INTERNATIONAL TELECOMMUNICATION UNION

ITU-T T.1

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

TERMINAL EQUIPMENT AND PROTOCOLS FOR TELEMATIC SERVICES

STANDARDIZATION OF PHOTOTELEGRAPH APPARATUS

ITU-T Recommendation T.1

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation T.1 was published in Fascicle VII.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 T.1

STANDARDIZATION OF PHOTOTELEGRAPH APPARATUS

(former CCIT Recommendation D.1; amended at New Delhi, 1960; Geneva, 1964; Mar del Plata, 1968; Malaga-Torremolinos, 1984 and Melbourne, 1988)

The CCITT,

considering

that the transmission of pictures is possible only if certain characteristics of the transmitting and receiving equipments are identical,

unanimously declares the view

that phototelegraph apparatus and the associated modulating and demodulating equipment should be constructed and employed according to the following standards:

1 Scanning track

At the transmitting apparatus the message area should be scanned in a "negative" direction. The orientation of the document in relation to the scanning plane will depend upon its dimensions and is of no consequence.

At the receiving apparatus scanning takes place in a "negative" direction for "positive" reception and in a "positive" direction for "negative" reception.

2 Index of cooperation

The normal index is 352 (corresponds to a factor of cooperation of 1105).

The preferred alternative index, for use when less dense scanning is required, or when the characteristics of circuits (and particularly combined radio and metallic circuits) so demand, is 264 (a factor of cooperation of 829).

The admissible tolerances on the above-mentioned values are ± 1%.

3 Dimensions of apparatus

3.1 *Apparatus with drum scanning*

The most currently used drum diameters are 66, 70 and 88 mm.

The drum factor of the sending apparatus shall not be more than 2.4.

The drum factor of the receiving apparatus shall not be less than 2.4.

The width of the picture-retaining device (dead sector) may not exceed 15 mm. An allowance of 3% of the total length of a scanning line is also made for phasing. Thus, since the total circumference of a drum of the diameter of 66 mm is about 207 mm, the usable circumference will be at least 186 mm.

3.2 *Apparatus with flat-bed scanning*

The total lengths of the most current scanning lines are 207, 220 and 276 mm of which 15 mm are not used for effective transmission, because of the possibility that the receiving station may use a drum apparatus.

Before transmitting a picture to a receiving station using a drum apparatus, it is necessary to ensure that the value of ratio:

$$\frac{\text{length of document to be transmitted}^{1)}}{\text{total length of a scanning line}} \times \pi\textbf{Error! Bookmark not defined.}$$

is less or at most equal to the drum factor of the receiver used.

3.3 Table 1/T.1 gives corresponding values of index of cooperation *M*, factor of cooperation *C*, drum diameter *D*, total length of scanning line *L*, scanning pitch *P* and scanning density *F* for apparatus in most common use.

TABLE 1/T.1

M	*C*	*D* (mm)	*L* (mm)	*P* (mm)	*F* (lines/mm)
264	829	66	207	1/4	4
264	829	70	220	1/3.77	3.77
264	829	88	276	1/3	3
350	1099	70	220	1/5	5
352	1105	66	207	3/16	16/3
352	1105	88	276	1/4	4

Note – The maximum dimensions of the pictures to be transmitted result from the parameters given in the table.

4 Reproduction ratio

In the case where apparatus working with different lengths of scanning line (but with the same index of cooperation) are interconnected, there will be a slight change in size and the reproduction will bear the same proportion as the original, the ratio being that of the total lengths of the scanning lines.

5 Drum rotation speed – scanning line frequency

5.1 Table 2/T.1 gives the normal and approved alternative combinations of drum rotation speeds or of scanning line frequencies and indices of cooperation.

1) Measured in the direction perpendicular to the scanning line.

TABLE 2/T.1

	Drum rotation speed in rpm or scanning line frequency	Index of cooperation	
		Metallic circuits	Combined metallic and radio circuits
Normal conditions	60 90	352	352 264
Alternatives for use when the phototelegraph apparatus and metallic circuits are suitable	90 120 150	264 and 352 264 and 352 264	

Note 1 – In the case of transmitters operating on metallic circuits, the index 264 is not intended to be used with an 88-mm drum. In the case of transmitters operating on combined metallic and radio circuits, the index 264 associated with a drum diameter of 88-mm is intended to be used only exceptionally.

Note 2 – The provisions given in the table are not intended to require the imposition of such standards on users who use their own equipment for the transmission of pictures over leased circuits. However, the characteristics of the apparatus used should be compatible with the characteristics of the circuits used.

5.2 The speed of transmitters must be maintained as nearly as possible to the nominal speed and in any case within ± 10 parts in 10^6 of the nominal speed. The speed of receivers must be adjustable and the range of adjustment should be at least ± 30 parts in 10^6 from the nominal speed. After regulation, the speeds of the transmitting and receiving sets should not differ by more than 10 parts in 10^6.

6 Judder

The stability of the speed during one rotation should be such that the maximum shift of the drum surface from the average position should not exceed one quarter of the scanning pitch *P* at normal index 352, which means that the maximum angle of the oscillations should not exceed 0.08 degree measured from the average position.

7 Synchronization

When phototelegraph stations have available a standard of frequency which is better than ± 5 parts in 10^6, verification of the synchronism between the two stations may be dispensed with. In view of the saving of time, this method should be adopted wherever possible.

To compare the speeds of a transmitter and a receiver, an alternating current whose frequency bears an unvarying relationship to the transmitter speed and has a nominal value of 1020 Hz is used.

Where there is the possibility that the transmitter and receiver may be connected by a circuit liable to introduce frequency drifts, for example, by a carrier telephone circuit, the use of the simple 1020-Hz synchronizing tone is unsatisfactory. The preferred method of overcoming this difficulty is to transmit the phototelegraph carrier (of about 1900 Hz) modulated by the 1020-Hz synchronizing tone.

At the receiving end, the 1020-Hz synchronizing frequency is restored by detection and can then be used in the normal manner.

8 Phasing

Phasing is performed after the speeds of the transmitter and receiver drums have been equalized.

For phasing purposes, the transmitter sends a series of alternating white and black signals in such a way that the black lasts 95% and the white 5% of the total scanning line period (admissible tolerance: ± 0.5% of the total duration of a scanning line). The apparatus must be so adjusted that the pulses corresponding to the signal for white are transmitted:

- during scanning of the “dead sector”, when drum apparatus is used,
- during “lost time”, when flat-bed apparatus is used,

and that they are placed at the middle of the dead sector (or of the interval corresponding to the lost time).

(Tolerance admitted in the position of the "white" pulses: Δ_E = ± 1% of a “total scanning line length”.)

At the receiving station, phasing signals are used to start the apparatus so that short white pulses occur in the middle of the "lost time" (tolerance admitted: Δ_R = ± 2% of a "total scanning line length").

Note – These tolerances allow for the fact that the restitution of the original may deviate from its nominal position by 3% of a “total scanning line length”, when the sending and receiving stations are operating with the maximum authorized drift in the same direction.

9 Contrast

The transmitter must transmit the original document without changing the contrast of the tone scales of the picture to be transmitted.

10 Modulation and demodulation equipment

10.1 *Amplitude modulation*

Phototelegraph equipment shall normally provide for transmission and reception of an amplitude-modulated audio-frequency carrier, which is the normal mode of transmission for international metallic circuits.

The level of the output signal of the transmitter shall be greatest for white and least for black. It is desirable that the ratio of nominal white signal to nominal black signal should be approximately 30 decibels.

To simplify multi-destination operation and AM/FM conversion for radio operation it is desirable that the amplitude of the transmitted signal should vary linearly with the photocell voltage and that no corrections for tone scale should be made at the phototelegraph transmitting station.

For audio-frequency telephone circuits, the frequency of the picture carrier-current is fixed at about 1300 Hz. This frequency gives the least delay distortion on lightly loaded underground cables.

In the case of carrier telephone circuits providing a transmission band from 300 to 3400 Hz, a carrier-current frequency of about 1900 Hz is recommended.

10.2 *Frequency modulation*

Preferably phototelegraph apparatus should also provide for transmission and reception of a frequency-modulated audio-frequency carrier for use when necessary:

a) on combined metallic and radio circuits;

b) on wholly metallic circuits.

In such a case, the characteristics of the frequency-modulated output should be:

mean frequency.....	1900 Hz
white frequency.....	1500 Hz
black frequency.....	2300 Hz

The deviation of frequency should vary linearly with photocell voltage or, in the case of conversion from amplitude modulation to frequency modulation, with the amplitude of the amplitude-modulated carrier.

The stability of the transmission must be such that the frequency corresponding to a given tone does not vary by more than 8 Hz in a period of 1 second and by more than 16 Hz in a period of 15 minutes.

The receiving apparatus must be capable of operating correctly when the drift of black and white frequencies received does not exceed their nominal value by more than ± 32 Hz.

Note - It is recognized that there are difficulties operating with these frequency limits on the public switched telephone network (PSTN) where certain types of signalling equipment are used. By prior agreement between users on the PSTN, alternative frequencies of 1300 Hz for white and 2100 Hz for black may be used.

11 Positive or negative reception

Selection of positive or negative reception should be made by adjustment at the receiver. The adaptation of the transmitted signals to the characteristics of the photographic materials must also be effected at the receiving end according to the type of reproduction, negative or positive.

12 Colour transmission (optional)

12.1 Phototelegraphy apparatus constructed in accordance with this Recommendation can be used in colour phototelegraphy by splitting the spectrum of light reflected from the picture elements into three basic colours and transmitting the three resulting signals sequentially. Then each signal can be treated and transmitted as a phototelegraphy signal as specified in this Recommendation above.

12.2 The splitting of light reflected from picture element into three spectral components should be performed simultaneously. Thus synchro and phase coincidence and electronic colour correction can be achieved.

12.3 The triad RGB (red, green, blue) shall be used as a basis of main colours. The red colour shall be in range of 575-700 nm, green 485-575 nm, blue 400-485 nm.

Note – For the high quality reproduction of art images by means of graphic facilities, transmission of fourth components (i.e. black overtone) is desirable.

12.4 The order of signal transmission shall be as follows: red, green, blue. In the case of negative reproduction the order of colour separated signals transmission is reversed.

12.5 The speeds of the transmitting and receiving sets should not differ by more than 1 part in 10^7.