International Telecommunication Union

ITU-R

Radiocommunication Sector of ITU

Recommendation ITU-R F.1099-5

(02/2013)

Radio-frequency channel arrangements for high- and medium-capacity digital fixed wireless systems in the upper 4 GHz (4 400-5 000 MHz) band

F Series

Fixed service

International Telecommunication Union

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***Note**: This ITU-R Recommendation was approved in English under the procedure detailed in Resolution ITU-R 1.*

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RECOMMENDATION ITU-R F.1099-5

Radio-frequency channel arrangements for high- and medium-capacity digital fixed wireless systems in the upper 4 GHz (4 400-5 000 MHz) band

(Question ITU-R 247/5)

(1994-1995-1997-1999-2007-2013)

Scope

This Recommendation provides radio-frequency channel arrangements for fixed wireless systems (FWSs) operating in the upper 4 GHz band (4 400-5 000 MHz), which may be used for high- and medium-capacity fixed systems, based on a 10 MHz common pattern. Annexes 1 and 2 provide channel arrangements in line with the main body provisions, with 20, 40, 80 MHz. Annex 3 provides an alternative arrangement with 28 MHz channels. Both co-channel and alternated arrangements are provided as well as information on multi-carrier transmission based on these arrangements.

The ITU Radiocommunication Assembly,

considering

a) that high-capacity digital fixed wireless systems (FWSs) of 90 Mbit/s or higher rates conveying plesiochronous or synchronous digital hierarchy (PDH or SDH) signals are required in the 5 GHz radio-frequency (RF) bands;

b) that the centre gaps of the individual channel arrangements and the guard spacing at the edges of the band can be chosen by non-occupancy of a suitable number of RF-channel positions in a homogeneous basic pattern;

c) that the uniform basic pattern spacing should not be unjustifiably small nor so large as to jeopardize efficient use of the available spectrum;

d) that the absolute frequencies of the basic pattern should be defined by a single reference frequency;

e) that single- and multi-carrier digital FWS are both useful concepts to achieve the best technical and economic trade-off in the system design,

recommends

1 that the preferred RF channel arrangement for high-capacity digital FWS of 90 Mbit/s or higher rates conveying PDH or SDH signals (see Note 1), operating in the 5 GHz band, should be selected from a homogeneous pattern with the following characteristics.

Centre frequencies f_p of the RF channels within the basic pattern:

$$f_p = 5\,000 - 10\,p \qquad \text{MHz}$$

p : integral 1, 2, 3 ... (see Note 2);

2 that all the go channels should be in one half of the band and all the return channels should be in the other half of the band;

3 that the channel spacing XS, the centre gap YS, the guard spaces Z_1S and Z_2S at the edges of the band and the antenna polarization should be agreed between the administrations concerned;

4 that the alternated or co-channel arrangement plan should be used, examples of which are shown in Fig. 1;

5 that RF channel arrangements derived from *recommends* 1 for the 5 GHz band and given in Annexes 1 and 2 should be regarded as part of this Recommendation;

6 that if multi-carrier transmission (see Note 3 and Annex 1, § 2) is employed, the overall number of n carriers will be regarded as a single channel, the centre frequency and channel spacing of which will be that defined according to Fig. 1, disregarding the actual centre frequencies of the individual carriers, which may vary, for technical reasons, according to practical implementations.

NOTE 1 – Actual gross bit rates including overhead may be as much as 5% or higher than net transmission rates.

NOTE 2 – Due regard should be taken of the fact that in some countries where additional RF channels interleaved between those of main patterns are required, the values of the centre frequencies of these RF channels should be given by the following equation (see Annexes 1 and 2):

$$f_p = 4\,995 - 10\,p \qquad \text{MHz}$$

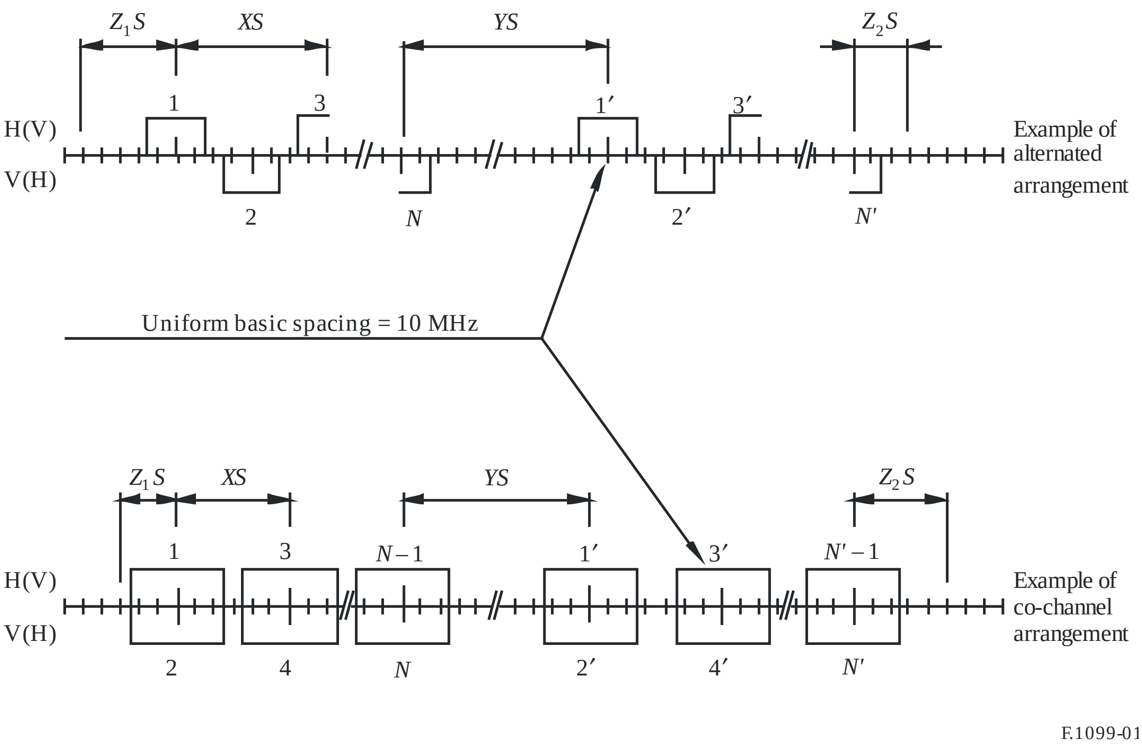
NOTE 3 – A multi-carrier system is a system with n (where $n > 1$) digitally modulated carrier signals simultaneously transmitted (or received) by the same RF equipment. The centre frequency should be regarded as the arithmetic average of the n individual carrier frequencies of the multi-carrier system.

NOTE 4 – Due regard should be taken of the fact that in some countries a different radio-frequency channel arrangement, based on 28 MHz channel separation, is used (see Annex 3).

FIGURE 1

Examples of channel arrangements based on *recommends* 1 and 2

(For definitions of *X, Y, Z* and *S* see Recommendation ITU-R F.746)



Annex 1

RF channel arrangement for the band 4 400-5 000 MHz with channel separation of 40 or 80 MHz

1 40 MHz RF channel arrangement

1.1 The following RF channel arrangement provides seven go and seven return channels with a transmission capacity up to 2 × 155 Mbit/s for radio systems with a suitable higher level modulation and spectrum efficiency up to 7.75 bit/s/Hz. The RF channel arrangement should be as shown in Fig. 2 and should be derived as follows:

let f_0 be the frequency (MHz) of the centre of the band of frequencies occupied, $f_0 = 4\,700$,

f_n be the centre frequency (MHz) of one RF channel in the lower half of the band,

f'_n be the centre frequency (MHz) of one RF channel in the upper half of the band,

then the frequencies of individual channels are expressed by the following relationships:

lower half of the band: $f_n = f_0 - 310 + 40\,n$ MHz

upper half of the band: $f'_n = f_0 - 10 + 40\,n$ MHz

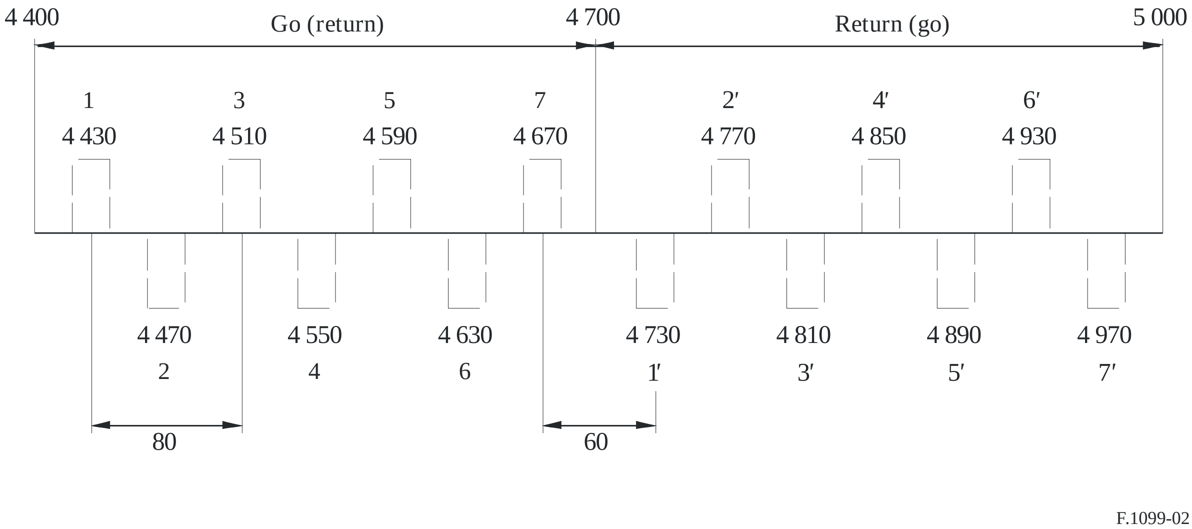
where:

n = 1, 2, 3, 4, 5, 6 or 7.

FIGURE 2

Radio-frequency channel arrangement for radio-relay systems operating in the 5 GHz band (see Note 1)

(All frequencies in MHz)



Note 1 – Where a fewer number (four or less) of RF channels are initially planned or required, the go and return paired assignments may employ the same polarisation. In this case, only the even numbered or odd numbered channels are utilized.

1.2 All the go channels should be in one half of the band and all the return channels should be in the other half of the band.

1.3 Different polarizations should be used in an alternated pattern for RF channels in the same half of the band or where it is possible, band re-use in the co-channel mode may be utilized.

2 80 MHz co-channel dual polarized channel arrangement

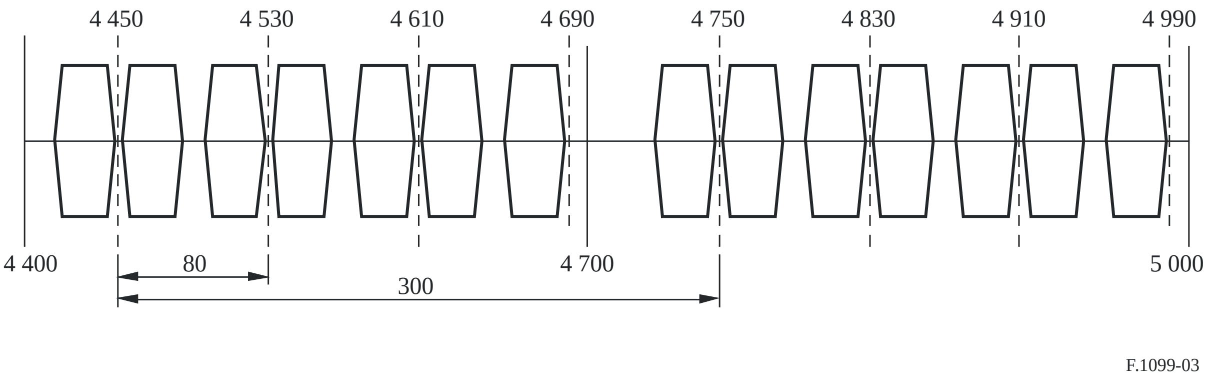
The channel arrangement depicted in Fig. 3 is based upon the use of a 2-carrier system transmitting $2 \times 2 \times 155.52$ Mbit/s ($4 \times$ STM-1) via two carrier pairs using both polarizations in the co-channel arrangement.

In addition to the quadruplets of carriers in both go and return sub-band, two cross-polar single carriers can be introduced as protection channels if necessary. Due to the fact that each carrier, i.e. baseband bit stream, can be switched individually, this $(n + 2)$-configuration acts at least as efficiently as a $(n/2 + 1)$-configuration when used as frequency diversity.

FIGURE 3

Radio-frequency channel arrangement for a 2 × 2 × 155.52 Mbit/s (4 × STM-1) radio-relay system operating in the 5 GHz (4 400-5 000 MHz) band

(All frequencies in MHz)



Annex 2

RF channelling arrangements for the band 4540-4900 MHz with channel separation of 20 or 40 MHz

This Annex describes a RF channelling plan for digital radio systems in the band 4540-4900 MHz. The arrangement provides for up to four go and four return channels each accommodating either 4×45 Mbit/s, 6×45 Mbit/s or the SDH bit rate at 2×155 Mbit/s. A 512-QAM modulation scheme allows for system operation at STM-1 or $2 \times$ STM-1. An alternative arrangement provides up to eight go and eight return channels each accommodating either 2×45 Mbit/s, 3×45 Mbit/s or the SDH bit rate at 155 Mbit/s.

1 The RF channel arrangement is shown in Fig. 4 and is derived as follows:

Let f_0 be the frequency at the centre of the band:

f_0 = 4 720 MHz

f_n : centre frequency of one RF channel in the lower half of the band (MHz),

f'_n : centre frequency of one RF channel in the upper half of the band (MHz),

then the centre frequencies of the individual channels are expressed by the following relationships:

lower half of the band: $f_n = f_0 - 195 + 40\,n$ MHz

upper half of the band: $f'_n = f_0 - 5 + 40\,n$ MHz

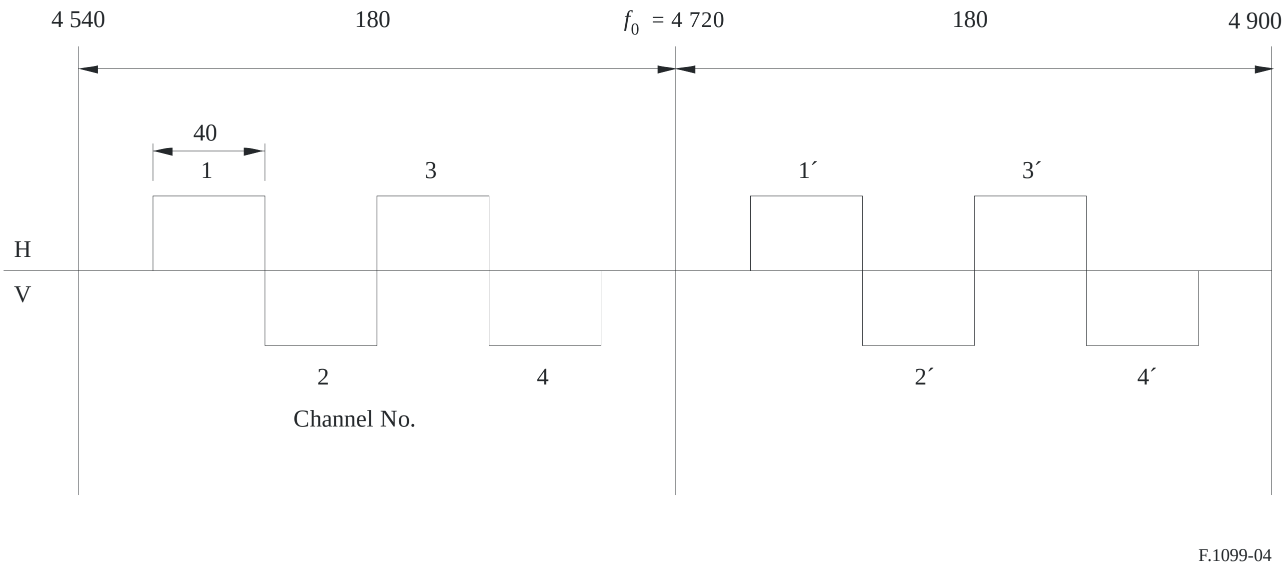
where:

n = 1, 2, 3 or 4.

FIGURE 4

Radio-frequency channel arrangement for the 5 GHz band

(All frequencies in MHz)



2 An alternative arrangement is shown in Fig. 5 and the assignments are expressed as follows:

The centre frequencies of the individual channels are expressed by the following relationships:

lower half of the band: $f_n = f_0 - 185 + 20\,n$ MHz

upper half of the band: $f'_n = f_0 + 5 + 20\,n$ MHz

where:

f_0 = 4 720 MHz

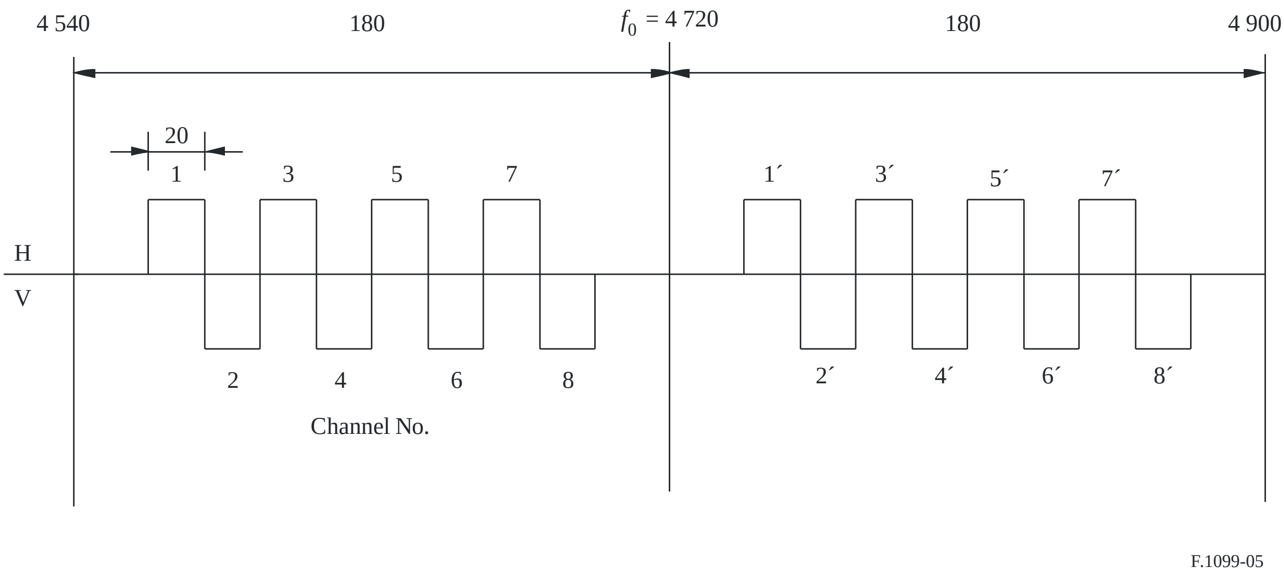
n = 1, 2, 3, 4, 5, 6, 7 or 8.

3 All the go channels should be in one half of the band and all the return channels should be in the other half of the band.

FIGURE 5

Alternative radio-frequency channel arrangement for the 5 GHz band

(All frequencies in MHz)



Annex 3

RF channel arrangement in the band 4 400-5 000 MHz with channel separation of 28 MHz

This Annex describes a RF channelling plan for digital systems in the band 4 400-5 000 MHz. The arrangement provides for up to 10 go and 10 return channels, each accommodating either 4×34 Mbit/s or 1×139.368 Mbit/s or the synchronous bit rates.

A 64-QAM or more complex modulation scheme allows for system operation at those bit rates.

1 The RF channel arrangement is shown in Fig. 6 and is derived as follows:

Let f_0 be the frequency at the centre of the band:

$f_0 = 4\,700$ MHz

f_n be the centre frequency of one radio-frequency channel in the lower half of the band (MHz)

f'_n be the centre frequency of one radio-frequency channel in the upper half of the band (MHz),

the centre frequencies of the individual channels are expressed by the following relationships:

lower half of the band: $f_n = f_0 - 310 + 28\ n$

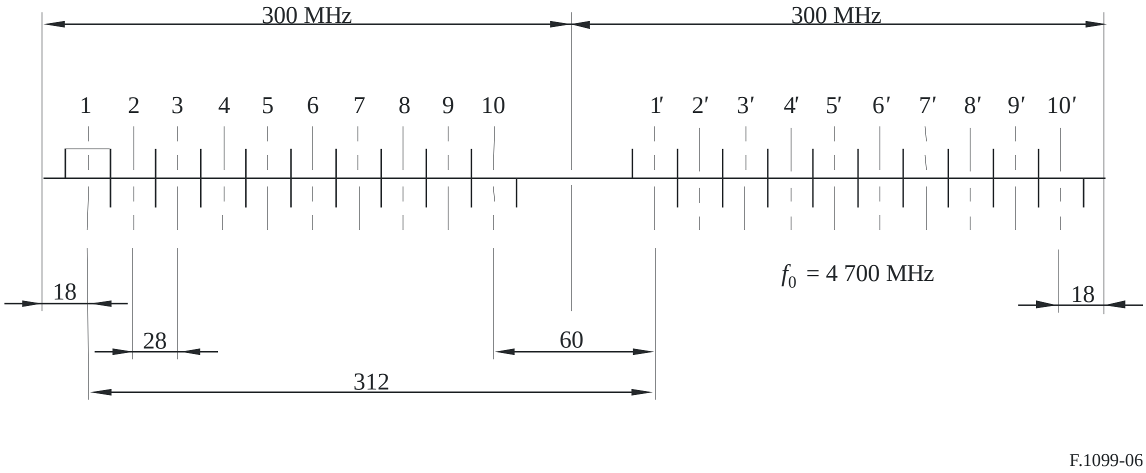
upper half of the band: $f'_n = f_0 + 2 + 28\ n$

where:

n = 1, 2, 3, 4, 5, 6, 7, 8, 9, 10.

FIGURE 6

Radio-frequency channel arrangement for the band 4 400-5 000 MHz with a 28 MHz channel spacing



2 All the go channels should be in one half of the band and all the return channels should be in the other half of the band.

3 This RF channelling arrangement also allows transmission of SDH, STM-1 at 155 520 kbit/s signals, using an appropriate modulation method.

4 When the equipment and network characteristics permit, co-channel frequency reuse of the arrangement can be employed, with the agreement of the administrations concerned, for improving spectral efficiency.

5 When very high capacity links (e.g. twice Synchronous Transfer Mode-1(STM-1) are required and network coordination permits, with the agreement of the administrations concerned, the use of any two adjacent 28 MHz channels specified in *recommends* 1 is possible, for wider bandwidth systems, with centre frequency lying in the central point of the distance between the two 28 MHz adjacent channels.