
* concerning patterns in which adjacent channels have a different polarisation (alternated pattern).

6.2 Spectral decoupling between channels of one pattern

In the case of the systems under test, the IRF is approximately 22 dB between adjacent channels of the same pattern independent of the type of pattern arrangement (subdivision or interleaved).

This value is by no means sufficient to be able to occupy adjacent channels in the same pattern within the same geographical area and without mutual coordination if it has to be ensured that no harmful interference is caused between the channels.

For instance, a radio relay operator "A" cannot setup and operate a radio relay network in channel 4 without prior coordination with radio relay operator "B" using, for example, channel 5 (see **Annexes 8** and **9**).

6.3 Conclusion regarding the spectral decoupling between channels of one pattern

Independent of the type of pattern arrangement used (subdivision or interleaved), the adjacent channels of one pattern always have to be coordinated.

Normally, even the channels with a larger frequency separation ("not-immediately adjacent channels") have to be included in the coordination.

In Germany, a central and independent office of the Federal Office for Posts and Telecommunications is in charge of this task in order to ensure the highest possible degree of efficiency and frequency economy in terms of frequency assignments and coordination.

If "guard bands" are introduced between two operators by not using one or even several channels, a non-interference operation can also be achieved. A high degree of frequency economy, however, cannot be ensured by way of the latter possibility (**Annex 10**).

Which of the two types of pattern arrangements is more effective than the other has to be determined in *each single case*, depending on the required IRF value.

6.4 Spectral decoupling between the channels of two patterns

The main differences between a subdivision and an interleaved arrangement of channel patterns are the frequency separations between the channel center frequencies of the two patterns under test (Delta f) and the resulting IRF values. These differences can best be illustrated if the channel spacing varies by a factor of 2. The following values concerning the systems A (8 * 2 Mbit/s; channel spacing 14 MHz) and B (4 * 2 Mbit/s; channel spacing 7 MHz) were taken from the example:

Delta f	Subdivision	Interleaved
0 MHz	---	1 channel; IRF = 0 dB
+/- 3.5 MHz	2 channels; IRF = 0 dB	---
+/- 7.0 MHz	---	2 channels; IRF = 7 - 11 dB
+/- 10.5 MHz	2 channels; IRF = 18 - 23 dB	---
+/- 14.0 MHz	---	2 channels; IRF = 31 - 35 dB
+/- 17.5 MHz	2 channels; IRF = 38 - 49 dB	---
+/- 21.0 MHz	---	2 channels; IRF = 50 - 66 dB
+/- 24.5 MHz	2 channels; IRF = 56 - 61 dB	---
+/- 28.0 MHz	---	2 channels; IRF = 61 - 71 dB
+/- 31.5 MHz	2 channels; IRF = 66 - 71 dB	---

Table 2: Comparison of spectoral decoupling

6.5 Conclusion regarding the spectral decoupling between channels of two patterns

In order to be able to decide which of the two methods ensures a higher degree of frequency economy, the frequency distribution of the required IRF value should be tested in a radio relay network which has been expanded to full capacity.

This test is very time-consuming and the result depends on the following factors (among others):

* data of the antenna used,
* structure of the network,
* geographical and topographical conditions,
* characteristics of the radio relay systems used.

7 ASPECTS OF COORDINATION WITHIN THE NETWORK OF ONE OPERATOR AND COORDINATION BETWEEN SEVERAL OPERATORS

The aspects of coordination are illustrated by means of the example of a German mobile network operator (e-plus) and the frequency assignment criteria and principles that will be employed by the Radiocommunications Agency of the UK.

7.1 Coordination within the network of one operator (Example: e-plus)

In order to ensure effective coordination all employees of the operator (e-plus) involved in the planning of the network make use of a planning tool providing information on the envisaged and established links of the mobile network.

Moreover, several provisions concerning the priority of the frequency usage have been applied by the operator "e-plus" in order to avoid problems in the border area between different network operators.

Thus, a high degree of planning efficiency within the network of the operator "e-plus" is ensured.

7.2 Coordination between several operators (Example: e-plus - MMO)

The data of the envisaged "links" of both operators (e-plus and Mannesmann Mobilfunk (MMO)) are exchanged via diskettes in an agreed format.
By means of this data exchange the operators are enabled to recognise problems concerning the planning on time and to act accordingly, thus further increasing the efficiency in planning.

The Federal Office for Posts and Telecommunications, however, is responsible for the actual and final assignment of frequencies.

In order to improve coordination between the frequency administration and the operators, efforts are being made to provide the operators with access to the data base of the BAPT, which contains all "links" existing in a particular frequency band.
Thus, an interference analysis including all planned and existing "links" could be carried out rendering the time-consuming coordination among operators unnecessary.
Furthermore, all data of envisaged "links" could be electronically and directly fed into the data base of the administration by the operators.

This approach would further increase the degree of efficiency in planning and ensure efficient coordination between the operators and the frequency administration.

7.3 Frequency assignment and coordination in the UK

The following example gives the prospects for the frequency assignment criteria and principles that will be employed, by the Radiocommunications Agency, in the selection of frequencies for use by fixed radio services operating in the bands 12.75 GHz to 13.25 GHz and 14.25 GHz to 14.50 GHz.

The 12.75 GHz to 13.25 GHz band has been divided into three sub-bands each having a low and high (go and return) group of frequencies.

* The "first" sub-band is primarily for private user digital links.

* The "second" sub-band is, at present, reserved for Mercury Communications Ltd, and operated in accordance with their own assignment criteria.
In order to minimise interference between these channels and those in the adjacent sub-bands utilised by other users, partial coordination is carried out. Extending this process to full coordination is under consideration.

* The "third" sub-band is a shared band for analogue and digital links.

The 14.25 GHz to 14.50 GHz band is a shared band for analogue and digital links and has a low and high (go and return) group of frequencies.

7.3.1 Assignment of frequencies

The Radiocommunications Agency will, as far as possible, assign frequencies on the basis that the estimated level of any individual co channel and adjacent channel interference at the receiver input should not exceed the values shown in **Table 3** and **Table 4** for 99.9% of the time.

The W/U ratios in these tables are given for an unwanted interferer when the wanted signal is at a defined sensitivity input level.

Minimum Capacity, Mbit/s	W/U (dB)	Co-channel interference limit (dBW)
2	27	-140
2x2	27	-138
8	27	-135
2x8	27	-133
34	27	-130
140/155	39	-135

Table 3: Single entry co-channel interference limits

Minimum Capacity, Mbit/s	W/U (dB)	Adjacent-channel interference limit (dBW)
2	3	-116
2x2	3	-114
8	3	-111
2x8	3	-109
34	3	-106
140/155	16	-112

Table 4: Single entry adjacent channel interference limits

Furthermore W/U-ratios, given by the matrices in **Annex 11**, for single entry interferes, for all digital systems (mixed capacities) have been calculated for various channel separations.

The values listed in **Annex 11** represent an overview of the spectral decoupling required to ensure non-interference operation of digital radio relay systems. Referring to the example given in chapter 6 concerning the spectral decoupling of 4-FSK modulated systems, the latter values revealed the same tendency. As regards the problem which channel pattern arrangement method should be used, the selection of the method is based on the same variety of factors independent of whether 4-FSK or QAM modulated systems are concerned. However, if only the aspects of frequency assignment and coordination are taken into consideration, a coordination is required at all events no matter whether the frequencies are assigned and coordinated by a central body (e.g. BAPT, Germany) or whether the decentralized approach is used, i.e. by means of the so-called block assignment, particular frequency ranges are assigned exclusively to certain operators who will then have to coordinate these frequencies among themselves. Frequency coordination is indispensable in any case in order to ensure non-interference operation.

8 EQUIPMENT COSTS

In order to be able to evaluate the problems concerning the method of pattern arrangement to be used in terms of the equipment costs involved, one of the manufacturers for radio relay equipment carried out a detailed study.

The results of that study revealed that owing to the use of inexpensive and flexible technologies (fraction N components) the selected method of pattern arrangement did not have any significant impact on the resulting costs.

Thus, in terms of the costs involved, none of the two methods has advantages over the other.

In view of network and frequency planning, both methods are also considered equivalent.

9 PROS AND CONS OF THE TWO METHODS

A superficial examination of the study reveals certain subjective advantages and disadvantages of the two pattern arrangement methods (subdivision and interleaved).

These advantages and disadvantages largely depend on the conditions under which one of the two methods is to be chosen. Major factors are the *number of channels that can be implemented*, *the time and effort required for frequency coordination*, *network and frequency planning aspects (frequency economy)*, *and equipment costs*.

In view of the variety of these factors which arise in the planning and implementation of radio relay networks, the selection of the pattern arrangement method is always based on the *case at hand* and its characteristics.

When several individual cases are compared, it becomes obvious that the advantages of <u>one</u> case may well constitute disadvantages in <u>another</u> case.

For this reason it is extremely difficult, if not impossible, to compile a list giving the definitive advantages and disadvantages of the two methods of pattern arrangement without referring to this specific problem.

10 SUMMARY

In this study a comparison was drawn between the two methods of pattern arrangement: subdivision and interleaved.

The following aspects were examined:

* **Number of channels which can be occupied**
  Result: Which method of pattern arrangement provides for crucial advantages over the other has to be determined in *each single case*.

* **Frequency partitioning between several operators**
  Result: No method of pattern arrangement has advantages over the other.
  Both types of pattern arrangement require a coordination of frequencies between the operators.

* **Aspects of network and frequency planning (frequency economy)**
  Result: Which of the two types of pattern arrangement is more effective than the other concerning the frequency economy has to be determined in *each single case*, depending on the required IRF values to be used in a specific network (i.e. at network hub points).

* **Equipment costs**
  Result: No significant differences in the cost structure were revealed on the basis of a study of equipment costs.
  Both types pf pattern arrangement should considered equivalent in terms of the costs involved.

However, prior to applying these results to all other cases, especially those obtained in conjunction with the spectral decoupling, other radio relay systems have to be tested.

Finally, it should be noted that no type of pattern arrangement has crucial advantages over the other. It can be assumed that future studies and tests will not result in any decided preference being accorded to either type of pattern arrangement. Therefore, it is likely that both will continue to co-exist on equal terms.

11 POSSIBLE MODE OF PROCEDURE REGARDING THE USE OF NEW FREQUENCY RANGES BY THE FIXED SERVICE

1. Determination of band limits for the available frequency range.

2. Specification of guard bands.
   The width of these guard bands should be chosen taking the protection requirements of the services in adjacent frequency ranges into consideration.

3. After the guard bands have been determined, the remaining frequency range can actually be used for the planning of a channel pattern arrangement.

4. Prior to planning the channel pattern arrangement, the type of channel usage (narrow band, broadband or both, analog, digital) should be defined as the latter determines the width of the channels to be planned (e.g. 28 MHz, 14 MHz, 7 MHz).

5. When the type of channel usage and the width of the channels required have been defined, the equipment costs should also be considered.

   Would it be possible to use equipment of another frequency range, which has been allocated to the fixed service?
   Would it be possible to reduce any costs by specifying the same duplex spacing for this frequency range as for other frequency ranges?

   Equipment manufacturers should be included in the discussion focussing on these factors.

6. After all preconditions have been defined such as
   * band limits
   * width of the guard bands
   * frequency range which can actually be used
   * width of the channels
   * if need be, preconditions owing to the use of equipment in other frequency ranges (e.g. duplex spacing)

   the aspect of frequency economy should be taken into consideration (chapter 3).

   Depending on defined preconditions and methods of pattern arrangement (subdivision or interleaved), a particular number of channels can be specified in the frequency range which can actually be used. The aforementioned mode of procedure should be applied to all predefined channel widths. Depending on the precondition, the resulting number of channels can be the same for both methods of pattern arrangement or it can be different.

   Subsequently, the method leading to greater frequency economy can be selected for every predefined channel width. This may result in a channel pattern arrangement which varies from one pattern to the next concerning the method of channel pattern arrangement.

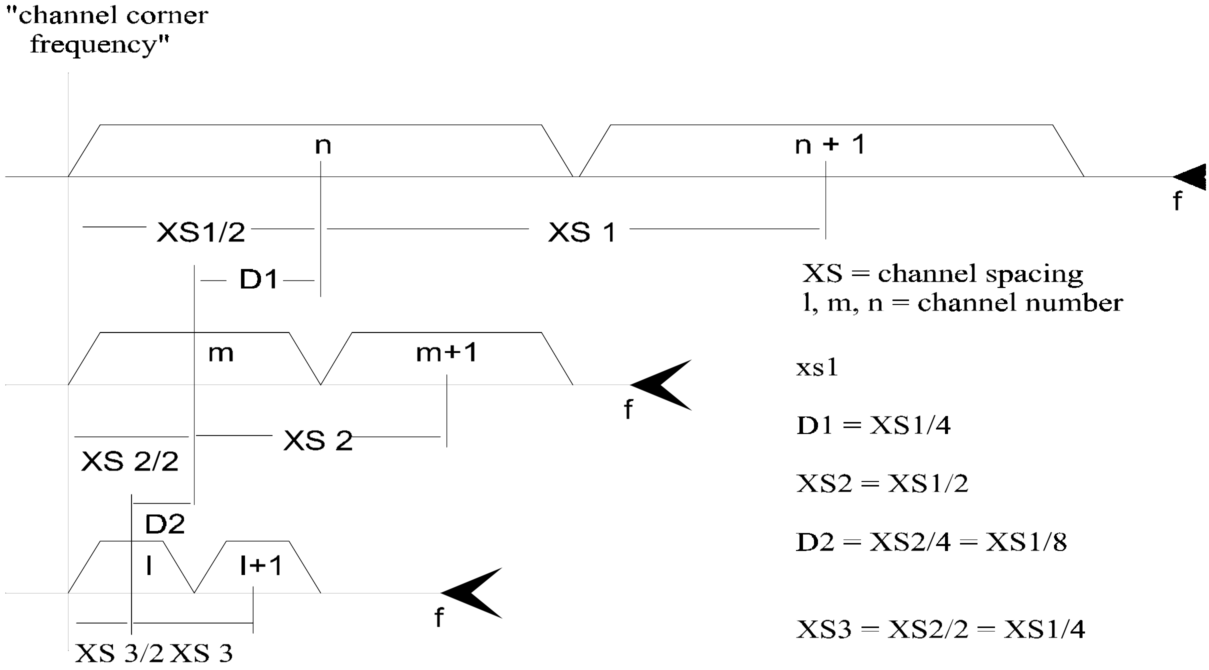
   However, if the number of usable channels is the same, one of the two methods of pattern arrangement should be selected in order to ensure a homogeneous set-up of the entire pattern.

This approach is a valuable tool for selecting the appropriate mode of procedure regarding the use of new frequency ranges by the fixed service.

However, if frequency ranges are considered which are already intensively used by the fixed service, factors such as the costs incurring because of the change from the old to the new pattern play the key role since none of the two methods of pattern arrangement has crucial advantages over the other so that no changes in the frequency ranges intensively used could be justified. Moreover, these ranges are used according to current ITU R Recommendations in most cases.

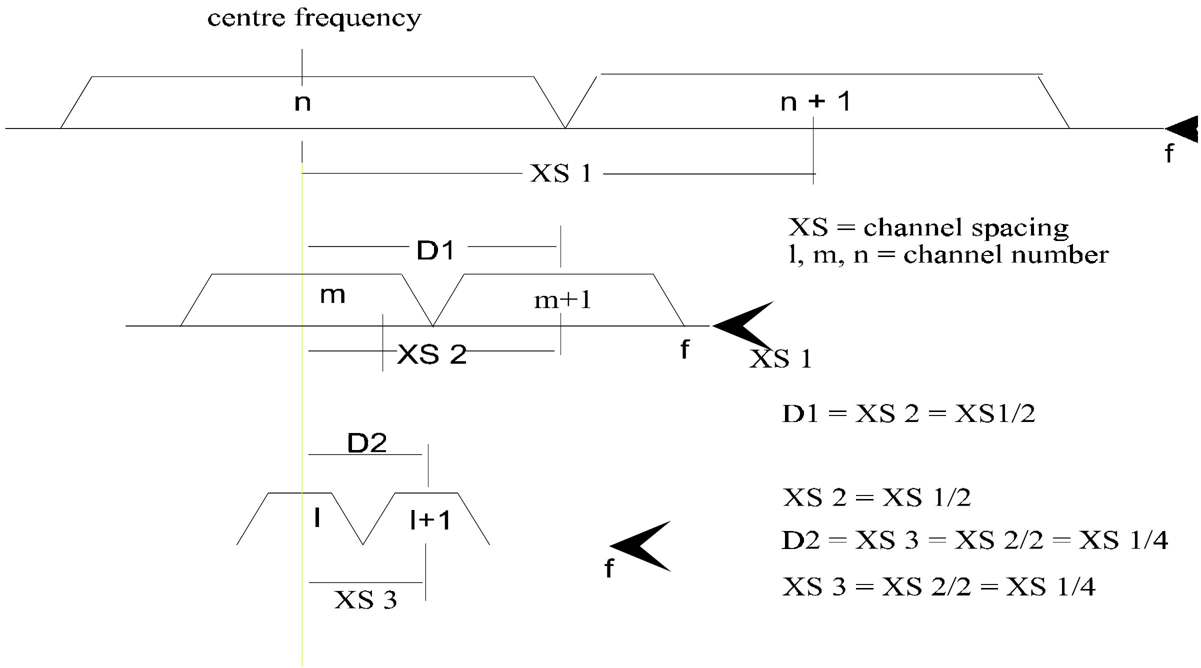
Annex 1

Subdivision Arrangement



Annex 2

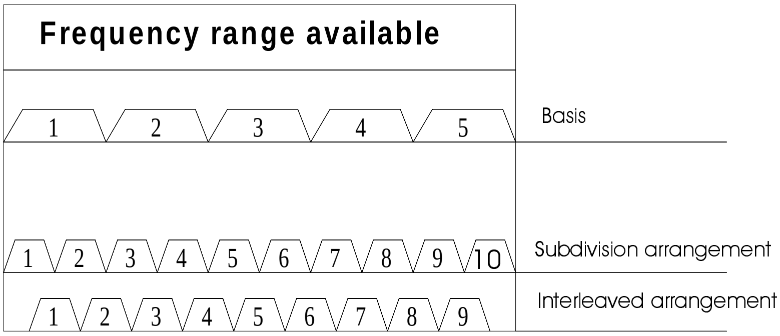
Interleaved Arrangement



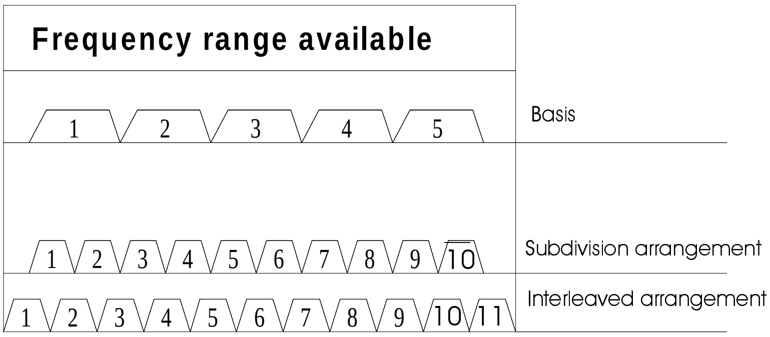
Annex 3

Number of channels which can be occupied within a frequency range

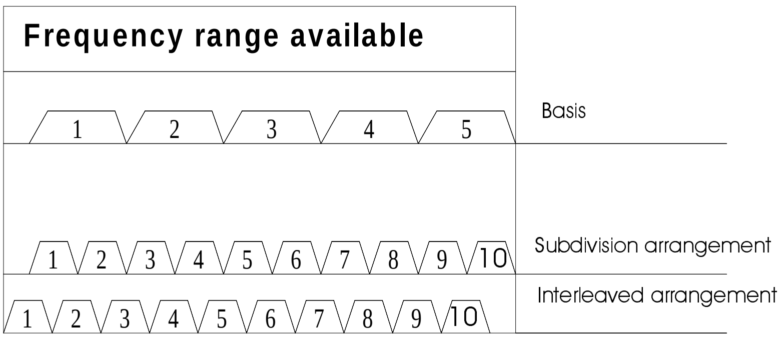
Case 1: Concerning the subdivision arrangement one more channel can be occupied than in the case of the interleaved arrangement



Case 2: Concerning the interleaved arrangement one more channel can be occupied than in the case of the subdivision arrangement



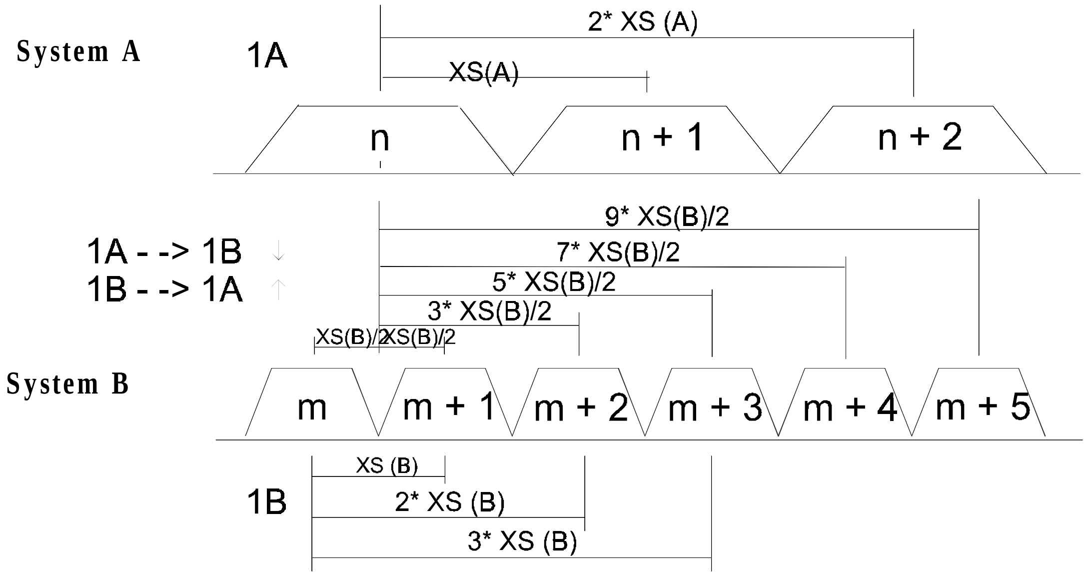
Case 3: No difference in the number of channels concerning both types of pattern arrangement



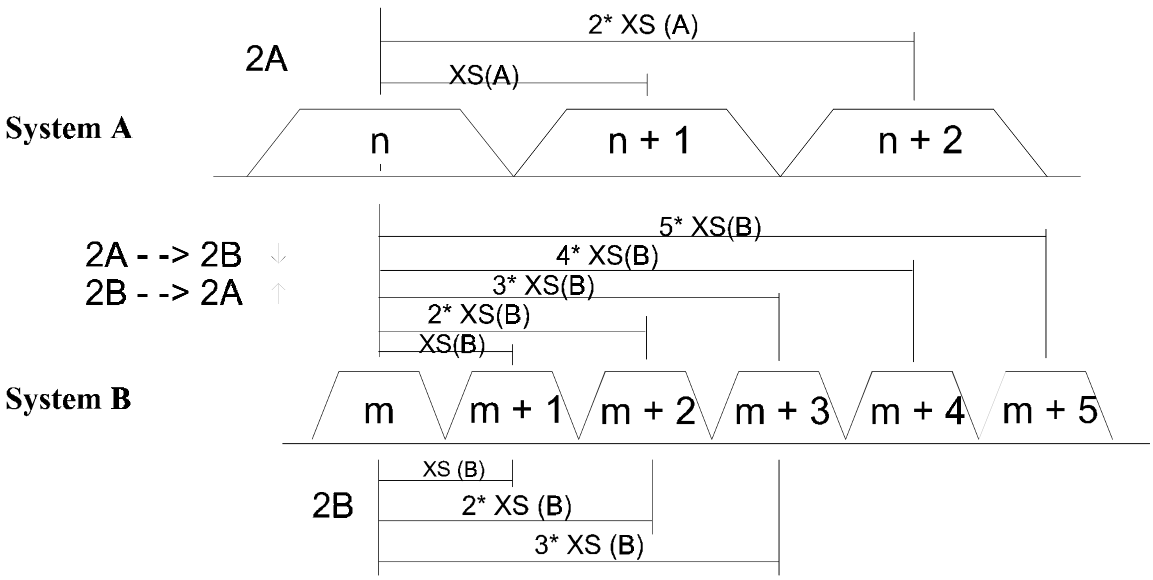
Annex 4

Frequency Separation XS(A) = 2 * XS(B)

1 Subdivision



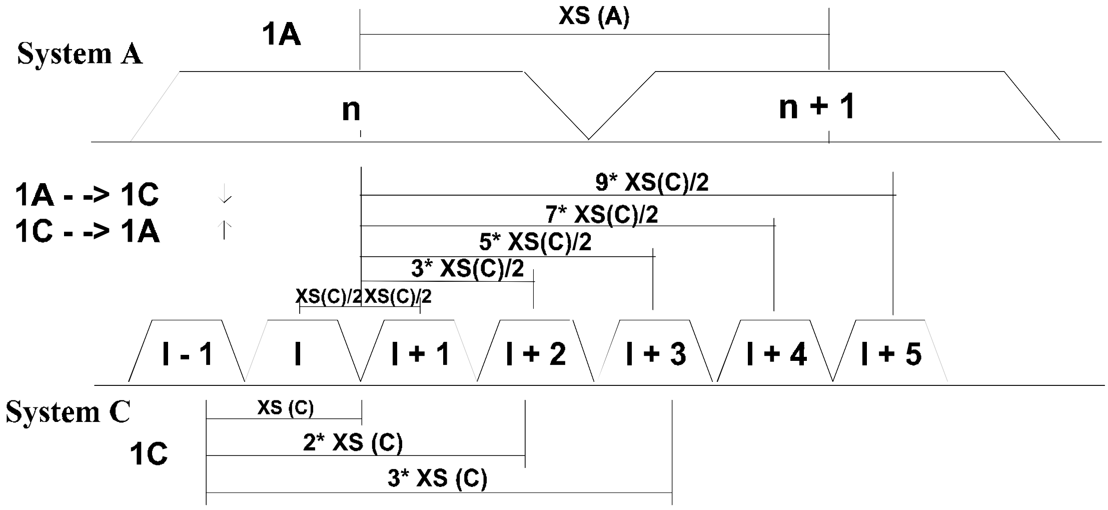
2 Interleaved



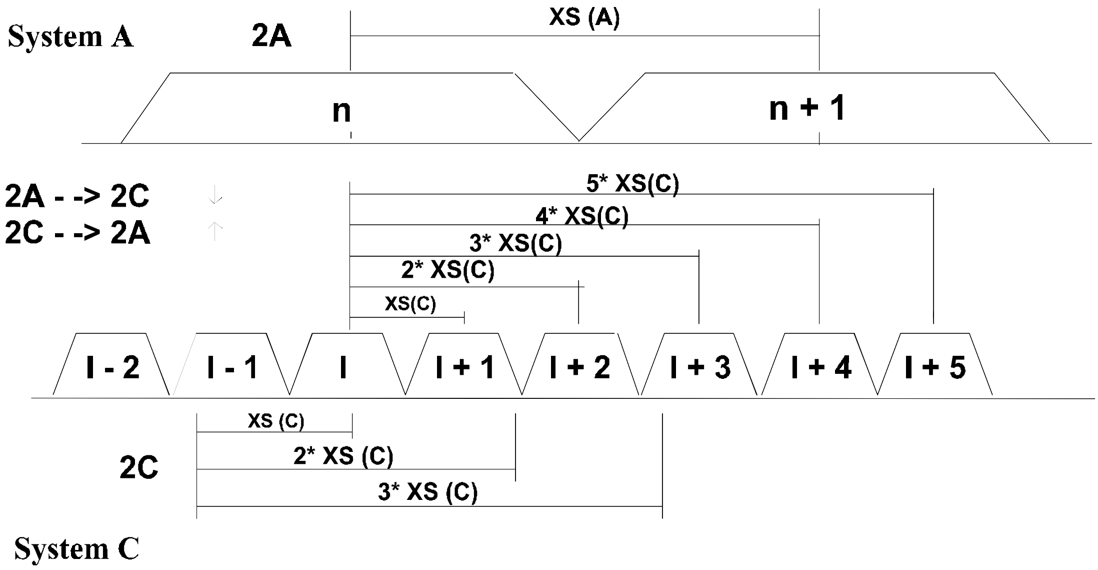
Annex 5

Frequency Separation XS(A) = 4 * XS(C)

1 Subdivision



2 Interleaved



Annex 6, Page 1

1 Table A6.1: Spectral decoupling between the channels of one pattern

A) 8 * 2 Mbit/s	14 MHz		22 dB	58 dB	71 dB
B) 4 * 2 Mbit/s	7 MHz		22 dB	58 dB	71 dB
C) 2 * 2 Mbit/s	3.5 MHz		22 dB	58 dB	71 dB

2 Spectral decoupling between the channels of two patterns

2.1 Table A6.2.1: System A (8 * 2 Mbit/s, 14 MHz channel spacing) causes interference to system B (4 * 2 Mbit/s, 7 MHz channel spacing);
XS(B) = 7 MHz

n * XS(B)/2 n =	Subdivision arrangement Delta f	IRF	Interleaved arrangement Delta f	IRF
0			0 MHz	1 dB
1	+ 3.5 MHz	1 dB		
2			+7 MHz	11 dB
3	+ 10.5 MHz	23 dB		
4			+14 MHz	35 dB
5	+ 17.5 MHz	49 dB		
6			+21 MHz	66 dB
7	+ 24.5 MHz	71 dB		
8			+28 MHz	71 dB
9	+ 31.5 MHz	71 dB		

2.2 Table A6.2.2: System B (4 * 2 Mbit/s, 7 MHz channel spacing) causes interference to system A (8 * 2 Mbit/s, 14 MHz channel spacing);
XS(B) = 7 MHz

n * XS(B)/2 n =	Subdivision arrangement Delta f	IRF	Interleaved arrangement Delta f	IRF
0			0 MHz	0 dB
1	+ 3.5 MHz	0 dB		
2			+7 MHz	7 dB
3	+ 10.5 MHz	18 dB		
4			+14 MHz	31 dB
5	+ 17.5 MHz	38 dB		
6			+21 MHz	50 dB
7	+ 24.5 MHz	56 dB		
8			+28 MHz	61 dB
9	+ 31.5 MHz	66 dB		

Annex 6, Page 2

2.3 Table A6.2.3: System A (8 * 2 Mbit/s, 14 Mhz channel spacing) causes interference to system C (2 * 2 Mbit/s, 3.5 Mhz channel spacing) XS(C) = 3.5 Mhz

n * XS(C)/2 n=	Subdivision arrangement Delta f	 IRF	Interleaved arrangement Delta f	 IRF
0			0 MHz	4 dB
1	1.75 MHz	4 dB		
2			3.5 MHz	7 dB
3	5.25 MHz	12 dB		
4			7.0 MHz	17 dB
5	8.75 MHz	21 dB		
6			10.5 MHz	26 dB
7	12.25 MHz	33 dB		
8			14.0 MHz	40 dB
9	15.75 MHz	47 dB		
10			17.7 MHz	55 dB
11	19.25 MHz	63 dB		
12			21.0 MHz	71 dB
13	22.75 MHz	71 dB		
14			24.5 MHz	71 dB
15	26.25 MHz	71 dB		

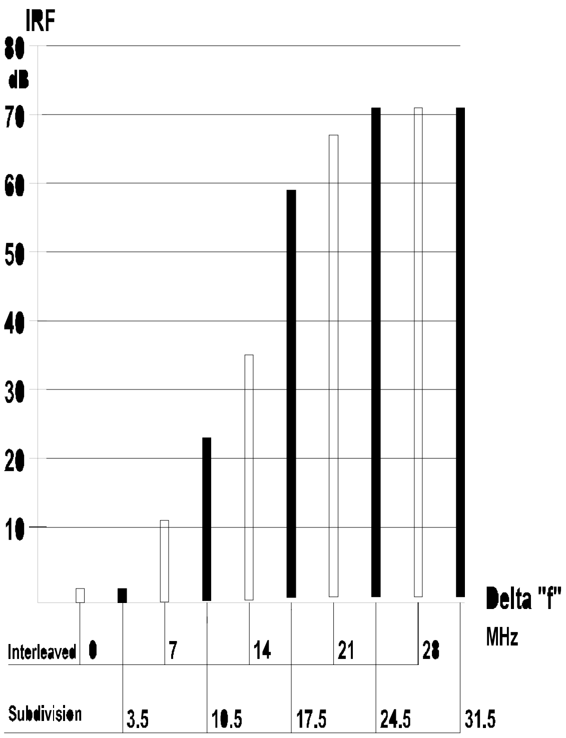
2.4 Table A6.2.4: System C (2 * 2 Mbit/s, 3.5 MHz channel spacing) causes interference to system A (8 * 2 Mbit/s, 14 Mhz channel spacing) XS(C) = 3.5 Mhz

n * XS(C)/2 n=	Subdivision arrangement Delta f	 IRF	Interleaved arrangement Delta f	 IRF
0			0 MHz	0 dB
1	1.75 MHz	0 dB		
2			3.5 MHz	?? dB
3	5.25 MHz	?? dB		
4			7.0 MHz	?? dB
5	8.75 MHz	?? dB		
6			10.5 MHz	19 dB
7	12.25 MHz	25 dB		
8			14.0 MHz	32 dB
9	15.75 MHz	35 dB		
10			17.5 MHz	39 dB
11	19.25 MHz	45 dB		
12			21.0 MHz	51 dB
13	22.75 MHz	54 dB		
14			24.5 MHz	57 dB
15	26.25 MHz	59 dB		
16			28.0 MHz	62 dB
17	29.75 MHz	64 dB		
18			31.5 MHz	67 dB
19	33.25 MHz	69 dB		
20			35.0 MHz	71 dB
21	36.75 MHz	71 dB		

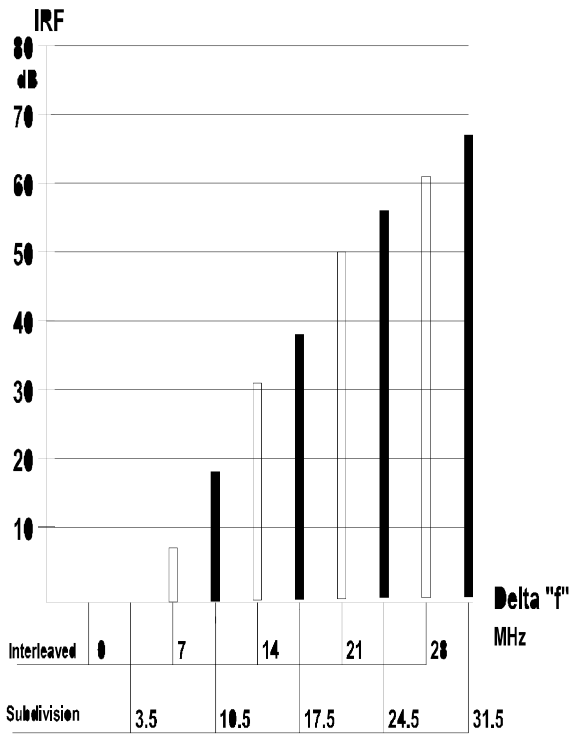
Annex 7/1

Spectral decoupling between the channels of two patterns

System A (8*2 Mbit/s, 14 MHz channel spacing)
causes interference to system B
(4*2 Mbits, 7 MHz channel spacing)



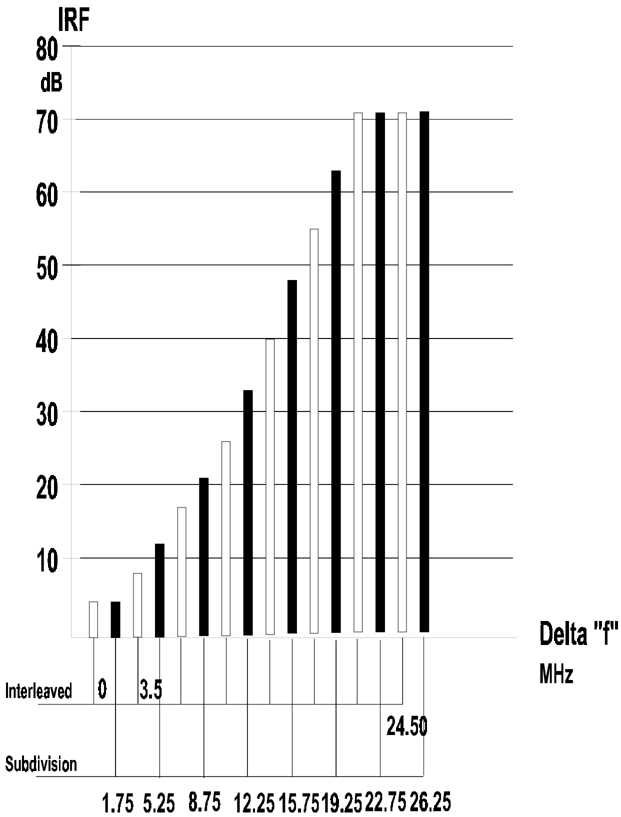
System B (4*2 Mbit/s, 7 MHz channel spacing)
causes interference to system A
(8'2 Mbit/s, 14 MHz channel spacing)



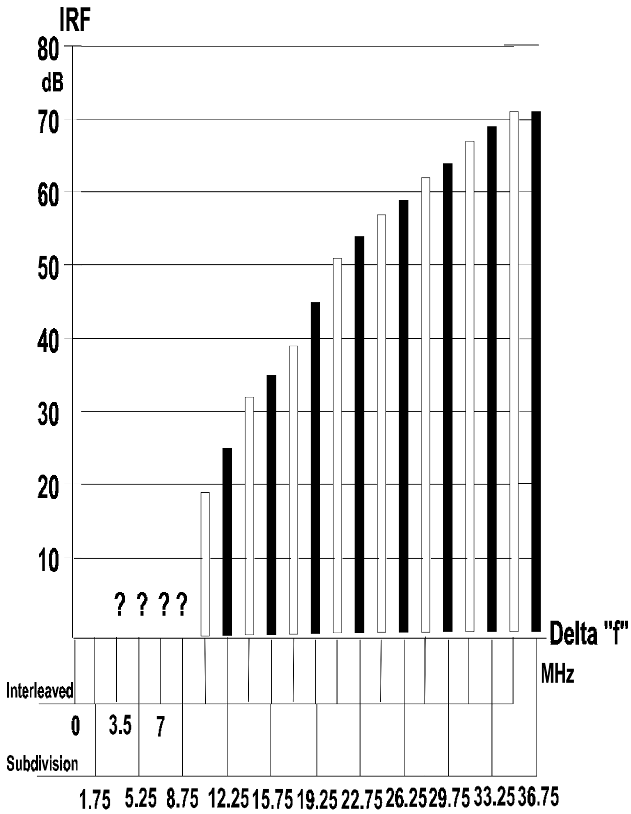
Annex 7/2

Spectral decoupling between the channels of two patterns

System A (8 * 2 Mbit/s, 14 MHz channel spacing)
causes interference to system C
(2 * 2 Mbit/s, 3.5 MHz channel spacing)

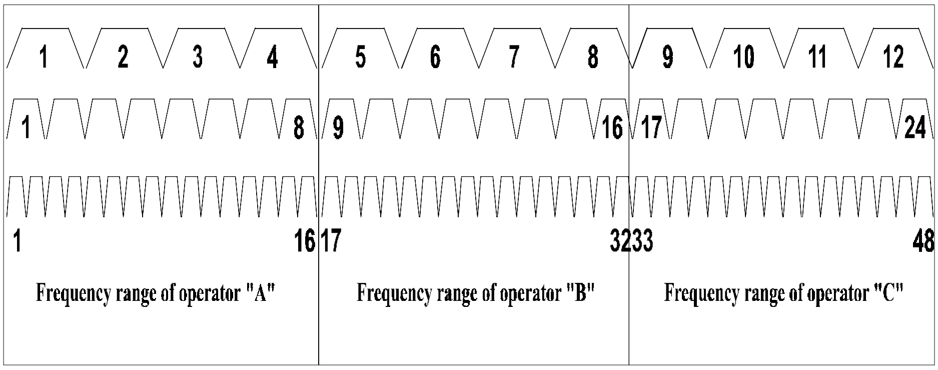


System C (2 * 2 Mbit/s, 3.5 MHz channel spacing)
causes interference to system A
(8 * 2 Mbit/s, 14 MHz channel spacing)

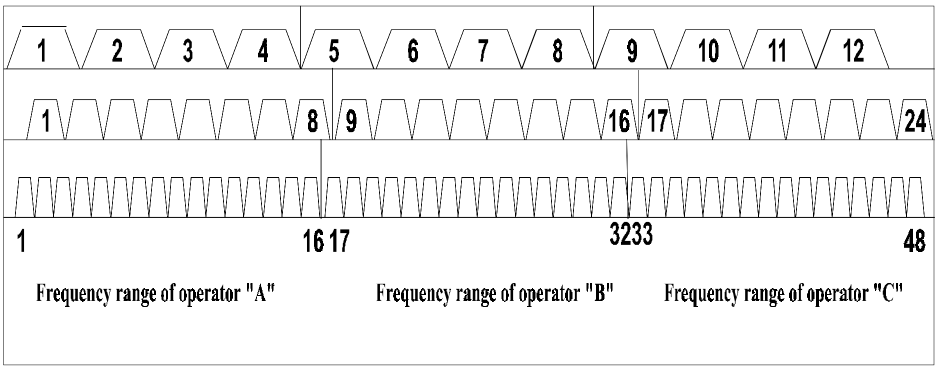


Annex 8

Partitioning of the frequency range between several operators



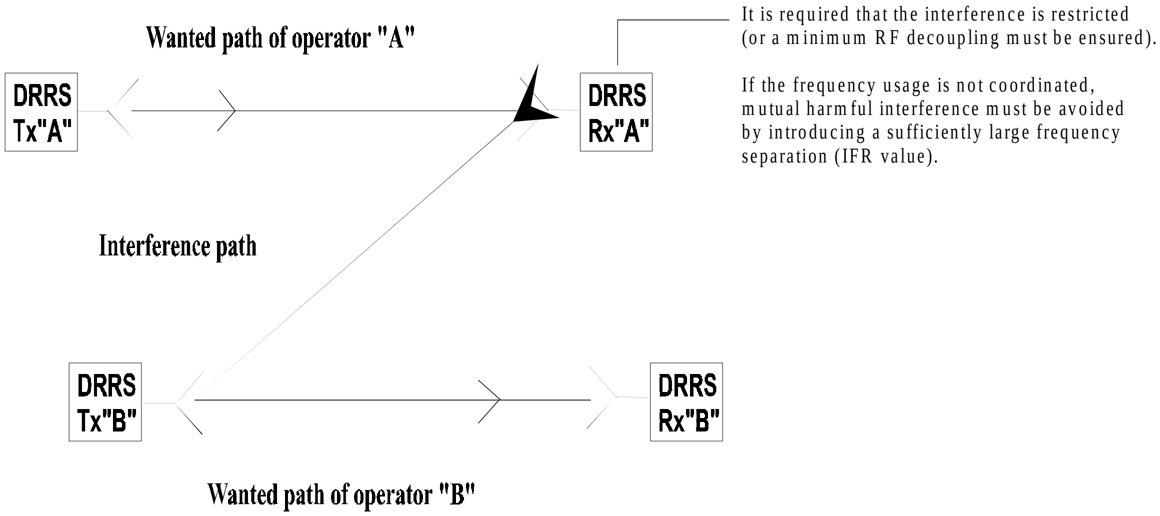
Subdivision



Interleaved

Annex 9

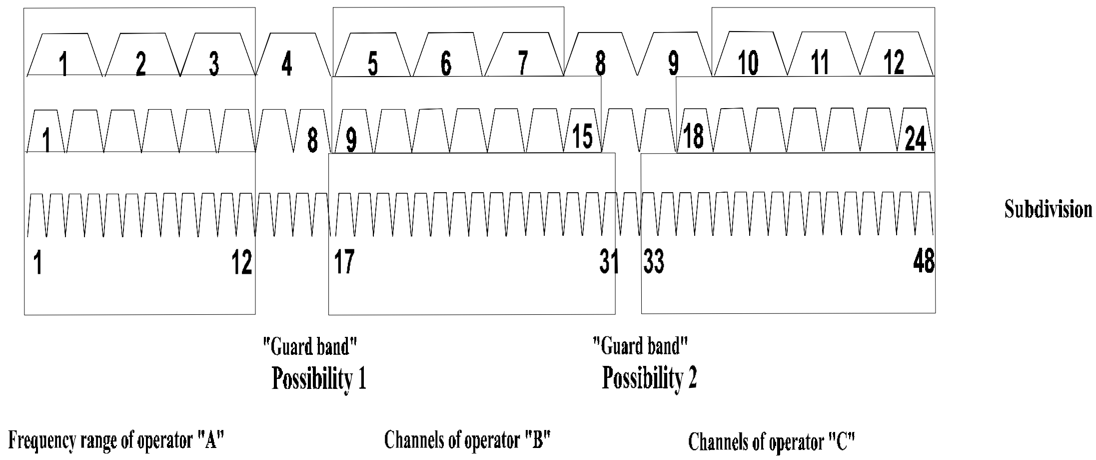
Interference Scenario

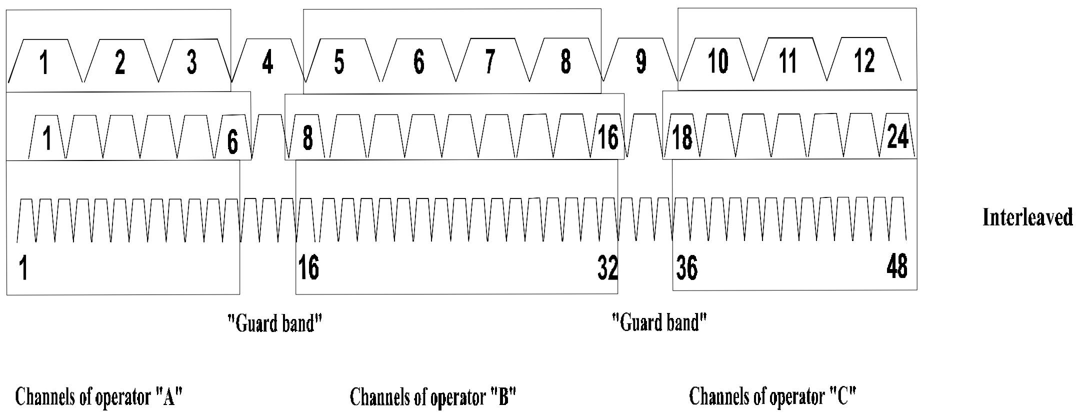


DRRS = Digital Radio Relay System
Tx = Transmitter
Rx = Receiver

Annex 10

Partitioning of the frequency range between several operators and examples of guard bands whcih ensure an IRF value of at least 50 db





Annex 11; Page 1

Wanted to unwanted levels used for frequency assignment in the UK

Wanted to unwanted levels against normalised frequency for the bands 12.75 GHz to 13.25 GHz and 14.25 GHz to 14.50 GHz.

Table A11.1 Wanted 1.75 MHz/2 Mbit/s

Unwanted (MHz/Mbit/s)	XS MHz	W/U dB vs. Normalised frequency XS							
		0.0	<0.5	>=0.5	>=1.0	>=1.5	>=2.0	>=2.5	>=3.0
1.75/2	1.75	27	27	24	3	-11	-21	-31	-40
3.5/2x2	2.625	24	24	21	0	-14	-24	-34	-40
7/8	4.375	21	21	18	-3	-17	-27	-37	-40
14/2x8	7.875	18	18	15	-6	-20	-30	-40	-40
28/34	14.875	15	15	12	-9	-23	-33	-40	-40
28/140 or 155	14.875	15	15	15	-9	-23	-33	-40	-40

Table A11.2 Wanted 3.5 MHz/2x2 Mbit/s

Unwanted (MHz/Mbit/s)	XS MHz	W/U dB vs. Normalised frequency XS							
		0.0	<0.5	>=0.5	>=1.0	>=1.5	>=2.0	>=2.5	>=3.0
1.75/2	2.625	27	27	24	3	-11	-21	-31	-40
3.5/2x2	3.5	27	27	24	3	-11	-21	-31	-40
7/8	5.25	24	24	21	0	-14	-24	-34	-40
14/2x8	8.75	21	21	18	-3	-17	-27	-37	-40
28/34	15.75	18	18	15	-6	-20	-30	-40	-40
28/140 or 155	15.75	18	18	18	-3	-20	-30	-40	-40

Table A11.3 Wanted 7 MHz/8 Mbit/s

Unwanted (MHz/Mbit/s)	XS MHz	W/U dB vs. Normalised frequency XS							
		0.0	<0.5	>=0.5	>=1.0	>=1.5	>=2.0	>=2.5	>=3.0
1.75/2	4.375	27	27	24	3	-11	-21	-31	-40
3.5/2x2	5.25	27	27	24	3	-11	-21	-31	-40
7/8	7.0	27	27	24	3	-11	-21	-31	-40
14/2x8	10.5	24	24	21	0	-14	-24	-34	-40
28/34	17.5	21	21	21	-3	-17	-27	-37	-40
28/140 or 155	17.5	21	21	21	-3	-17	-27	-37	-40

Annex 11; Page 2

Table A11.4 Wanted 14 MHz/2x8 Mbit/s

Unwanted (MHz/Mbit/s)	XS MHz	W/U dB vs. Normalised frequency XS							
		0.0	<0.5	>=0.5	>=1.0	>=1.5	>=2.0	>=2.5	>=3.0
1.75/2	7.875	27	27	24	3	-11	-21	-31	-40
3.5/2x2	8.75	27	27	24	3	-11	-21	-31	-40
7/8	10.5	27	27	24	3	-11	-21	-31	-40
14/2x8	14.0	27	27	24	3	-11	-21	-31	-40
28/34	21.0	24	24	21	0	-14	-24	-34	-40
28/140 or 155	21.0	24	24	24	0	-14	-24	-34	-40

Table A11.5 Wanted 28 MHz/34 Mbit/s

Unwanted (MHz/Mbit/s)	XS MHz	W/U dB vs. Normalised frequency XS							
		0.0	<0.5	>=0.5	>=1.0	>=1.5	>=2.0	>=2.5	>=3.0
1.75/2	14.875	27	27	24	3	-11	-21	-31	-40
3.5/2x2	15.75	27	27	24	3	-11	-21	-31	-40
7/8	17.5	27	27	24	3	-11	-21	-31	-40
14/2x8	21.0	27	27	24	3	-11	-21	-31	-40
28/34	28.0	27	27	24	3	-11	-21	-31	-40
28/140 or 155	28.0	27	27	27	3	-11	-21	-31	-40

Table A11.6 Wanted 28 MHz/140/155 Mbit/s

Unwanted (MHz/Mbit/s)	XS MHz	W/U dB vs. Normalised frequency XS							
		0.0	<0.5	>=0.5	>=1.0	>=1.5	>=2.0	>=2.5	>=3.0
1.75/2	14.875	39	39	37	20	-3	-10	-20	-40
3.5/2x2	15.75	39	39	37	20	-3	-10	-20	-40
7/8	17.5	39	39	37	20	-3	-10	-20	-40
14/2x8	21.0	39	39	37	20	-3	-10	-20	-40
28/34	28.0	39	39	36	20	-3	-10	-20	-40
28/140 or 155	28.0	39	39	35	16	-16	-40	-40	-40