INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

V.56

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

DATA COMMUNICATION OVER THE TELEPHONE NETWORK

COMPARATIVE TESTS OF MODEMS FOR USE OVER TELEPHONE-TYPE CIRCUITS

ITU-T Recommendation V.56

(Extract from the *Blue Book*)

NOTES

1   ITU-T Recommendation V.56 was published in Fascicle VIII.1 of the *Blue Book*. This file is an extract from the *Blue Book*. While the presentation and layout of the text might be slightly different from the *Blue Book* version, the contents of the file are identical to the *Blue Book* version and copyright conditions remain unchanged (see below).

2   In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

Recommendation V.56

COMPARATIVE TESTS OF MODEMS FOR USE OVER
TELEPHONE-TYPE CIRCUITS

(Geneva, 1972; amended at Geneva, 1976 and 1980,
Malaga-Torremolinos, 1984 and at Melbourne, 1988)

To facilitate the work of Administrations in making comparative tests of modems for use over telephone-type circuits offered by different manufacturers, it is recommended that the tests should be made in the laboratory under the following operating conditions:

**1   List of test parameters** (see Table 1/V.56)

TABLE 1/V.56

Test parameters

Ref. No.	Parameter	Four-wire point-to-point	Two-wire switched network	
			Serial modems	Parallel modems
1	Total attenuation or receiving signal level	X	X	
2	Attenuation distortion	X	X	
3	Envelope or group delay distorsion	X	X	
4	Frequency shift (or offset)	X	X	
5	Sudden changes of attenuation	X	X	
6	Interruptions	X	X	
7	Phase hits	X	X	
8	Phase jitter	X	X	
9	Harmonic distortion	X	X	X
10	Listener echo		X	
11	"White" noise	X	X	
12	Implusive noise	X	X	
13	Single tone interference		X	

2   Block diagram for standard test measuring set-up

It is proposed that comparative tests be made using either all or parts of the measuring set-up shown in Figure 1 /V.56.
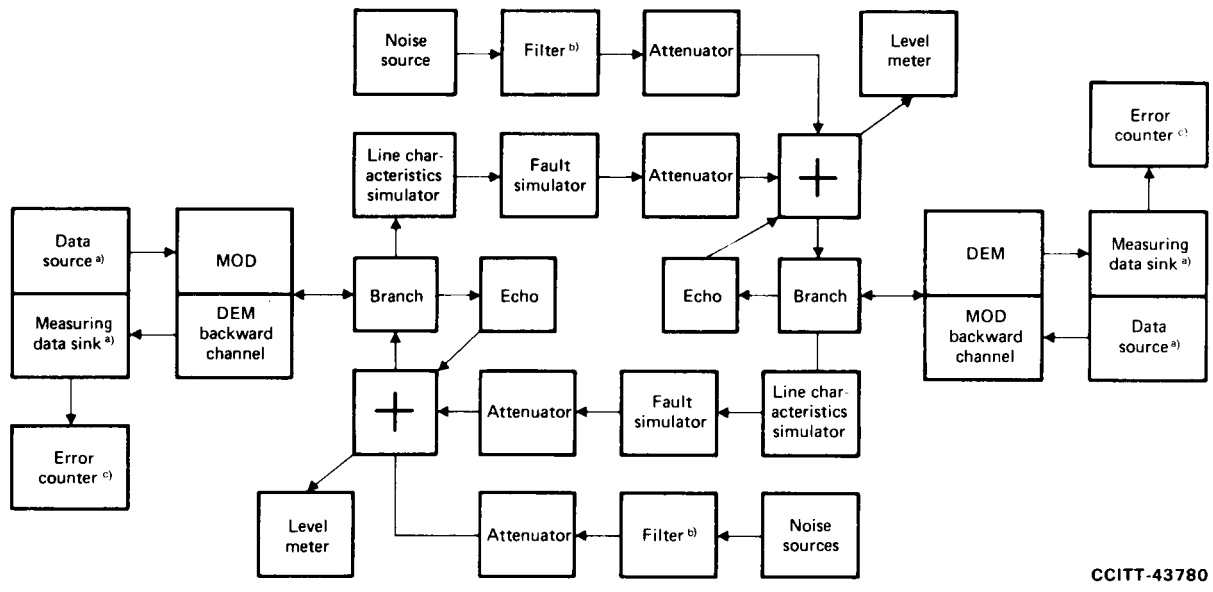
a) 511-bit pseudo random text.
b) 300-3400-Hz band pass filter; the filter is left out if impulsive noise in the form of a square wave is used.
c) For bit and block error count, see Recommendation V.52.

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FIGURE 1/V.56

Measuring set-up for the standard tests of modems

3 Test parameters

3.1 *Parameters of the line characteristics simulator*

3.1.1 *Symmetric line distortion*

See Tables 2/V.56 and 3/V.56. The tolerances for all values are ± 5%.

3.1.2 *Asymmetric line distortion*

See Tables 4/V.56 and 5/V.56. The tolerances for all values are ± 5%.

3.1.3 *Ripple distortion*

The ripple distortion is within the tolerance scheme of Recommendation M.1020 [1]. See Tables 6/V.56 and 7/V.56. The tolerances for all values are ± 5% ± 0.1 ms.

TABLE 2/V.56

Frequency (Hz)	Attenuation distortion (dB)		
	Mode 1 (see Note 1)	Mode 2 (see Note 2)	Mode 3 (see Note 5)
300	6	12	K_1 b)
500	3	8	$0.35 K_1$
800	1	2 a)	0
≈ 1600	0	0	0
2500	Unspecified	8	$0.2 K_1$
2800	3	Unspecified	$0.3 K_1$
3000	6	12	$0.4 K_1$

a) To be clarified.

b) K_1 is a multiplier with values 1, 2, 3, 4, 5, 6 and 7.

Frequency (Hz)	Attenuation distortion (dB)		
	Mode 1 (see Note 1)	Mode 2 (see Note 2)	Mode 3 (see Note 5)
500	3	4.5	$1.20\ K_1$ [a]
600	1.5	3	$1.90\ K_1$
1000	0.5	1.5	$0.32\ K_1$
≈ 1800	0	0	0
2600	0.5	1.5	$0.12\ K_1$
2800	3	3	$0.23\ K_1$
2900	Unspecified	4	$0.31\ K_1$
3000	Unspecified	Unspecified	$0.40\ K_1$

[a] K_1 is a multiplier with values 1, 2, 3, 4, 5, 6 and 7.

TABLE 4/V.56

Frequency (Hz)	Attenuation distortion (dB)		
	Mode 1 (see Note 1)	Mode 2 (see Note 2)	Mode 3 (see Note 5)
800	0	0	0
2000	0.75	Unspecified	Unspecified
2500	Unspecified	8	$8\ K_2$ [a]
2800	3	Unspecified	Unspecified
3000	6	12	$12\ K_2$

[a] K_2 is a multiplier with values 0.4, 0.8, 1.2 and 1.6.

TABLE 5/V.56

Frequency (Hz)	Group-delay distortion (ms)		
	Mode 1 (see Note 1)	Mode 2 (see Note 2)	Mode 3 (see Note 5)
500	0	0	0
1900	Unspecified	Unspecified	$0.075\ K_3$[a]
2600	0.5	1.5	Unspecified
2800	3	3	$0.225\ K_3$
2900	Unspecified	4	Unspecified
3000	Unspecified	Unspecified	$0.30\ K_3$

[a] K_3 is a multiplier with values 0.5, 1, 2, 4 and 8. All values of Mode 3 are provisional.

TABLE 6/V.56

Frequency (Hz)	Group-delay distortion (ms)
	Mode 1
500	2.0
600	1.3
1000	0 (see Note 3)
1400	0.5 (see Note 4)
1800	0 (see Note 3)
2200	0.5 (see Note 4)
2600	0.3 (see Note 3)
2800	2.0

TABLE 7/V.56

Frequency (Hz)	Group-delay distortion (ms)
	Mode 2
500	2.0
600	0,8
800	0.8 (see Note 4)
1000	0 (see Note 3)
1200	0.5 (see Note 4)
1400	0 (see Note 3)
1600	0.5 (see Note 4)
1800	0 (see Note 3)
2000	0.5 (see Note 4)
2200	0 (see Note 3)
2400	0.5 (see Note 4)
2600	0.3 (see Note 3)
2800	2.0

Notes to Tables 2/V.56 to 7/V.56

Note 1 - Mode 1 is in conformity with Recommendation M.1020 [1].

Note 2 - Mode 2 is in conformity with Recommendation M.1025 [2].

Note 3 - Ripple valley values (minima).

Note 4 - Ripple peak values (maxima).

Note 5 - Mode 3 is in conformity with the relevant European specifications.

3.2   *Parameters of the fault simulator*

a)   Phase hits: with external control of timing (e.g. 0.25; 1; 100 Hz) adjustable continuously or in steps up to 165 degrees.

b)   Frequency shifts e.g. ± 5 Hz, ± 6 Hz or ± 10 Hz by means of channel converters.

c)   Peak-to-peak phase jitter from 0.2 degree to 30 degrees continuously from 50 to 300 Hz, sinusoidal waveform.

d)   Sudden changes of attenuation: with external control of timing (e.g. 0.1; 0.25; 1; 100 Hz) adjustable continuously or in steps up to total attenuation.

e)   Interruptions: with fixed duration of 1 ms and repetition period of 1s and/or with single interruptions with variable duration.

3.3   *Noise sources* (this subject needs further study)

a)   White noise.

b)   Impulsive noise: with adjustable level and adjustable pulse duration between 100 μs and 1 ms and with repetition period of 1 second.

c)   Statistically distributed noise by recording or by simulation which is information to assist in standardizing a "Random noise simulator" which would encourage the utilization of block error counts.

d)   Single tone interference: with adjustable level of an additional signal frequency, variable between 300 and 3100 Hz.

e)   Harmonic distortion:

i)   using a calibrating signal frequency of 700 Hz with the same r.m.s. level as the data signal and with its adjustable harmonic levels: a_{H2}, a_{H3} and a_{H4}, and

ii)   using a calibrating signal frequency of 700 Hz with the same peak-to-peak level as the data signal and with its adjustable harmonic levels: a_{H2}, a_{H3}, and a_{H4}.

3.4   *Listener echo*

Listener echo: with the variable echo attenuation between 0 and 20 dB and variable echo time delay τ_E between 0 and 20 ms (worst case relevant).

4   Measuring procedure

4.1   *Measurement of the bit error rate* (p_S) *as a function of the signal-to-noise ratio* (S/N) *in the case of white noise*

The receiving level at the summation point should be -30 dBm for switched line comparisons and -20 dBm for leased line comparisons.

For a comparison, the value of *S/N* ratio at defined p_S values can be ascertained (e.g. $3 \cdot 10^{-4}$ or 10^{-5}).

4.2   *Measurement of the number of the bit error per second* (F/t) *as a function of the different faults and noise parameters* (X)

The receiving level at the summation point should be -30 dBm for switched line comparisons and -20 dBm for leased line comparisons.

For a comparison, the value of *F/t* for different defined fault and noise parameters, or the value of the

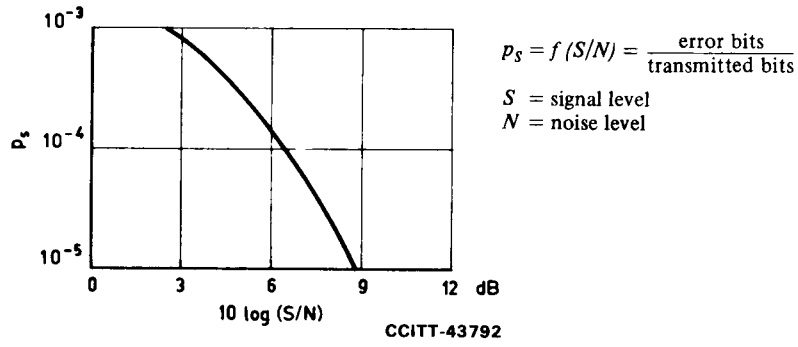different parameters at the limit of the error-free region, can be ascertained.

$$p_S = f \, (S/N) = \frac{\text{error bits}}{\text{transmitted bits}}$$

S = signal level
N = noise level

FIGURE 2/V.56

Example of bit error rate as a function of the signal-to-noise ratio

$$F/t = f(X)$$

$$X = \Phi_S, \Phi_j, a_S, t_i, a_p, a_t, a_H$$

Φ_S = f (degree of the phase hits)
Φ_j = degree of phase jitter
a_S = relative level of the sudden changes of attenuation
t_i = duration of interruptions
a_p = impulsive noise level (dBm)
a_t = single tone level (dBm)
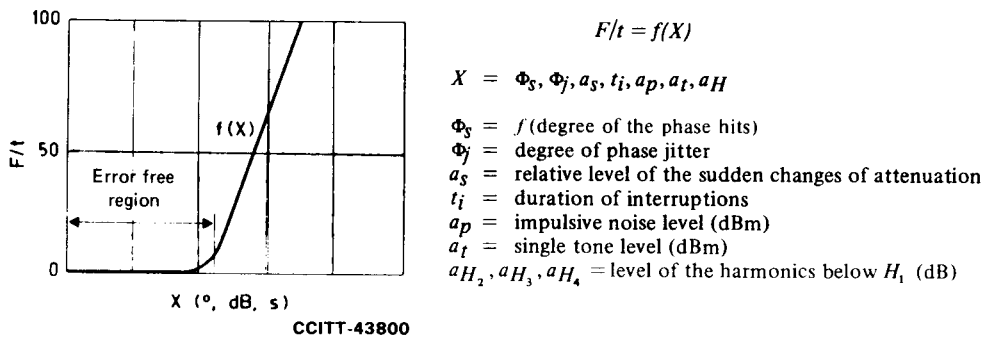$a_{H_2}, a_{H_3}, a_{H_4}$ = level of the harmonics below H_1 (dB)

FIGURE 3/V.56

**Example of bit error per second as a function of the value
of different fault and noise parameters**

5   Comparative tests of modems (Table 8/V.56)

TABLE 8/V.56

Eighteen selected tests according to §§ 1, 2, 3 and 4

Test	Test parameter according to Table 1/V.56	Test parameters according to §	Measuring procedure according to §
A	11	3.3a)	4.1
B	2, 3, 11	3.1.1 mode 1, 3.3a)	4.1
C	2, 3, 11	3.1.1 mode 2, 3.3a)	4.1
D	2, 3, 11	3.1.2 mode 1, 3.3a)	4.1
E	2, 3, 11	3.1.2 mode 2, 3.3a)	4.1
F	2, 3, 4, 11	3.1.1 mode 1, 3.2b) (± 6 Hz), 3.3.a)	4.1
G	2, 3, 4, 11	3.1.1 mode 2, 3.2b) (± 10 Hz), 3.3.a)	4.1
H	2, 3, 7	3.1.1 mode 1, 3.2a)	4.2
J	2, 3, 7	3.1.1 mode 1, 3.2a)	4.2
K	8	3.2c)	4.2
L	2, 3, 5	3.1.1 mode 1, 3.2d)	4.2
M	2, 3, 5	3.1.1 mode 2, 3.2d)	4.2
N	6	3.2e)	4.2
P	12	3.3b)	4.2
R	13	3.3d)	4.2
S	9	3.3 c) ii)	4.1
T	10, 11	3.4, 3.3a)	4.1
U	Statistic noise	3.3c)	4.1 (for block errors)

References

[1]   CCITT Recommendation *Characteristics of special quality international leased circuits with special bandwidth conditioning*, Vol. IV, Rec. M.1020.

[2]   CCITT Recommendation *Characteristics of special quality international leased circuits with basic bandwidth conditioning*, Vol. IV, Rec. M.1025.