RECOMMENDATION ITU-R F.383-7*

Radio-frequency channel arrangements for high capacity radio-relay systems operating in the lower 6 GHz band

(Question ITU-R 136/9)

(1959-1963-1966-1982-1986-1990-1992-1999-2001)

The ITU Radiocommunication Assembly,

considering

a) that it is sometimes desirable to be able to interconnect radio-relay systems on international circuits in the 6 GHz band at radio frequencies;

b) that, in a frequency band 500 MHz wide, it may be desirable to interconnect up to eight go and eight return channels;

c) 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;

d) that many interfering effects can be substantially reduced by a carefully planned arrangement of the radio frequencies in radio-relay systems employing several radio-frequency (RF) channels;

e) that the use of certain types of modulation permits the use of the RF channel arrangements defined for 1 800 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;

f) that for these digital radio systems, further economies are possible by accommodating up to eight go and eight return channels on a single antenna;

g) that it may sometimes be desirable to interleave additional RF channels between those of the main pattern;

h) that there may be a desire to interconnect more than eight go and eight return RF channels, each with a capacity significantly lower than 1 800 telephone channels;

j) that it is also highly desirable to be able to operate systems using a mix of analogue and digital radio channels on the same route,

recommends

1 that the preferred RF channel arrangement for up to eight go and return channels with each channel being either an analogue channel accommodating 1 800 telephone channels, or the equivalent, or a digital channel with a capacity of the order of 140 Mbit/s, or synchronous digital

---

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

hierarchy bit rates and operating at frequencies in the lower 6 GHz band (Note 7), should be as shown in Fig. 1 and 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:

lower half of the band: $f_n = f_0 - 259.45 + 29.65\,n$ MHz

upper half of the band: $f'_n = f_0 - 7.41 + 29.65\,n$ MHz

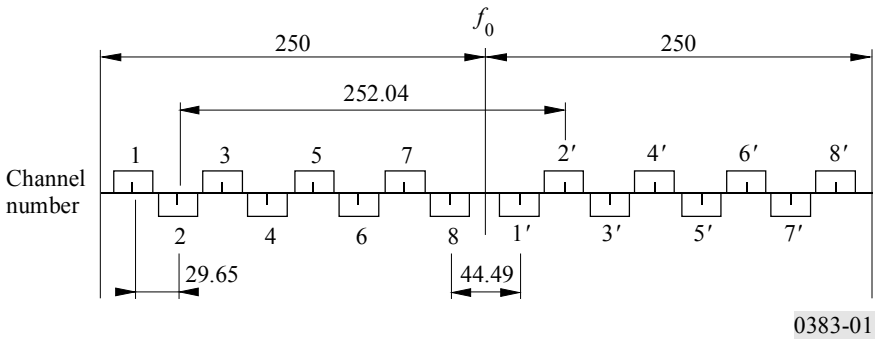
where:

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

FIGURE 1

Radio-frequency channel arrangement for radio-relay systems operating in the 6 GHz band for use in international connections

(All frequencies in MHz)



2 that, in a 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 the go and return channels on a given section should preferably use polarizations as shown below:

	Go	*Return*
H(V)	1 3 5 7	2′ 4′ 6′ 8′
V(H)	2 4 6 8	1′ 3′ 5′ 7′

The following alternative arrangement of polarization may be used by agreement between the administrations concerned:

	Go	*Return*
H(V)	1 3 5 7	1′ 3′ 5′ 7′
V(H)	2 4 6 8	2′ 4′ 6′ 8′

4 that, when common transmit-receive antennas for double polarization are used and not more than four channels are accommodated on a single antenna, it is preferred that the channel frequencies be selected by either making n = 1, 3, 5 and 7 in both halves of the band or making n = 2, 4, 6 and 8 in both halves of the band (see Note 2);

5 that, when additional RF channels, interleaved between those of the main pattern, are required, the values of the centre frequencies of these RF channels should be 14.825 MHz below those of the corresponding main channel frequencies; in systems for 1 800 channels, or the equivalent, and digital high capacity digital systems, it may not be practical, because of the bandwidth of the modulated carrier, to use interleaved frequencies;

6 that up to 16 go and return RF channels, each with a capacity of up to 600 telephone channels, may be obtained on the same route if the additional RF channels are used simultaneously, with those of the main pattern. Different polarizations should be used alternately for adjacent RF channels in the same half of the band (see Note 3);

7 that the preferred centre frequency is 6 175.0 MHz; other centre frequencies may be used by agreement between the administrations concerned.

NOTE 1 – For analogue radio-relay systems the RF arrangement shown in Fig. 1 is suitable for use with the preferred intermediate frequency of 70 MHz (see Recommendation ITU-R F.403, Volume IX, Part 1, 1990). For analogue radio-relay systems it is also suitable for use with an intermediate frequency of 74.12965 MHz, which enables a common oscillator (14.82593 MHz) to be used for generating all the local oscillations for the system, if desired.

NOTE 2 – When common transmit-receive antennas are used and not more than four channels are accommodated on a single antenna, channel frequencies may be selected, by agreement between administrations, by making n = 1, 3, 5 and 7 in the lower half of the band, and n = 2, 4, 6 and 8 in the upper half of the band. If a second similar antenna is used for four further channels, the channel frequencies may be selected by making n = 2, 4, 6 and 8 in the lower half of the band and n = 1, 3, 5 and 7 in the upper half of the band, but if only three further channels are required, the channel frequencies may be selected by making n = 2, 4 and 6 in the lower half of the band and n = 3, 5 and 7 in the upper half of the band to avoid the difficulty of separating frequencies 8 and 1′.

NOTE 3 – The use of a single antenna working allows for seven go and seven return channels based on the preferred arrangement of polarization and eight go and eight return channels based on the alternative arrangement of polarization.

NOTE 4 – The primary purpose of this Recommendation is to facilitate the international interconnection of high-capacity radio-relay systems. It should therefore be noted, that the use of both the main and interleaved arrangements of radio frequencies on a route would limit the provision of systems with a capacity of 1 800 telephone channels using analogue modulation or the equivalent and the provision of high capacity digital channels operating on that route.

NOTE 5 – In the Russian Federation, a RF channel arrangement conforming to the scheme in Fig. 1 of Recommendation ITU-R F.497 is used in the frequency band 5 925-6 425 MHz and for systems with a capacity of 1 800 telephone channels, or the equivalent. The reference frequency f_0 is then 6 172 MHz.

NOTE 6 – It should be noted that some administrations use different RF channel arrangement in the frequency band 5 925-6 425 MHz for high capacity digital radio-relay systems with a capacity of up to 2 × STM-1 (see Annex 1).

NOTE 7 – Actual bit rates including overhead may be as much as 5% or more higher than net transmission rates.

ANNEX 1

Frequency arrangements derived from a homogeneous frequency pattern for the 6 GHz band

RF channel arrangements, derived from Recommendation ITU-R F.635, for the 6 GHz band are described below.

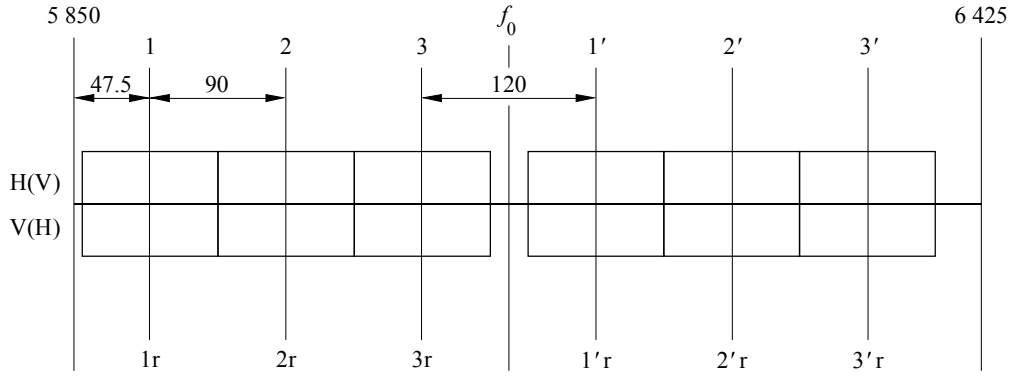
1 90 MHz co-channel RF channel arrangements for the lower 6 GHz band

The radio channelling plans shown in Fig. 2, for the frequency band 5 850-6 425 MHz are based upon the use of 140 Mbit/s systems employing reduced bandwidth quaternary phase-shift keyed (RB 4-PSK) modulation.

FIGURE 2

Radio-frequency channel arrangements for the lower 6 GHz band

(All frequencies in MHz)



f_0 (centre frequency) = 6 137.5 MHz
Symbol rate = 74 MBd
$X = 1.22$ $Y = 1.62$ $Z = 0.64$

0383-02

2 60 MHz RF channel arrangements for the 6 GHz band

Table 1 describes RF channel arrangements for the band 5 925-6 425 MHz which are used for 16-QAM or 256-QAM systems. Further information on the applications given in Table 1 is given in Recommendation ITU-R F.635.

TABLE 1

RF channel arrangements for the 6 GHz band

Modulation (capacity per channel)	16-QAM (STM-1)	16-QAM (STM-1) 256-QAM (2 × STM-1)	256-QAM (2 × STM-1)[1]
Frequency band (MHz)	5 925-6 425	5 925-6 425	5 925-6 425
Centre frequency of the band f_0 (MHz)	6 175	6 175	6 175
Centre frequency of the carriers f_n (MHz)	$f_0 \pm (40 + 60\,n)$ $n = 0, 1, 2, 3$	$f_0 \pm 20\,n$ $n = 0, 1, \ldots 12$	$f_0 \pm (15 + 10\,n)$ $n = 0, 1, \ldots 23$
Interleaved or co-channel	Co-channel	Co-channel	Co-channel
Transmission method	Single carrier transmission method	3-carrier transmission method (20 MHz bandwidth/carrier)	6-carrier transmission method (10 MHz bandwidth/carrier)
Number of channels	8	8	8
Channel separation *XS* (MHz) *X*	 60 1.54	 60 1.54	 60 1.54
Centre gap *YS* (MHz) *Y*	 80 2.06	 80 2.06	 80 2.06
Guardband *ZS* (MHz) *Z*	 30 0.77	 30 0.77	 30 0.77

[1] This arrangement is applicable to hops under very severe propagation conditions.

3 40 MHz radio-frequency channel arrangement for the lower 6 GHz band

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

Let f_0 be the frequency (MHz) of the centre of the band of frequencies occupied, $f_0 = 6\,175$

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: $f_n = f_0 - 260 + 40\,n$ MHz

upper half of the band: $f'_n = f_0 - 20 + 40\,n$ MHz

where:

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

In the above arrangement band reuse by "co-channel dual polarization" may be utilized as shown in Fig. 3.

FIGURE 3

40 MHz radio-frequency channel arrangement for radio-relay systems operating in the lower 6 GHz band

(All frequencies in MHz)