

RECOMMENDATION ITU-R F.436-5

**ARRANGEMENT OF VOICE-FREQUENCY, FREQUENCY-SHIFT
TELEGRAPH CHANNELS OVER HF RADIO CIRCUITS**

(Question ITU-R 145/9)

(1966-1970-1978-1994-1995-1999)

The ITU Radiocommunication Assembly,

considering

- a) that lack of standardization in the arrangement of channels for voice-frequency multi-channel telegraph systems working over HF radio circuits can give rise to difficulties when setting up such systems;
- b) that it is necessary to use the radio-frequency spectrum to the best advantage in the interests of both spectrum economy and circuit efficiency;
- c) that frequency shift systems are in use on many routes;
- d) that the frequency exchange method of operation is in use on long routes suffering from severe multipath distortion,

recommends

- 1** that the channel arrangement shown in Table 1 be preferred for start-stop systems operating at a modulation rate of 50 Bd;
- 2** that the channel arrangement shown in Table 2 be preferred for synchronous systems operating at a modulation rate of approximately 100 Bd (96 Bd with automatic error correction);
- 3** that the channel arrangement shown in Table 3 be preferred for synchronous systems operating at a modulation rate of approximately 200 Bd (192 Bd with automatic error correction);
- 4** that for frequency-exchange systems, the central frequencies of Tables 1, 2 and 3 should be paired in the manner found to be best suited to the propagation considerations of the route. (A typical arrangement would take adjacent channels giving 240, 340 or 480 Hz between tones).

NOTE 1 – Theoretical work in Japan indicates an optimum frequency-shift of $0.8 B$ (Hz), where B is the modulation rate (Bd). This would lead to a required minimum bandwidth (at the -3 dB points) of B (Hz). Laboratory experiments and measurements on the synchronous automatic repeat request (ARQ) circuits Frankfurt-Osaka support these conclusions. For circuits which are not operating near maximum usable frequency (MUF) and for asynchronous circuits, some theoretical results indicate B to $2B$ as the best frequency-shift.

TABLE 1

**Central frequencies of voice-frequency-shift telegraph channels with
a channel separation of 120 Hz and a modulation index of about 1.4
(Frequency-shift = ± 35 Hz or ± 30 Hz)**

Channel position	Central frequency (Hz)	Channel position	Central frequency (Hz)
1	420	11	1 620
2	540	12	1 740
3	660	13	1 860
4	780	14	1 980
5	900	15	2 100
6	1 020	16	2 220
7	1 140	17	2 340
8	1 260	18	2 460
9	1 380	19	2 580
10	1 500	20	2 700

NOTE 1 – See ITU-T Recommendation R.39.

TABLE 2

**Central frequencies of voice-frequency-shift telegraph channels with
a channel separation of 170 Hz and a modulation index of about 0.8
(Frequency-shift = ± 42.5 Hz or ± 40 Hz)**

Channel position	Central frequency (Hz)	Channel position	Central frequency (Hz)
1	425	8	1 615
2	595	9	1 785
3	765	10	1 955
4	935	11	2 125
5	1 105	12	2 295
6	1 275	13	2 465
7	1 445	14	2 635
		15	2 805

NOTE 1 – See ITU-T Recommendation R.39.

TABLE 3

**Central frequencies of voice-frequency-shift telegraph channels with
a channel separation of 480 Hz and a modulation index of about 0.8
(Frequency-shift = ± 80 Hz)**

Channel position	Central frequency (Hz)	Channel position	Central frequency (Hz)
1	600	4	2 040
2	1 080	5	2 520
3	1 560	6	3 000

NOTE 1 – See ITU-T Recommendation R.38A.
