

## RECOMMENDATION ITU-R F.393-4\*,\*\*

**ALLOWABLE NOISE POWER IN THE HYPOTHETICAL REFERENCE  
CIRCUIT FOR RADIO-RELAY SYSTEMS FOR TELEPHONY USING  
FREQUENCY-DIVISION MULTIPLEX**

(1956-1959-1963-1966-1974-1978-1982)

The ITU Radiocommunication Assembly,

*considering*

- a) that the hypothetical reference circuit is intended as a guide to designers and constructors of actual systems;
- b) that the total noise power in a radio-relay system is dependent on the one hand upon a number of factors concerned with equipment design, and on the other hand upon the path attenuation and the variation of path attenuation with time, which are in turn dependent upon factors such as the spacing of stations and the nature of the intervening terrain;
- c) that the total noise power in the hypothetical reference circuit should not be such as would appreciably affect conversation in a substantial number of telephone calls or the transmission of telephone signalling;
- d) that while a conventional load has been adopted for the multiplex signal (see Note 9), no conventional values have been adopted for propagation characteristics in any frequency range or in any climate;
- e) that it is desirable to prepare, for radio-relay systems, clauses which define a noise performance considered equivalent to that of cable systems;
- f) that during normal operation, periods of high noise will occur which will cause short interruptions, these interruptions being mostly caused by adverse propagation conditions (see Note 12),

*recommends*

1. that the noise power at a point of zero relative level in any telephone channel on a 2500 km hypothetical reference circuit for frequency-division multiplex radio-relay systems should not exceed the values given below, which have been chosen to take account of adverse propagation conditions:
  - 1.1 7500 pW0p, psophometrically weighted (Note 14) one-minute mean power (Note 15) for more than 20% of any month;
  - 1.2 47 500 pW0p, psophometrically weighted (Note 14) one-minute mean power (Note 15) for more than 0.1% of any month;
  - 1.3 1 000 000 pW0, unweighted (with an integrating time of 5 ms) for more than 0.01% of any month;
2. that in a part of the hypothetical reference circuit consisting of one or more of the homogeneous sections defined in Recommendation ITU-R F.392, the one-minute mean noise power not exceeded for 20% of the month shall be considered to be proportional to the number of sections involved;
3. that in parts of a hypothetical reference circuit consisting of one or more of the equal homogeneous sections defined in Recommendation ITU-R F.392, the small percentage of a month in which the one-minute mean power may exceed 47 500 pW0p and in which the noise power (with an integrating time of 5 ms) may exceed 1 000 000 pW0, should be regarded as proportional to the number of homogeneous sections involved;

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\* The Recommendation relates only to "line-of-sight" radio-relay systems.

\*\* Radiocommunication Study Group 9 made editorial amendments to this Recommendation in 2000 in accordance with Resolution ITU-R 44.

4. that the following Notes should be regarded as part of the Recommendation:

*Note 1.* – Noise in the frequency-division multiplex equipments is excluded from the foregoing. On a 2500 km hypothetical reference circuit, the ITU-T allows 2500 pW0p mean value for this noise.

*Note 2.* – This Recommendation relates to the hypothetical reference circuit and the indicated figures are design objectives and it is not intended that they will be quoted in specifications for equipment or used for acceptance tests.

*Note 3.* – The noise performance of radio-relay systems designed to the *objectives* of this Recommendation is considered equivalent to that of cable systems having noise averaging 3 pW/km over *long* circuits (noise in the frequency-division multiplex equipment is excluded).

*Note 4.* – It is assumed that noise surges and clicks from power supply systems and from switching apparatus are reduced to negligible proportions and will not be taken into account when calculating the noise power.

*Note 5.* – For the calculation of noise in hypothetical reference circuits the characteristics preferred by the ITU-R and to be found in their Recommendations, should be used where appropriate; where more than one value is recommended, the designer should indicate the value chosen.

*Note 6.* – The requirements of the Recommendation are unlikely to be met unless the line-of-sight radio-relay system has adequate clearance over intervening terrain.

*Note 7.* – Designers should indicate their assumptions regarding the lengths of repeater sections, the nominal attenuation between transmitter outputs and receiver inputs, intermodulation noise in feeders and the radio path, possible interference between the radio channels of the system under consideration, precautions taken against fading (in particular, the use or not of diversity reception and protection channels) and the distribution curve of fading over short periods of time. Designers are expected to fit their noise distribution curves to fall below the figures specified in § 1.1 and 1.2.

*Note 8.* – It is assumed that, at junctions between the homogeneous sections of a hypothetical reference circuit, the telephone channels, groups, supergroups and mastergroups are interconnected at random; and that the noise coming from the homogeneous sections of the hypothetical reference circuit is power-additive.

*Note 9.* – It is assumed that, during the busy hour, the multiplex signal can be represented by a uniform- spectrum signal, the mean power absolute level of which, at a point of zero relative level is equal to  $(-15 + 10 \log_{10} N)$  dBm for 240 channels or more, and  $(-1 + 4 \log_{10} N)$  dBm for numbers of channels between 12 and 240 (this value is provisional for systems with a capacity of less than 60 channels),  $N$  being the total number of channels for which the radio-relay system is to be designed.

*Note 10.* – The requirement indicated by § 1.3 is related to the need to transmit signalling for telephony satisfactorily. It covers also the performance requirement for frequency-modulation VF telegraphy at 50 bauds over telephone channels. For amplitude-modulation VF telegraphy at 50 bauds, the ITU-T has stated performance requirement in its Recommendation G.442.

*Note 11.* – Recommendation ITU-R SF.357 fixes the maximum permissible value of interference caused by systems in the fixed-satellite service to a telephone channel of a radio-relay system. The values indicated in Recommendation ITU-R SF.357 (or smaller values calculated taking account of the parameters of the radio-relay system) should, in principle, be included in the general objectives with regard to noise (see ITU-T Recommendation G.222, Vol. III, Fascicle III.2). In certain cases, however, additional noise may cause the limits fixed in the general objectives to be slightly exceeded. This should not cause serious concern, provided that the provisions of ITU-T Recommendation G.222, § 2.6 are met.

*Note 12.* – Adverse propagation conditions can result in a decrease of the wanted signal and/or an increase in the level of interfering signals.

*Note 13.* – This Recommendation applies only when the system is considered to be available in accordance with the non-availability criteria defined in Recommendation ITU-R F.557 and includes periods of high noise exceeding 1 000 000 pW0 unweighted which persist for periods of less than 10 consecutive seconds. Periods of high noise which persist for 10 consecutive seconds duration or longer are taken into account by Recommendation ITU-R F.557.

*Note 14.* – The level of uniform-spectrum noise power in a 3.1 kHz band must be reduced by 2.5 dB to obtain the spherometrically weighted noise power.

*Note 15.* – The one-minute mean power was chosen by ITU-T which is responsible for all studies concerned with the quality of telephone transmission (CCITT *Red Book*, 1957 and ITU-T Recommendation G.222, Vol. III, Fascicle III.2).