RECOMMENDATION ITU-R S.482-2*

Measurement of performance by means of a signal of a uniform spectrum for systems using frequency-division multiplex telephony in the fixed-satellite service

(1974-1978-1986)

The ITU Radiocommunication Assembly,

considering

a) that it is desirable to measure the performance of satellite links in the fixed-satellite service for frequency-division multiplex telephony under conditions closely approaching those of actual operation;

b) that a signal with a continuous uniform spectrum (white noise) has statistical properties similar to those of a multiplex signal when the number of channels is not too small;

c) that the use of a signal with a continuous uniform spectrum to measure the performance of such links is already widespread;

d) that it is necessary to standardize the frequencies and bandwidths of the measuring channels to be used for such measurements;

e) that for reasons of international compatibility it is necessary to standardize the minimum attenuation and the bandwidth of the stop filters which may have to be used in the white-noise generator;

f) that the ITU-T has indicated, for the planning of telephone circuits, a mean value of speech power in the baseband of a multiplex telephone system to be taken into consideration during the busy hour (ITU-T Recommendation G.223, Blue Book, Vol. III.2),

recommends

1 that the performance of frequency-division multiplex satellite links in the fixed-satellite service should be measured by means of a signal with a continuous uniform spectrum in the frequency band used for the telephone channels;

2 that the nominal power level of the uniform spectrum test signal should be in accordance with the conventional load, specified in ITU-T Recommendation G.223**;

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* Radiocommunication Study Group 4 made editorial amendments to this Recommendation in 2001 in accordance with Resolution ITU-R 44 (RA-2000).

** The level of the conventional load in dBm0 is given by:
- $-1 + 4 \log N$, for $N < 240$ channels
- $-15 + 10 \log N$, for $N \geq 240$ channels.

2.1 that the sending equipment should be capable of providing, at the output of an inserted band-stop filter, a loading level of at least up to +10 dB, relative to the nominal power level defined above;

2.2 that, within the bandwidth corresponding to the baseband of the system under test, the r.m.s. voltage of the white noise spectrum measured in a band of about 2 kHz should not vary by more than ±0.5 dB. This degree of spectrum uniformity should be met in the level range of up to +6 dB, relative to the nominal power level;

2.3 that the white noise test signal should be available at the output of the sending equipment with a peak factor of about 12 dB with respect to the r.m.s. value;

3 that the nominal effective cut-off frequencies (the cut-off frequencies of hypothetical filters having ideal square cut-off characteristics and transmitting the same power as the real filters) and tolerances, for the band-limiting filters proposed for the various bandwidths of systems to be tested, should be as specified in Table 1. (To reduce the number of filters required, compromises have been made between the nominal effective cut-off frequency and the system bandwidth-limiting frequency in some cases. The tolerances ensure that consequent calibration errors do not exceed ±0.1 dB and errors in measurement of intermodulation noise do not exceed ±0.2 dB assuming system pre-emphasis conforming to Recommendation ITU-R S.464.);

3.1 that the discrimination of a low-pass filter should be at least 20 dB at a frequency of more than 10% above nominal cut-off and at least 25 dB at frequencies of more than 20% above nominal cut-off. The discrimination of a high-pass filter should be at least 25 dB at frequencies of more than 20% below nominal cut-off;

3.2 that to limit discrimination against measuring channels, the spread of losses introduced by any pair of high-pass and low-pass filters should not exceed 0.2 dB over a range of frequencies which includes the upper and lower measuring channels;

4 that values of the characteristics for the discrimination in each stopband at the output of a sending equipment are given in Table 2. The passband of each band-stop filter shall be designed to cover at least the largest baseband frequency range with which it is to be used, as indicated in the column entitled “Limits of band . . .” in Table 1. These characteristics are intended to apply over a temperature range from 10° to 40° C;

5 that, when the receiving equipment is connected directly to a sending equipment provided with band-stop filters which only just meet the requirements of *recommends* 4, the ratio of the noise power indicated by the receiving equipment when the band-stop filter is by-passed, to that indicated when the filter is in circuit, should be a minimum of 67 dB; this requirement applies when a conventional load is applied. The minimum effective bandwidth of the receiver should be 1.7 kHz. The maximum reading of absolute noise power arising from leakage given by a receiver of 1.74 kHz effective bandwidth and which just meets the foregoing leakage requirement is −85.6 dBm0p;

6 that additional measuring channels may be provided by agreement between the administrations concerned;

6.1 that for the selection and technical characteristics of any new measuring or band-limiting filters the technical details indicated in the Annex I to former Report 553 should be taken into account.

NOTE 1 – An overall accuracy of ±2 dB and better, is assumed for systems in operation in the fixed-satellite service. Attention is also drawn to ITU-T Recommendation G.228, Annex A and Annex B which discuss the method of measurement and the measuring accuracy.

TABLE 1

Capacity (channels)	Limits of band occupied by telephone channels (kHz)	Effective cut-off frequencies of band-limiting filters (kHz)		Frequencies of recommended measuring channels[1] (kHz)
		High pass	Low pass	
12	12-60	12 ± 0.5	60 ± 0.5	16 56
24	12-108	12 ± 0.5	108 ± 1.0	16 98
36	12-156	12 ± 0.5	156 ± 1.0	16 140
48	12-204	12 ± 0.5	204 ± 1.5	16 185
60	12-252	12 ± 0.5	252 ± 2.0	16 240
72	12-300	12 ± 0.5	300 ± 2.0	16 270
96	12-408	12 ± 0.5	408 ± 3.0	16 240 394
132	12-552	12 ± 0.5	552 ± 4.0	16 240 534
192	12-804	12 ± 0.5	804 ± 6.0	16 394 770
252	12-1 052	12 ± 0.5	1 052 ± 8.0	16 534 1 002
312	12-1 300	12 ± 0.5	1 296 ± 8.0	16 534 1 248
372	12-1 548	12 ± 0.5	1 548 ± 10	16 534 1 002 1 490
432	12-1 796	12 ± 0.5	1 796 ± 12	16 534 1 002 1 730
492	12-2 044	12 ± 0.5	2 044 ± 14	16 534 1 248 1 940
552	12-2 292	12 ± 0.5	2 292 ± 17	16 770 1 730 2 150
612	12-2 540	12 ± 0.5	2 600 ± 20	16 770 1 730 2 438
792	12-3 284	12 ± 0.5	3 284 ± 25	16 1 002 2 438 3 150
972	12-4 028	12 ± 0.5	4 100 ± 30	16 1 002 2 438 3 886
1 092	12-4 892	12 ± 0.5	4 892 ± 40	70 1 002 2 438 4 650
1 200	12-5 340	12 ± 0.5	5 340 ± 45	70 1 002 3 150 4 650
1 332	12-5 884	12 ± 0.5	5 884 ± 50	70 1 002 3 150 4 650 5 340
1 872	12-8 120	12 ± 0.5	8 160 ± 75	70 1 002 3 150 5 340 7 600

[1] See also *recommends* 6.1 of this Recommendation.

TABLE 2

Centre frequency f_c (kHz)	Bandwidth (kHz) in relation to f_c, over which the discrimination should be at least: (1)				Bandwidth (kHz) in relation to f_c outside of which the discrimination should not exceed:	
	70 dB	55 dB	30 dB	3 dB(2)	3 dB	0.5 dB
16	±1.5	± 2.1	± 2.7	–	± 5	± 7
56	±1.5	± 1.8(3)	± 2.1(3)	–	± 5	± 10
70	±1.5	± 2.2	± 3.5	–	± 12	± 18
70(4)	±1.5	± 1.7	± 2.0	–	± 5	± 10
98	±1.5	± 1.8	± 2.1	–	± 4	± 9
140	±1.5	± 1.8	± 2.2	–	± 5	± 14
185	±1.5	± 1.8	± 2.2	–	± 5	± 17
240	±1.5	± 1.8	± 2.2	–	± 5	± 21
270	±1.5	± 2.3	± 2.9	–	± 8	± 24
394	±1.5	± 3.0	± 4.5	–	± 11	± 35
534	±1.5	± 3.5	± 7.0	–	± 15	± 48
770	±1.5	± 3.8	± 8.0	–	± 21	± 70
1 002	±1.5	± 4.0	± 9.0	–	± 27	± 90
1 248	±1.5	± 4.0	±11.0	–	± 35	± 110
1 490	±1.5	± 4.1	±12.0	–	± 42	± 135
1 730	±1.5	± 4.2	±14.0	–	± 48	± 155
1 940	±1.5	± 4.3	±15.0	–	± 52	± 175
2 150	±1.5	± 4.4	±17.0	–	± 55	± 195
2 438	±1.5	± 4.5	±19.0	–	± 60	± 220
3 150	±1.5	± 9.0	±22.0	–	± 85	± 285
3 886(5)	±1.5	±15.0	±30.0	–	±110	± 350
		± 1.8	± 3.5	±8.0	± 12	± 100
4 650	±1.5	± 2.0	± 3.8	±8.5	± 13	± 120
5 340	±1.5	± 2.2	± 4.0	±8.5	± 14	± 150
7 600	±1.5	± 2.4	± 4.6	±9.5	± 16	± 200

(1) The discrimination values quoted are relative referred to the minimum attenuation of band-stop filters within the baseband frequency range defined by high-pass and low-pass filters in Table 1.

(2) New 3 dB-column from ITU-T Recommendation G.228.

(3) The values accepted at the Final Meeting of Study Group 4 were: ±2.0 (55 dB) and ±2.5 (30 dB).

(4) New band-stop filter from ITU-T Recommendation G.230.

(5) The characteristics recommended for the filters 16 kHz to 3 150 kHz inclusive are based on inductor-capacitor type filters. Those characteristics recommended for the filters at 4 650 kHz and above are based on crystal-type filters. Optional characteristics are recommended for the 3 886 kHz filter to permit a choice of design between a coil-capacitor type (upper line in table) or crystal-type filter (lower line in table).

The design of the receiver selectivity of 3 886 kHz should be matched to the characteristic of the crystal-type band-stop filter. It is suggested that in the range from 3 150 kHz to 7 600 kHz the receiver selectivity should be related to the characteristics of crystal-type band-stop filters.