9E2c: Influence of the ionosphere

RECOMMENDATION 520-2

USE OF HIGH FREQUENCY IONOSPHERIC CHANNEL SIMULATORS

(1978-1982-1992)

The CCIR,

considering

a) that testing of HF transmission systems while in operation is time-consuming and costly;

b) that some administrations have reported good correlation between the results of laboratory tests conducted on simulators and the results of tests of a data transmission system in operation,

recommends

1. that, when simulators are used to predict, in a qualitative sense, how well a particular system of data transmission may be expected to perform on HF circuits, the representative channel parameter combinations listed in Annex 1 be considered on a provisional basis;

2. that, for comparative evaluation of different systems of data transmission, the additional channel parameter combinations listed in Annex 2 be considered on a provisional basis;

3. that Annex 3 should be referred to for the additional information concerning parameters to be considered in simulation.

ANNEX 1

Simulator parameters for qualitative testing

1. If applicable, it is desirable to perform all simulator tests in both diversity and non-diversity configurations to evaluate the effectiveness of the diversity combining scheme used. Back-to-back tests with additive noise should be completed prior to testing with the simulator to ascertain that the equipment performs properly.

2. Representative channel parameter combinations

2.1 Gaussian noise and flat fading: bit error probability as a function of energy-per-bit to Gaussian noise density ratio for a single fading path with no frequency-shift.

Suggested values for frequency spread (fading rate): 0.2 Hz and 1 Hz.

2.2 Gaussian noise, multipath and fading: bit error probability as a function of energy-per-bit to Gaussian noise density ratio for two independently fading paths with equal mean attenuation, equal frequency spreads and non-frequency shifts.

Suggested parameter values for general testing:

2.2.1 Good conditions

Differential time delay: 0.5 ms
Frequency spread: 0.1 Hz

2.2.2 Moderate conditions

Differential time delay: 1 ms
Frequency spread: 0.5 Hz

2.2.3 Poor conditions

Differential time delay: 2 ms
Frequency spread: 1 Hz

2.2.4 Flutter fading (if required)

Differential time delay: 0.5 ms
Frequency spread: 10 Hz.

2.3 Doppler, multipath and fading (if required): bit error probability as a function of frequency offset of both components of a two component multipath structure with equal mean attenuation, equal frequency spreads and no noise.

Suggested parameter values:

— differential time delay: 0.5 ms

— frequency spread: 0.2 Hz

— range of frequency offset: 0 to 10 Hz.

ANNEX 2

Additional parameters for comparative testing

1. The following tests, in conjunction with those listed in Annex 1, enable comparative evaluation of equipment.

2. Additional tests for comparative purposes

The following tests provide greater knowledge of the specific capabilities of a modem. In conjunction with the foregoing tests, this will enable comparative evaluation of equipment.

2.1 Flat fading: bit error probability as a function of frequency spread for a single fading path with no noise or frequency-shift.

Suggested range of frequency spread: 0.1 to 50 Hz.

The results of this test will show the capabilities of the modem with respect to frequency spread distortion in the channel and the effect of internal noise in the modem receiver (and RF receiver if it is used).

2.2 Multipath and fading: bit error probability as a function of the differential time delay of two independently fading paths with equal mean attenuation and equal frequency spreads and with no noise or frequency-shift.

Suggested parameter values:

— frequency spread: 0.2 Hz and 1 Hz

— range of differential time delay: 0.1 to 5 ms.

The result of this test will show the capabilities of the modem with respect to time spread and frequency spread distortion in the channel and the effect of internal noise and intermodulation distortion in the modem and RF receiver.

2.3 ***Multipath and fading****:* bit error ratio as a function of the ratio of the mean levels of two independently fading paths with unequal mean attenuation, equal frequency spreads and with no noise or frequency-shift.

Suggested parameter values:

— differential time delay: 5 ms

— frequency spread: 0.2 Hz

— range of mean level ratios: —40 to 0 dB.

The results of this test will show the sensitivity of the modem to relative low strength path components with large time delays.

ANNEX 3

Parameters to be considered in simulation

1. This Annex deals with the question of parameters to be specified when using HF ionospheric channel simulators to evaluate equipment intended for operation over HF radio circuits.

2. It may be preferable that HF ionospheric channel simulators be capable of simulating the following channel parameters:

Parameter	Range
Fading depths	2 to 40 dB (in steps of 2 dB)
Duration of fading (1) (duration of a fade is defined as the time interval that the signal level is below a given reference level)	0.05 to 1.5 s (in steps of 0.05 s)
Fading rate (1)	5, 10, 20, 40 per minute
Delay time (1)	0 to 5 ms
Spectral width of a single selective fade (1)	0.1 to 1.2 kHz
Rate at which a selective fade moves through the spectrum (1)	0.5 to 2 kHz/s
Frequency drifts	0 to 7 Hz
Signal-to noise ratio using white Gaussian noise having a bandwidth of 2.7 kHz	0 to 40 dB

(1) These parameters are not all independent of each other.

To assess and test the following telegraphy and data transmission procedures:

— modulation methods,

— diversity procedures,

— error correction procedures,

simulation of the HF medium should expediently be effected at audio frequencies as per Recommendation 348.

Due to the fact that the efficiency of the telegraphy and data transmission procedures on HF radio paths does not only depend on the properties of the transmission medium but also on the characteristics of the radio installations, it would also be possible to incorporate specific parameters of these radio systems into the simulator, for instance, frequency drifts, automatic volume control, sudden frequency and phase jumps such as sometimes occur due to frequency synthesizers in the radio-frequency equipment, etc.

Assessment of performance can be based on the character error ratio, bit error ratio or the rate of distortion.

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