INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

G.611

TRANSMISSION MEDIA CHARACTERISTICS

CHARACTERISTICS OF SYMMETRIC CABLE PAIRS FOR ANALOGUE TRANSMISSION

ITU-T Recommendation G.611

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation G.611 was published in Fascicle III.3 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 G.611

CHARACTERISTICS OF SYMMETRIC CABLE PAIRS FOR ANALOGUE TRANSMISSION

(former Recommendation G.321, Geneva, 1974; amended at Geneva, 1980)

1 Cable specification - Examples of the electric characteristics of a star-quad cable designed to provide 12, 24, 36, 48, 60 or 120 carrier telephone channels on each quad pair

1.1 *Types of cable*

Administrations which decide to equip their symmetric pair cable network should, wherever possible, choose those which conform to the types of cable defined below.

New cables laid in the European and North-African international telephone network include unloaded symmetric pairs, designed to be used for 12, 24, 36, 48, 60 or 120 carrier telephone channels on each pair. These pairs are laid up in star quads and all unloaded pairs of the same cable are one of the types whose nominal characteristics are shown in Table 1/G.611.

It is essential that a repeater section crossing a frontier should be of a uniform type throughout its length. When a frontier section is between a large and a small country, the Administration of the larger country should do everything possible to use whichever of the three types has been adopted by the smaller country, so as not to oblige the Administrations of small countries to use sections of international cable of a different type from that of their national cables.

Note 1 - Some Administrations, by paying special attention to crosstalk balance and adopting appropriate repeater spacing, have been able to set up systems with 2 supergroups, in accordance with Recommendation G.322, on paper-insulated symmetric pairs conforming with this present specification.

Note 2 - It is also possible to set up 2 supergroup systems that conform with Recommendation G.322 on pairs of type II *bis* and type III *bis*. Type II *bis* pairs are insulated by polythene and type III *bis* pairs by styroflex.

TABLE 1/G.611

	Type I	Type II	Type II bis	Type III	Type III bis
Diameter of conductors (mm)	0.9	1.2	1.2	1.3	1.3
Effective capacity (nF/km)	33	26.5	21	28	22
Characteristic impedance (Ω)					
to 60 kHz	153	178	206	170	196
to 120 kHz	148	174	203	165	193
to 240 kHz	—	172	200	163	190
to 550 kHz	—	—	198	—	188
Attenuation per unit length at 10° C in dB/km					
to 60 kHz	2.3	—	—	—	—
to 120 kHz	3.1	2.0	1.5	1.8	1.4
to 240 kHz	—	2.9	2.1	2.7	2.0
to 552 kHz	—	4.8	3.1	4.4	3.0

1.2 *Regularity of factory lengths*

The regularity may be characterized by one or other of the equivalent methods below, the choice of which is left to the Administrations concerned.

1.2.1 *Effective capacity*

The "effective capacity" is measured between the two conductors of the pair, all other cable conductors being connected together and to the sheath.

Ratios of the effective capacity

Type I cable - The average of the effective capacities of all the pairs in any factory length should not differ from the nominal value by more than ± 5%.

In any factory length, the difference between any individual value of effective capacity and the average value obtained for this factory length should not exceed ± 7.5%; the arithmetic mean of the magnitudes of these differences should not exceed 2.5%.

Types II, II bis, *III and III* bis *cables* - The average effective capacity of any length should not differ by more than ± 3% from the nominal value.

In any length, the difference between the effective capacity of any pair and the average capacity for the cable length should not exceed ± 5%.

1.2.2 *Impedance* (types II, II *bis,* III and III *bis* cables)

The real part of the characteristic impedance of any circuit, measured with a frequency of 120 kHz, should not depart by more than ± 5% from the mean value of all the pairs of the first manufacturing batch of each type. This mean value should not depart by more than ± 5% from the nominal value at 120 kHz.

The impedance will be measured on the factory lengths using a bridge, the circuits being terminated by an impedance equal to that which is measured by the bridge.

1.3 *Crosstalk*

The quality of the cable from the point of view of crosstalk may be characterized by one or other of the two equivalent methods below, the choice of which is left to the Administrations concerned.

1.3.1 *Direct measurements of crosstalk*

For a factory length of 230 metres the crosstalk between any two side circuits should satisfy the following conditions:

- far-end crosstalk ratio should be greater than 68 dB;
- near-end crosstalk attenuation should be greater than 56 dB.

For cables to be used with 5 groups or 2 supergroups these values should hold up to 240 kHz; and for cables with two groups, up to 120 kHz.

During these measurements, the circuits will be terminated by the real part of the nominal impedance for the frequency considered.

For factory lengths greater than 230 metres, the above limits will be reduced by

$$20 \log_{10} \frac{L}{230} \text{ dB,}$$

L being the length in metres. Lengths shorter than 230 metres should satisfy the same conditions as a length of 230 metres.

1.3.2 *Capacity unbalance and mutual inductances*

All the capacity unbalance measurements should be made with an alternating current of 800 Hz. The mutual impedance measurements should be made with an alternating current of 5000 Hz. All the measurements should be made at the ambient temperature, without applying corrections; but in case of dispute, the results obtained at 10 °C will be considered as final. All the conductors, other than those under test, should be connected to the cable sheath.

For a factory length of 230 metres the capacity unbalance should not exceed the values given in Table 2/G.611 and the mutual inductances should not exceed the values given in Table 3/G.611. These tables show different values for type I cables in one column, and for types II, II *bis*, III and III *bis* in the other.

TABLE 2/G.611

Capacity unbalance

	Mean of all readings (ignoring signs)		Maximum individual reading	
	Type I	Types II, II *bis*, III and III *bis*	Type I	Types II, II *bis*, III and III *bis*
Capacity unbalance in picofarads:				
between pairs of the same quad	33	17	125	60
between pairs of adjacent quads in the same layer	10	5	60	25
between pairs in nonadjacent quads in the same layer	{mean value not specified {because all possible {combinations are not {measured		20	10
between pairs in quads in adjacent layers	10	5	60	25
between any pair and earth	100	100	400	400

Note - The limits shown for the mean values do not apply to cables which have four or less quads.

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TABLE 3/G.611

Mutual inductances

	Mean of all readings (ignoring signs)		Maximum individual reading	
	Type I	Types II, II *bis*, III and III *bis*	Type I	Types II, II *bis*, III and III *bis*
Mutual inductances in nanohenrys:				
between pairs of the same quad	150	125	600	500
between pairs of adjacent quads in the same layer	100	40	400	150
between pairs in nonadjacent quads	50	20	350	150
between pairs in quads in adjacent layers	100	40	600	250

Note - The limits shown for the mean values do not apply to cables which have four or less quads.

For lengths greater than 230 metres, it is necessary to apply the following rules:

The average values from pair to pair given in Tables 2/G.611 and 3/G.611 should be multiplied by the square root of the ratio between the length in question and 230 metres.

All the maximum values, as well as the average values between a pair and earth, should be multiplied by the ratio between the length in question and 230 metres.

Lengths shorter than 230 metres should satisfy the same conditions as the length of 230 metres.

1.4 *Dielectric strength*

When specially requested, cables will have a construction such that the insulation of any cable length should be capable of withstanding, without breakdown, a potential difference specified in each particular case but not exceeding 2000 volts r.m.s., applied for at least 2 seconds between all the conductors, connected together and the earthed sheath. The test can be made with a 50-Hz alternating current. The value of the test voltage should not exceed by more than 10% the peak value of a sinusoidal voltage having the same r.m.s. value.

The test can also be carried out using direct current (see [1]). In such a case, the limit for the voltage will be 1.4 times the r.m.s. value of the voltage when using alternating current[1)].

1.5 *Insulation resistance*

In a length of cable, the insulation resistance measured between a conductor and all the other conductors connected together, and to the earthed sheath, should not be less than 10 000 MΩ-km, the potential difference used being at least 100 volts and not greater than 500 volts. The reading shall be made after electrification for one minute, the temperature being at least 15 °C.

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1) In reference [2], the CCITT does not recommend a formula for general application for tests on mixed dielectrics. However, for tests of telephone cables, the CCITT recommends the use of the factor 1.4 as representative of current commercial practice.

2 Specification of a repeater section

2.1 *Maximum attenuation in a repeater section*

The maximum attenuation at the highest frequency transmitted to line of a normal repeater section shall be 41 dB for low-gain systems with 1, 2 or 3 groups and 36 dB for low-gain systems with 4 or 5 groups or 2 supergroups.

2.2 *Crosstalk*

The far-end crosstalk ratio between circuits in the same direction, measured on the repeater sections of a carrier system on unloaded symmetric pairs, terminated at their two ends by impedances equal to their characteristic impedance, should not be less than the values shown below (which allow for the existence of any crosstalk balancing networks).

1) For the classical method of balancing, the repeater section far-end crosstalk ratio for low gain transistorized systems up to 120 channels on type II and III cables (or similar cables) or low-gain 120-channel systems on type II *bis* or III *bis* cables should not be less than 69.5 dB.

2) When a "balancing section" comprises several repeater sections, an equivalent result can be obtained from the formula $69.5 - 10 \log_{10} n$ (dB), where n is the number of repeater sections in the balancing section.

2.3 *Regularity of impedance*

The impedance of any circuit in a repeater section forming part of a carrier system on unloaded symmetric pairs should not differ from the nominal value by more than the values shown below:

± 5% (value measured at 60 kHz) for a repeater section forming part of a 12-channel system;

± 8% (value measured at 108 kHz) for a repeater section forming part of a 24-channel system;

± 8% (value measured at 120 kHz) for a repeater section forming part of a 36- or 48-channel system;

± 8% (value measured at 240 kHz) for a repeater section forming part of a 60-channel system;

± 8% (value measured at 552 kHz) for a repeater section forming part of a 120-channel system.

2.4 *Dielectric strength*

If it is desired to check the dielectric strength of a repeater section after laying, direct current will be applied to the cable at a voltage equal to the specified r.m.s. alternating current test voltage for tests on factory lengths (see § 1.4 above).

2.5 *Insulation resistance*

The insulation resistance measured at the end of the cable between any one conductor and all the other conductors bunched and connected to the earthed sheath (excluding internal repeater station wiring) should not be less than 10 000 MΩ-km measured at a potential difference of at least 100 volts and not more than 500 volts. The reading shall be made after electrification for one minute.

References

[1] *Dielectric strength tests*, Blue Book, Vol. III, Part 4, Annex 19, ITU, Geneva, 1965.

[2] *Ibid.*, § 4.