

RECOMMENDATION ITU-R F.384-7^{*,**}**Radio-frequency channel arrangements for medium and high capacity analogue or digital radio-relay systems operating in the upper 6 GHz band**

(Question ITU-R 136/9)

(1963-1966-1974-1982-1986-1990-1995-1999)

The ITU Radiocommunication Assembly,

considering

- a) that radio-relay systems with a capacity of 2 700 telephone channels should prove to be feasible in the 6 GHz band, if due care is exercised in the planning of radio paths to reduce multi-path effects;
- b) that it is sometimes desirable to be able to interconnect, at radio frequencies, radio-relay systems on international circuits in the 6 GHz band;
- c) that it may be desirable to interconnect up to eight go and eight return channels in a frequency band 680 MHz wide;
- d) that economy may be achieved if at least four go and four return channels can be interconnected between systems, each of which uses common transmit-receive antennas;
- e) that a common radio-frequency (RF) channel arrangement for both up to 1 260 and 2 700 telephone channel radio-relay systems offers considerable advantages;
- f) that the use of certain types of digital modulation (see Recommendation ITU-R F.1101) permits the use of the RF channel arrangement defined for 2 700 telephone channel systems for the transmission of digital channels with a bit rate of the order of 140 Mbit/s or synchronous digital hierarchy bit rates;
- g) that for these digital 140 Mbit/s radio systems, further economies are possible by accommodating up to eight go and return channels on a single antenna with suitable performance characteristics;
- h) that many interfering effects can be reduced substantially by a carefully planned arrangement of the radio frequencies in radio-relay systems employing several RF channels;
- j) that RF channels should be so arranged that for analogue radio-relay systems an intermediate frequency of 70 MHz may be used for up to 1 260 telephone channels;
- k) that RF channels should be so arranged that for analogue radio-relay systems an intermediate frequency of 140 MHz may be employed for 2 700 telephone channels;

* This Recommendation applies only to line-of-sight and near line-of-sight radio-relay systems.

** Radiocommunication Study Group 9 made editorial amendments to this Recommendation in 2001 in accordance with Resolution ITU-R 44.

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

recommends

1 that the preferred radio-frequency channel arrangement for up to eight go and eight return channels, each accommodating 2 700 telephone channels, or a bit rate of the order of 140 Mbit/s, or synchronous digital hierarchy bit rates (Note 3), and operating at frequencies in the upper 6 GHz band, should be derived as follows:

Let f_0 be the frequency of the centre of the band of frequencies occupied (MHz),

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

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

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

$$\text{lower half of the band: } f_n = f_0 - 350 + 40 n \quad \text{MHz}$$

$$\text{upper half of the band: } f'_n = f_0 - 10 + 40 n \quad \text{MHz}$$

where:

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

2 that, in the section over which the international connection is arranged, 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 different polarizations should be used alternately for adjacent radio-frequency channels in the same half of the band;

4 that, when common transmit-receive antennas are used, and not more than four channels are accommodated on a single antenna, it is preferred that the channel frequencies be selected by making either:

$$n = 1, 3, 5 \text{ and } 7 \text{ in both halves of the band}$$

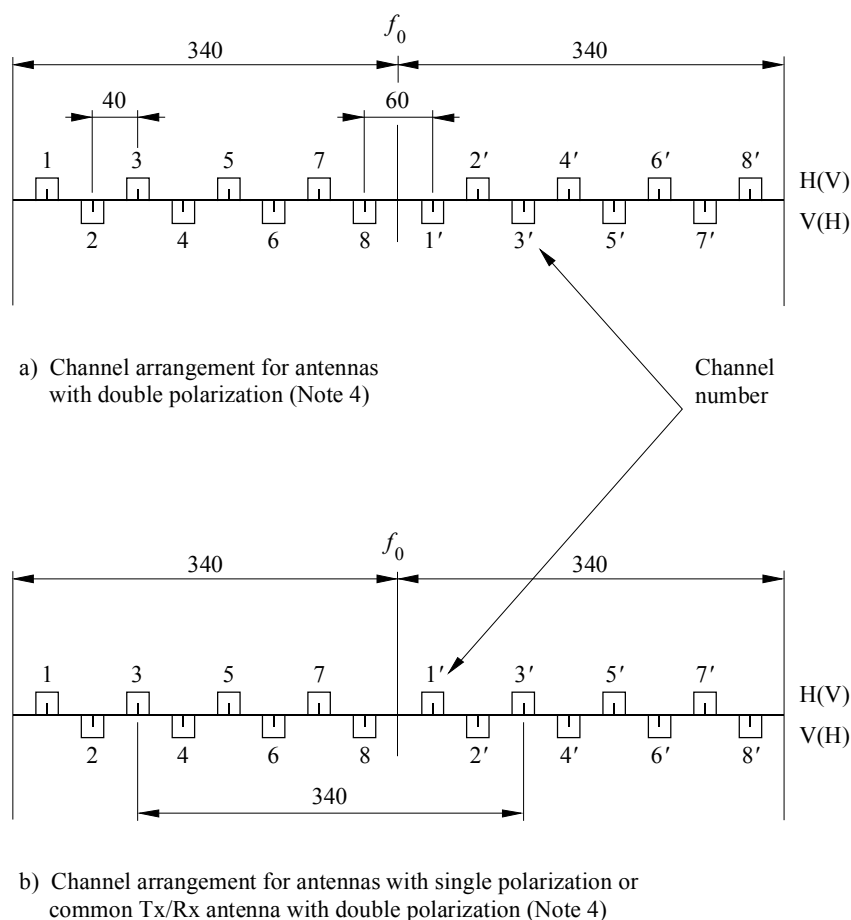
or

$$n = 2, 4, 6 \text{ and } 8 \text{ in both halves of the band (Note 4);}$$

5 that the preferred arrangement of RF polarization should be one of those shown in Fig. 1;

6 that a co-channel arrangement may also be used for digital radio-relay systems which can be derived from the arrangements given in Figs. 1a) or 1b);

FIGURE 1
Channel arrangement for antennas with single and double polarizations
 (All frequencies in MHz)



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7 that the preferred radio-frequency channel arrangement for up to 16 go and 16 return channels, each accommodating up to 1 260 telephone channels, or the equivalent, or digital plesiochronous or synchronous medium capacity rates, should be obtained by interleaving additional channels between those of the main pattern and should be expressed by the following relationship:

$$\text{lower half of the band: } f_N = f_0 - 350 + 20 N \quad \text{MHz}$$

$$\text{upper half of the band: } f'_N = f_0 - 10 + 20 N \quad \text{MHz}$$

where:

$$N = 1, 2, 3, \dots 15, 16;$$

8 that, in the section over which international connection is arranged, all the go channels should be in one half of the band and all the return channels in the other half of the band;

9 that different polarizations should be used alternately for adjacent RF channels in the same half of the band;

10 that when common transmit-receive antennas are used, and not more than four radio-frequency channels are accommodated on a single antenna, it is preferred that the channel frequencies be selected by making either:

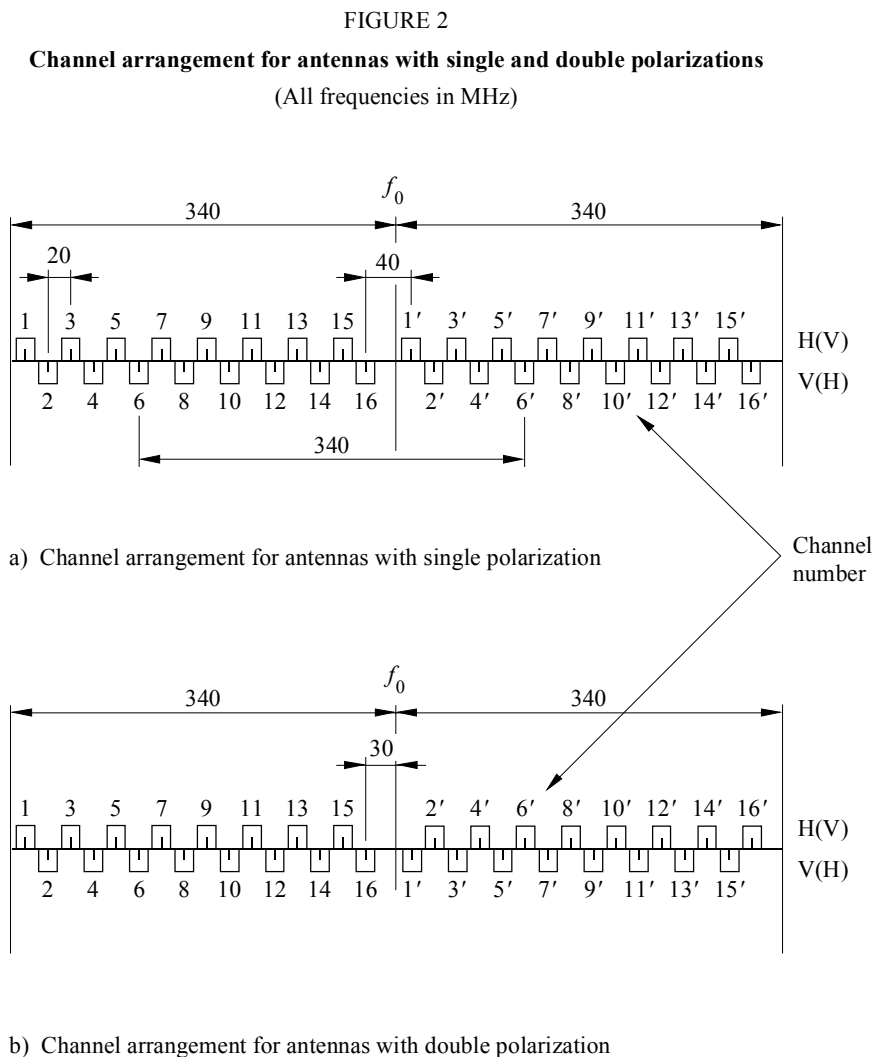
$$N = 1, 5, 9, 13 \text{ or}$$

$$N = 2, 6, 10, 14 \text{ or}$$

$$N = 3, 7, 11, 15 \text{ or}$$

$$N = 4, 8, 12, 16,$$

in both halves of the bands and the preferred arrangement of RF polarization is as shown in Fig. 2;



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11 that if multi-carrier transmission (Note 5) is employed, the overall number of n carriers will be regarded as a single channel. The centre frequency of that channel should be derived from *recommends* 1 or 7, disregarding the actual centre frequencies of the individual carriers, which may vary, for technical reasons, according to practical implementations. Operation of multi-carrier systems is addressed in greater detail in Annex 1;

12 that the preferred centre frequency f_0 , is 6770 MHz; other centre frequencies may be used by agreement between the administrations concerned.

NOTE 1 – This RF channel arrangement permits all local oscillator frequencies to be derived from a common oscillator, if desired.

NOTE 2 – The RF channel arrangements for systems of up to 1260-channel capacity and of 2700 channel capacity may be used on intersecting routes, as long as adequate antenna discrimination is provided.

NOTE 3 – Actual gross bit rates including overhead may be as much as 5% or more higher than net transmission rates.

NOTE 4 – The use of a single antenna working allows for seven go and return channels with the channel arrangement of Fig. 1a). The channel arrangement of Fig. 1b) and suitable antenna performance gives higher isolation between transmit and receive channels, allowing the use of the eight go and return channels.

NOTE 5 – 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.

ANNEX 1

Description of a multi-carrier system

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.

For high capacity multi-carrier transmission, the centre frequency of the channel should coincide with one of the corresponding frequencies of the basic channel arrangements given in *recommends* 1 or 7. The channel spacing may be an integer multiple of the basic values defined by *recommends* 1 or 7. Compatibility with existing configurations has to be taken into account when choosing the appropriate alternative.

Examples of co-polar channel arrangements using a two-carrier system with 64-QAM are shown below. Each carrier is modulated with 155.52 Mbit/s (STM-1)

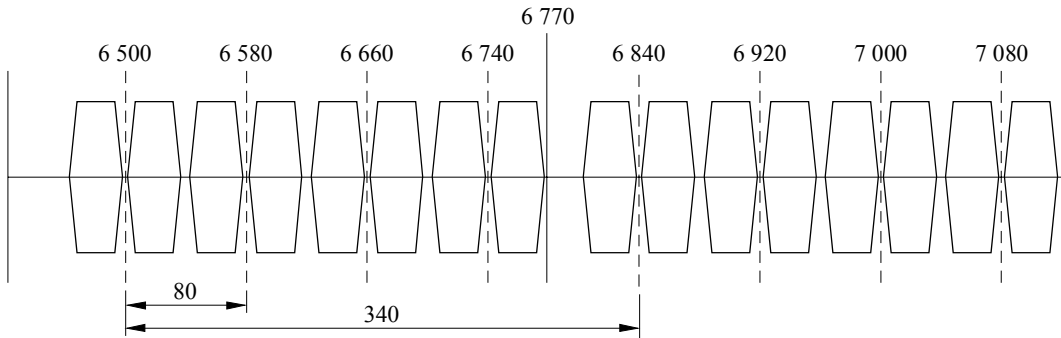
In a mixed analogue/digital environment the arrangement shown in Fig. 3a) is preferred because it places the carrier frequencies of the existing analogue system in the middle of the digital carrier pairs.

The centre frequencies of this channel arrangement are derived from *recommends* 1 by setting $n = 2, 4, 6, 8$. Channel spacing is 80 MHz. Each RF-channel contains 2×2 carriers allocated at ± 17.5 MHz around the centre frequency using both polarizations.

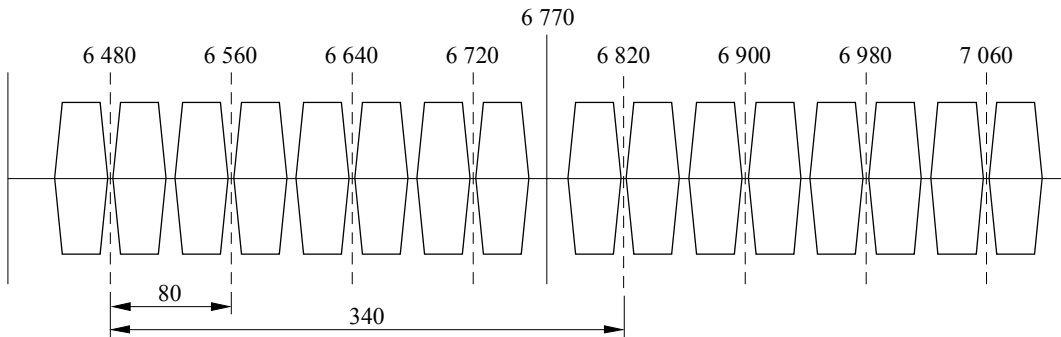
Figure 3b) shows an interleaved channel arrangement where centre frequencies are derived from *recommends 7* by setting $N = 3, 7, 11, 15$. This channel arrangement is adequate in a purely digital environment and is preferred because it provides more symmetrical guardbands at the band edges.

FIGURE 3

Example of radio-frequency channel arrangements for a $2 \times 2 \times 155.52$ Mbit/s ($4 \times$ STM-1) radio-relay system operating with 80 MHz channel spacing in the upper 6 GHz band
(All frequencies in MHz)



a) Channel arrangement preferred if compatibility with analogue radio-relay systems is required



b) Channel arrangement preferred if compatibility with analogue radio-relay systems is not required