RECOMMENDATION ITU-R F.497-5

RADIO-FREQUENCY CHANNEL ARRANGEMENTS FOR RADIO-RELAY SYSTEMS OPERATING IN THE 13 GHz FREQUENCY BAND

(Question ITU-R 136/9)

(1974-1978-1982-1990-1992-1995)

The ITU Radiocommunication Assembly,

considering

a) that the 12.75 to 13.25 GHz band is allocated *inter alia* to the fixed and mobile terrestrial services;

b) that, at these frequencies, radio-relay systems for digital or analogue transmission are feasible with repeater spacings and other features chosen according to rainfall conditions;

c) that it may be desirable to interconnect such systems at radio frequencies on international circuits;

d) that a uniform radio-frequency channel arrangement usable for both analogue and digital systems offers considerable advantages;

e) that the homogeneous frequency pattern based on an interval of 14 MHz (see Recommendation ITU-R F.636) is adaptable in this frequency band;

f) that it may sometimes be desirable to interleave additional radio-frequency channels between those of the main pattern;

g) that the radio-frequency channels should be so arranged that an intermediate frequency of 70 MHz be employed for analogue and for digital systems;

h) that high capacity digital radio-relay systems in the synchronous digital hierarchy (SDH) are required in the 13 GHz radio frequency band,

recommends

1 that the preferred radio-frequency channel arrangement for FDM radio-relay systems with a maximum capacity of 960 telephone channels or the equivalent, and for digital radio-relay systems with a capacity of 34 Mbit/s, operating in the 13 GHz band, should be derived as follows:

Let f_0 be a reference frequency near the centre of the 12.75 to 13.25 GHz band (MHz),

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

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

then the frequencies (MHz) of individual channels are expressed by the following relationship:

lower half of the band: $f_n = f_0 - 259 + 28\,n$ MHz

upper half of the band: $f'_n = f_0 + 7 + 28\,n$ MHz

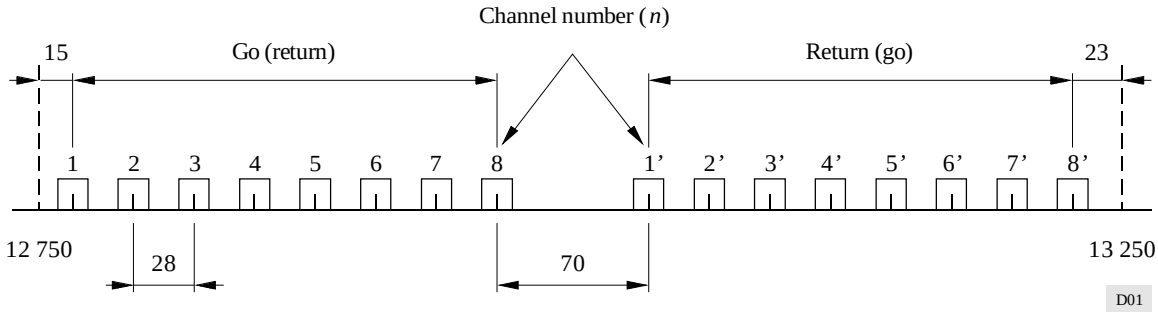
where:

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

The frequency arrangement is illustrated in Fig. 1;

FIGURE 1

Radio-frequency channel arrangement for radio-relay systems operating in the 13 GHz band
(Main pattern)
(All frequencies in MHz)



2 that, in the section through which an international connection is arranged to pass, 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, in FDM systems, horizontal and vertical polarization shall be used alternately for adjacent radio-frequency channels in the same half of the band;

4 that, in digital systems, with a capacity of 34 Mbit/s, both horizontal and vertical polarization shall be used, where possible, for each radio-frequency channel;

5 that for digital systems with a capacity of 70 to 140 Mbit/s the same radio-frequency channel arrangement may be used utilizing the RF channels number $n = 2, 4, 6$ and 8 in the case of a co-channel arrangement or $n = 1, 2, 3, 4, 5, 6, 7$ and 8 in the case of an alternated arrangement (the possible use of the channel number 1 would depend on the radiated spectrum width) (see Note 3);

6 that for SDH digital systems with a capacity of 155 Mbit/s the same radio-frequency channel arrangement shall be used utilizing the RF channels number $n = 1, 2, 3, 4, 5, 6, 7$ and 8 with an alternated arrangement. The possible use of the channel number 1 would depend on the radiated spectrum width (Note 3);

7 that, when additional radio-frequency channels with a maximum capacity of 300 FDM channels or of 240 digital channels, interleaved between those of the main pattern, are required, the values of the centre frequencies of these radio-frequency channels should be 14 MHz above those of the corresponding main channel frequencies. On the same route, it is advisable to use only systems having capacities no greater than these, when using this spacing;

8 that, when common transmit-receive antennas are used and no more than four channels are accommodated on a single antenna, it is preferred that the channel frequencies be selected by making either:

$$n = 1, 3, 5 \text{ and } 7 \quad \text{or} \quad 2, 4, 6 \text{ and } 8;$$

9 that, for international connections, the reference frequency should preferably be 12 996 MHz. Other values may be used by agreement between the administrations concerned;

10 that, in cases where smaller capacity radio channels having a capacity of 30 digital telephone channels (or the equivalent) are required, the following channel arrangements, (which occupy some of the bi-directional medium-capacity radio channels of the basic channel arrangement), should be used (see Note 2):

– *Alternative I:*

lower half of the band: $f_m = f_0 - 276.5 + 28\,n + 7\,m$ MHz

upper half of the band: $f'_m = f_0 - 10.5 + 28\,n + 7\,m$ MHz

where:

m = 1, 2, 3 or 4

n : channel number of the basic channel arrangement.

When n = 1, the channel arrangement of Fig. 2a) is obtained.

Additional channels may be obtained by choosing n = 2.

By agreement between the administrations concerned, n may be greater than 2.

– *Alternative II:*

lower half of the band: $f_m = f_0 - 66.5 + 7\,m$ MHz

upper half of the band: $f'_m = f_0 + 3.5 + 7\,m$ MHz

where:

m is preferably 3, 4, 5 or 6.

When additional channels are required, channel values of m = 1, 2, 7 or 8, may be used. This arrangement is illustrated in Fig. 2b).

– *Alternative III:*

To achieve double the number of low capacity channels using channels 1 and 1′ of the basic plan as compared with Alternative I:

lower half of the band: $f_m = f_0 - 274.75 + 28\,n + 3.5\,m$ MHz

upper half of the band: $f'_m = f_0 - 8.75 + 28\,n + 3.5\,m$ MHz

Some administrations have already implemented and may decide to continue to apply the following formulae:

lower half of the band: $f_m = f_0 - 273 + 28\,n + 3.5\,m$ MHz

upper half of the band: $f'_m = f_0 - 7 + 28\,n + 3.5\,m$ MHz

where:

m = 1, 2, 3, 4, 5, 6, 7 or 8

n : number of the basic channel arrangement.

When n = 1, the channel arrangement of Fig. 2c) is obtained.

Additional channels may be obtained by choosing n = 2.

By agreement between the administrations concerned, n may be greater than 2;

11 that due regard should be taken of the fact that a different channel arrangement for up to 960 telephone channel digital systems is also used; this arrangement is described in Annex 1;

12 that Note 1 should be regarded as part of this Recommendation.

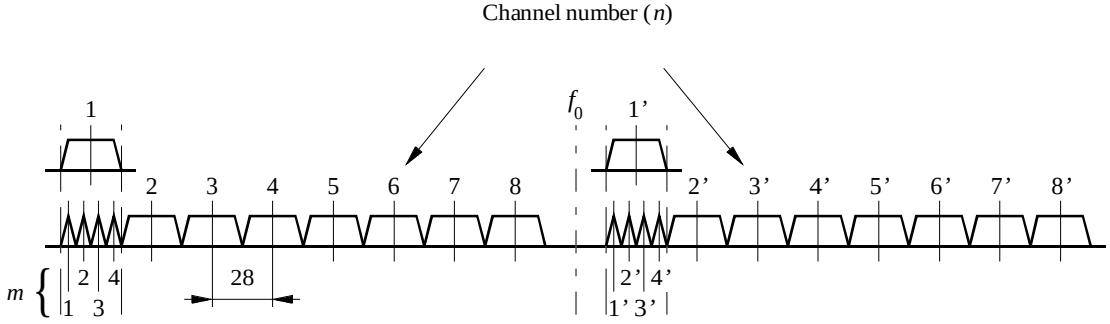
NOTE 1 – In some countries in Region 1, the basic channel spacing of this frequency pattern may be suitable for extension to adjacent frequency bands in the range 11.7 to 15.35 GHz, taking into account the appropriate Radio Regulations.

NOTE 2 – In order to reduce the possibility of an unacceptable degradation in performance occurring, care should be exercised in using mixed channel arrangements in a radio-relay network. This would especially apply if the low capacity channel arrangements described in § 10 and medium capacity radio-relay links, operating in accordance with the main channel arrangements are both present in the same network.

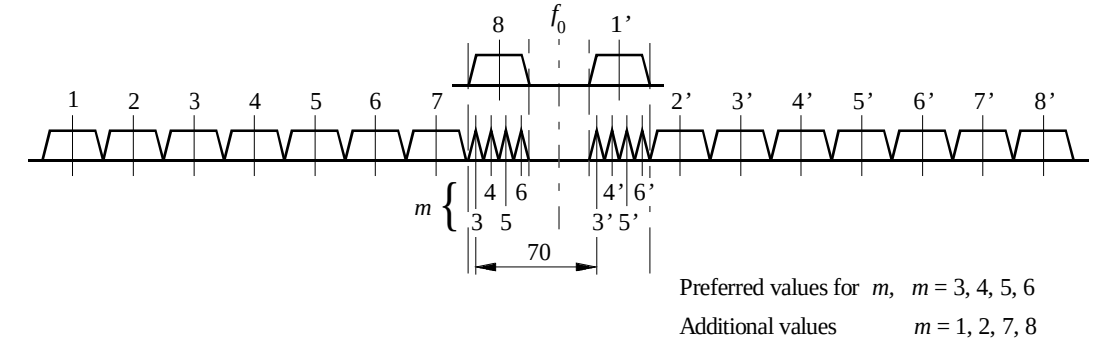
NOTE 3 – In the case of utilization with digital systems with a symbol rate of more than about 25 MBd, care should be taken when using the RF channel at the lower band edge with a guard band of 15 MHz.

FIGURE 2

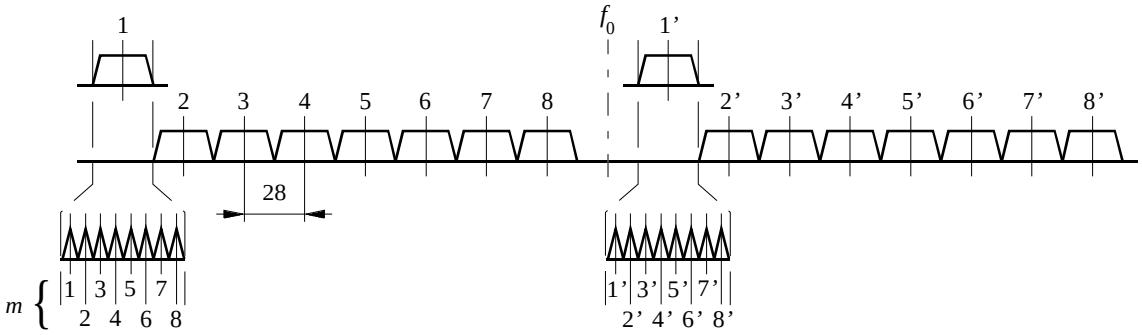
Examples of radio-frequency channel arrangements for smaller capacity digital systems
(as described in § 10)
(All frequencies in MHz)



a) Systems using channel No. 1 and 1' of the basic plan



b) Systems having 70 MHz frequency separation between the send and receive directions



c) Systems using channel No. 1 and 1' of the basic plan in order to achieve a more efficient use of the spectrum when compared with the arrangement in a)

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ANNEX 1

Description of the radio-frequency channel arrangement referred to in *recommends* 11

For some digital applications with a capacity of up to 960 telephone channels, a radio-frequency arrangement having the following characteristics may be used:

lower half of the band: $f_n = f_0 - 259 + 35\,n$ MHz

upper half of the band: $f'_n = f_0 + 21 + 35\,n$ MHz

where:

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

The arrangement is illustrated in Fig. 3.

The preferred reference frequency f_0 is the same as that given in *recommends* 9.

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. For the adjacent radio-frequency channels in the same half of the band different polarizations should preferably be used alternately.

FIGURE 3

Radio-frequency channel arrangement for high capacity digital systems
(All frequencies in MHz)