INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

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TELECOMMUNICATION
STANDARDIZATION SECTOR
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TRANSMISSION MEDIA CHARACTERISTICS

CHARACTERISTICS OF SYMMETRIC CABLE PAIRS USABLE WHOLLY FOR THE TRANSMISSION OF DIGITAL SYSTEMS WITH A BIT RATE OF UP TO 2 Mbits

ITU-T Recommendation G.613

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation G.613 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.613

CHARACTERISTICS OF SYMMETRIC CABLE PAIRS USABLE WHOLLY FOR THE TRANSMISSION OF DIGITAL SYSTEMS WITH A BIT RATE OF UP TO 2 Mbits

(Malaga-Torremolinos, 1984)

1 Preamble

This Recommendation deals with cables designed for the transmission of standard digital systems (Recommendations of the G.900 series), although these cables can also be used to transmit digital signals with a lower bit rate and voice frequency signals. The cables described carry signals in both transmission directions simultaneously. The provisions of this Recommendation apply to cables designed to allow for digital operation of all the cable circuits. However, some of the provisions may be used to assess the possibility of (partial or full) digital operation of existing cables.

2 Parameters to be measured

2.1 *Direct current resistance*

The following formula is used to correct the value R_t of direct current resistance measured at t°C for 20 °C:

$$R_{20} = R_t /(1 + 0.004\,(t - 20))$$

2.2 *Capacitance per unit length*

This is measured at 800 Hz or 1000Hz.

2.3 *Attenuation coefficient*

The value of the attenuation coefficient is obtained either by direct measurement of the attenuation or by calculation on the basis of the mutual capacitance and direct current resistance of the pair. The attenuation coefficient is measured at one frequency only, f_0, near the timing half-frequency.

System	Recommendation	f_0
1544 kbit/s	G.951	772 kHz
2048 kbit/s	G.952	1 MHz

For cables with polyolefin insulation, the value of the attenuation coefficient at frequency f (for values of f above with a few hundred kHz) can be related to α_0 by the equation $\alpha_f = \alpha_0 \sqrt{\frac{f}{f_0}}$.

The value of the attenuation coefficient measured at t°C is corrected for 20 °C by the equation:

$$\alpha_{20} = \alpha_t /(1 + 0.002\,(t - 20))$$

2.4 *Characteristic impedance*

2.4.1 *Echometric measurement*

When a pulse echometer is used, the impedance of the pair measured must be compensated by a calibrated balancing network which can be set in steps of about 0.5 Ω. Pulse duration will be equal to or less than 500 ns. With this method, which is both fast and simple, the value of the end impedance of the pair measured is read off directly on the scale of the balancing network.

2.4.2 *Sinusoidal measurement*

In this case, the pair tested will be terminated across an impedance, which is constantly equal to that measured by the bridge, unless it is long enough for the result of the measurement to be independent of end impedance (as for elementary cable sections).

2.5 *Crosstalk*

Crosstalk can be measured sinusoidally or digitally. The assignment of pairs to the direction of transmission depends on the structure and type of manufacture of the cable.

2.5.1 *Sinusoidal measurement*

2.5.1.1 *Far-end crosstalk*

The measurements are made between pairs assigned to the same direction of transmission, at frequency f_0. If the frequency at which measurement is carried out is not the timing half-frequency, the value is corrected using the 20 $\log_{10} f$ law. When the measurement is carried out on a pair of length, L, which is different from the specified reference length L_0, the measured value is corrected using $\sqrt{L / L_0}$ when the value is expressed in mV or 10 $\log_{10} \frac{L}{L_0}$ when the value is expressed in dB.

2.5.1.2 *Near-end crosstalk*

The measurements are made between pairs assigned to transmission in opposite directions at a frequency near the system's timing half-frequency.

2.5.2 *Digital measurement*

By means of digital measurement, it is possible to estimate the total noise on an elementary section, taking account of both near-end and far-end crosstalk. This estimate can be made on the basis of separate near-end and far-end crosstalk measurements on either factory lengths or elementary sections.[1)] These measurements can be made either in factory conditions or on installed cables.

2.5.2.1 *Far-end crosstalk*

The measurements are carried out between pairs assigned to the same direction of transmission. When the measurement is carried out on a pair of length, L, which is different from the specified reference length L_0, the measured value is corrected using $\sqrt{L / L_0}$ when the value is expressed in mV or 10 $\log_{10} (L / L_0)$ when the value is expressed in dB.

2.5.2.2 *Near-end crosstalk*

The measurements are made between pairs *assigned* to transmission in opposite directions.

3 Circuit characteristics

These are given in Table 1/G.613.

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1) One advantage of digital measurements is that it is possible to make a direct overall measurement of the total noise on an elementary section if enough generators are available.

4 Characteristics of connected cable sections

These are given in Table 2/G.613.

TABLE 1/G.613

Circuit characteristics *

Characteristics			Type I	Type II	Type II *bis*	Type III ****	f)
Operational bit rate (kbit/s)			2048	2048	2048	2048	
Repeaters gain **			34 dB				
Elements constituting the cable			star quad	pairs	pairs	pairs	
Nominal conductor diameter (mm)			0.8	0.7	1	0.6	
Nominal impedance *** at f_0 MHz (Ω)		1 MHz	100	130	130		
		772 kHz					
Nominal attenuation coefficient at f_0 and at 20° C *** (dB/km)		1 MHz	16	11.5 b)	8.5 b)	15.5	
		772 kHz					
Crosstalk in digital operation		a)	c)	-	-	-	
Total noise voltage (maximum value)		a)					
Minimum near-end crosstalk (mV)		a)	-	60 d, g)	60 d, g)		
		a)					
Minimum far-end crosstalk (mV)		a)	-	45 e, g)	45 e, g)		
		a)					
Sinusoidal crosstalk	Near-end (dB)	1 MHz				78 ± 3h)	
		772 kHz					
	Far-end (dB)	1 MHz				64 ± 3h)	
		772 kHz					
Nominal direct current resistance at 20°C (Ω/km)			68.6	94.1 b)	46.1 b)	63	
Nominal mutual capacitance (nF/km)			50	39	39	44	

Notes of Table 1/G.613

* At the present stage the values are given for information.
** Reference value for the numerical data of the cable in question.
*** A standard deviation or margins will be given at a later stage.
**** Cable with diametral screen separating the pairs assigned to the two directions of transmission.

a) To be specified.
b) Maximum value.
c) The specification value for factory controls is calculated to ensure compliance with the characteristics of connected cable.
d) Between pairs of different groups.
e) Between pairs belonging to one and the same group.
f) Other columns will contain the data supplied by administrations.
g) Values given in dB.
h) The value given here depends on the content of the cable. It is the rounded-down mean of a standard deviation of the total production and is therefore not a specification for individual cable lengths.

TABLE 2/G.613

Characteristics of connected cable sections *

Characteristics			Type of cable				
			Type I	Type II	Type II bis	Type III	a)
Operational bit rate (kbit/s)			2048	2048	2048		
Nominal impedance at f_0 MHz (Ω)		1 MHz	100	130	130		
		772 kHz					
Nominal attenuation coefficient at f_0 and at 20°C (dB/km)		1 MHz	16	11.5	8.5		
		772 KHz					
Crosstalk in digital operation		b)	40 mV				
Total noise voltage (maximum value)		b)					
Minimum near-end crostalk (mV)		b)					
		b)					
Minimum far-end crosstalk (mV)		b)					
		b)					
Sinusoidal crosstalk	Near-end (dB)	1 MHz					
		772 MHz					
	Far-end (dB)	1 MHz					
		772 MHz					

* At the present stage the values are given for information.

a) Other columns will contain the data supplied by Administrations.

b) To be specified.