

RECOMMENDATION ITU-R F.106-2*

The use of diversity for voice-frequency telegraphy on HF radio circuits

(1953-1970-1999)

The ITU Radiocommunication Assembly,

considering

- a) that, when voice-frequency equipment is used on radio circuits at frequencies lower than about 30 MHz, the quality of these circuits will, in general, be insufficient if no means of diversity reception is provided;
- b) that, in the presence of fading, space, polarization or frequency diversity gives comparable improvements in the quality of reception of telegraph signals transmitted over radio channels;
- c) that, for adequate frequency diversity, it appears necessary that the frequencies which are used in combination to obtain this diversity should differ by at least 400 Hz;
- d) that space or polarization diversity needs only half the bandwidth and less power for each telegraph channel, as compared with frequency diversity, but usually requires more equipment,

recommends

- 1 that, when voice-frequency telegraph systems are used on radio circuits at frequencies lower than about 30 MHz, diversity reception should be used on the individual voice-frequency channels;
- 2 that, whenever practicable, space or, possibly, polarization diversity should be used in preference to frequency diversity;
- 3 that, for frequency diversity, the channel frequencies used in combination should have a separation of at least 400 Hz so that adequate diversity effects may be obtained;
- 4 that reference should be made to Annex 1 for additional information concerning diversity techniques.

ANNEX 1

Use of coding diversity**1 Introduction**

There is a need for HF data transmission systems to provide reliable service in an efficient manner with multi-tone frequency shift keying (FSK) modems, as described in this Recommendation, or multi-tone phase shift keying (PSK) modems, as described in Recommendation ITU-R F.763. To

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compensate for the unfavourable nature of the selective fading phenomenon of the transmission medium, in-band or other frequency diversity techniques are widely utilized.

This Annex describes a coding technique that improves the in-band frequency diversity system.

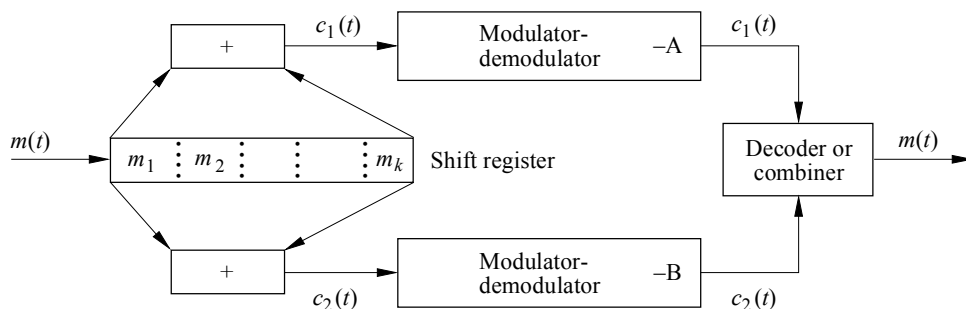
2 System description

The transmission scheme is shown in Fig. 1. The output $m(t)$ from a binary information source is fed into an encoder shift register of length K . After each shift of the register at the source data rate, the encoder generates two code bits, $c_1(t)$ and $c_2(t)$, which in turn drive corresponding data modulators. In practice, the centre frequency separation of these data modulators is usually about 1 kHz. The combined output of the modulators is then fed into an HF single-sideband (SSB) transmission system.

In frequency diversity operation, the system of Fig. 1 assumes its simplest form. The code bits are simply replicas of the information bit, i.e. $c_1(t) = c_2(t) = m(t)$. The decision on the value of a given information bit is based on the combined value of the outputs of the two demodulators. From an information theory context, frequency diversity can be described as a rate-half repetition coding technique that uses soft decisions.

In frequency diversity transmission, only two code bits contain information about any given information bit. With non-zero probability, both of these bits can be corrupted simultaneously by fading, interference or noise so that an incorrect decision is made on the information bit. When this occurs, there is no possibility of correcting the error by using the values of the other code bits. It therefore appears desirable to encode the information sequence such that more than a single pair of code bits is related to any given information bit. The system of Fig. 1 does this by mapping the information sequence prior to transmission.

FIGURE 1
General diversity structure



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Any type of rate-half error correcting code could be used in coded frequency diversity transmission, but convolutional codes are particularly suitable because their encoder structure fits the structure of frequency diversity transmission systems, and the Viterbi algorithm can be used efficiently to carry