THE INTERNATIONAL TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE
(C.C.I.T.T.)

IVth PLENARY ASSEMBLY

MAR DEL PLATA, 23 SEPTEMBER - 25 OCTOBER 1968

WHITE BOOK

VOLUME VII

*

Telegraph technique

Published by
THE INTERNATIONAL TELECOMMUNICATION UNION
1969

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CONTENTS OF THE C.C.I.T.T. BOOKS STILL APPLICABLE AFTER THE IVth PLENARY ASSEMBLY (1968)

Each volume contains, when appropriate, extracts from contributions received on the subject of the volume concerned whenever their interest is such as to warrant publication.

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TELEGRAPH TECHNIQUE

DEFINITIONS CONCERNING TELEGRAPH TERMS

(Geneva, 1964 and Mar del Plata, 1968)

Note. — These definitions are either new or modified from those appearing in the *List of definitions of essential telecommunication terms* (2nd edition or 1st supplement).

General terms

01.091

phototelegraph station

A phototelegraph installation operated by an administration (or recognized private operating agency) is known as a "*public* phototelegraph station", while a phototelegraph installation belonging to a private organization is known as a "*private* phototelegraph station".

01.261

meteorological telegram

A telegram sent by an official meteorological service or by a station in official relation with such a service, and addressed to such a service or to such a station, which consists solely of meteorological observations or forecasts.

01.28

private telegram

Telegram other than service or government or meteorological telegram.

General alphabetic telegraphy

31.01

character

1. A printed symbol such as a letter, figure, punctuation sign and, by extension, a non-printing function such as a space shift, carriage return or line feed contained in a message.
2. Information corresponding to such a symbol or function.

31.011

telegraph signal

A signal representing all or part of one or more telegraph messages.

31.012

character signal

A telegraph signal representing a character. In start-stop telegraphy the character signal includes start and stop elements.

31.02

signal element

Each of the parts constituting a telegraph or data signal and distinguished from the others by its nature, magnitude, duration and relative position (or by one or some of these features only).

31.07

code (telegraph or data)

A system of rules and conventions according to which the telegraph signals forming a message or the data signal forming a block should be formed, transmitted, received and processed.

31.071

redundant code

A code using more special elements than necessary to represent the intrinsic information.

Example:

— A 5-unit code using all the characters of international telegraph alphabet No. 2 is not redundant.
— A 5-unit code using only the figures in international telegraph alphabet No. 2 is redundant.
— A 7-unit code using only signals made of four "space" and three "mark" is redundant.

31.08

alphabet (telegraph or data)

A table of correspondence between an agreed set of characters and signals which represent them.

31.14

telegraph modulation

Variation in time of one or more quantized characteristics of an electromagnetic wave, alternating current or direct current according to the telegraph or data signals to be transmitted.

Note. — Delete definition 31.13.

31.15

restitution

Series of significant conditions determined by the decisions taken according to the products of the telegraph demodulation.

Note. — Delete definition 31.21.

31.20

significant condition of a (telegraph) modulation

Condition assumed by the appropriate device corresponding to the quantized value (or values) of the characteristic (or characteristics) chosen to form the telegraph modulation.

Example: In a two-condition modulation (or binary modulation) there are two significant conditions, generally designated A and Z (or 0 and 1).

31.22

significant interval

Time interval between two consecutive significant instants.

31.221

minimum interval

The duration of the shortest significant interval in a system using a code such that the theoretical durations of the significant intervals are not all multiples of a unit interval.

31.24

significant instants

The instants at which the successive significant conditions recognized by the appropriate device of the modulation or restitution begin.

Each of these instants is determined as soon as the appropriate device takes up the significant condition usable for a recording or a processing.

31.251

telegraph modulator

Unit (or group of units) converting a basic signal into a modulation product.

CORRIGENDA No. 3 TO VOLUME VII OF THE C.C.I.T.T. WHITE BOOK
(English edition)

Definitions of telegraph terms, page 5, add:

31.271

data signalling rate

It is given by

$$\sum_{i=1}^{i=m} \frac{1}{T_i} \log_2 n_i$$

where m is the number of parallel channels, T_i is the minimum interval for the i-th channel expressed in seconds, n_i is the number of significant conditions of the modulation in the i-th channel.

Data-signalling rate is expressed in bits per second.

Note: a) For a single channel (serial transmission) it reduces to $\frac{1}{T} \log_2 n$; with a two-condition modulation ($n = 2$), it is $\frac{1}{T}$;

b) For a parallel transmission with equal minimum intervals and equal number of significant conditions on each channel, it is $m \frac{1}{T} \log_2 n$ ($\frac{m}{T}$ in case of a two-condition modulation).

31.252

telegraph demodulator

Unit (or group of units) converting a telegraphic modulation product into a signal suitable for processing.

31.29

synchronous transmission

A transmission process such that between any two significant instants there is always an integral number of unit intervals.

31.291

asynchronous transmission

A transmission process such that between any two significant instants in the same group,* there is always an integral number of unit intervals. Between two significant instants located in different groups, there is not always an integral number of unit intervals.

* In data transmission this group is a block or a character.
* In telegraphy this group is a character.

31.292

serial transmission (by elements)

Transmission at successive intervals of the signal elements constituting a character signal.

Note. — The elements may be transmitted one after another (without interruption) or separately, but must not be transmitted simultaneously.

Examples:

— transmission of signal elements in accordance with the international telegraph alphabet No. 2 by a standard teleprinter
— telegraph transmission by a time-derived channel.

31.293

parallel transmission

The simultaneous transmission of code elements constituting one or more character signals.

TELEGRAPH CHANNELS

32.01

(telegraph) channel
telegraph channel (Am)

The transmission media and intervening apparatus involved in the transmission of telegraph signals in a given direction, between two terminal sets or, more generally, between two intermediate telegraph installations.

A means of one-way transmission of telegraph signals.

A telegraph channel is characterized by the number of significant conditions and by the modulation rate it is designed to transmit.

Example: a 50-baud channel for two-condition modulation.

Notes:

1. Separate telegraph channels can have common constituent parts (e.g. side and phantom circuits) or share a common path (as in the case of a multiplex).
2. When it is a question of a channel between two terminal sets, it can be referred to as a *complete telegraph channel.*
3. A retransmitter with storage of signals is considered a terminal set and terminates a complete channel.
4. A complete channel may include regenerative repeaters (without storage).

A channel not including any regenerative repeater is called an *ordinary channel.*

32.02

(telegraph) circuit
telegraph channel (Am)

A means of both-way communication between two points comprising associated " send " and " receive " channels.

The two associated channels may be symmetrical (that is to say, they may offer users the same possibilities in either direction of transmission), or, on the other hand, asymmetrical.

Example of a symmetrical telegraph channel: the two channels together making one standardized voice-frequency telegraph circuit.

Example of an asymmetrical telegraph circuit: for data transmission, a channel offering a rate of 1200 bauds in one direction, associated with a channel offering only 100 bauds in the other direction.

Note 1. — The circuit includes the signal conversion equipment in the case of data transmission.

Note 2. — Notes 1, 2, 3 and 4 of 32.01 apply to definition 32.02, *mutatis mutandis.*

32.021

frequency channel

A channel essentially characterized by its passband (definition 02.20).

This passband is designated by its upper and lower frequencies. Should the channel be made up by joining several sections in tandem its passband is that which will result from the whole.

Several frequency channels may share a common path, as in carrier systems; in which case each frequency channel is characterized by a particular frequency band reserved to it.

32.29

amplitude modulation

1. Modulation in which the amplitude of an alternating current is the characteristic varied.

2. Modulation in which the significant conditions are represented by currents of different amplitude.

32.30

frequency modulation

1. Modulation in which the frequency of an alternating current is the characteristic varied.

2. Modulation in which two or more particular frequencies correspond each to one significant condition.

The representative function of the modulated wave may be continuous or discontinuous at the significant instants.

32.301

phase modulation

Modulation in which the phase angle of a carrier is the characteristic varied.

32.302

phase-inversion modulation

A method of phase modulation in which the two significant conditions differ in phase by π radians.

32.303

differential modulation

A type of modulation in which the choice of the significant condition for any signal element is dependent on the choice for the previous signal element.

32.304

modulation with a fixed reference

A type of modulation in which the choice of the significant conditions for any signal element is based on a fixed reference.

32.305

modulation coherence

Modulation in which the succession of significant instants is simply related to the characteristics of the current transmitted to line.

Example: Modulation obtained by reversing the phase of a carrier when the current passes through zero.

32.306

element error rate

character error rate

The ratio of the number of elements (or characters) incorrectly received to the total number of elements (or characters) sent.

32.31

frequency shift signalling

frequency shift keying (F.S.K.)

Frequency modulation method in which the frequency is made to vary at the significant instants:

a) by smooth transitions. The modulated wave and the change in frequency are continuous at the significant instants;

b) by abrupt transitions. The modulated wave is continuous but the frequency is discontinuous at the significant instants.

Note. — Delete definition 32.32.

32.34

multiplex-multichannel

Use of a common channel in order to make two or more channels, either by splitting of the frequency band transmitted by the common channel into narrower bands, each of which is used to constitute a distinct channel (frequency-division multiplex), or by allotting this common channel in turn, to constitute different intermittent channels (time-division multiplex).

32.351

time-derived channel

Any of the channels obtained from multiplexing a channel by time-division.

32.361

frequency-derived channel

Any of the channels obtained from multiplexing a channel by frequency-division.

32.391

clock

Equipment providing a time base used in a transmission system to control the timing of certain functions such as the control of the duration of signal elements, the sampling, etc.

TELEGRAPH DISTORTION

33.02

ideal instants of a modulation (or of a restitution)

Instants with which the significant instants would coincide in certain conditions.

It will be necessary to indicate, in each particular case, how these ideal instants are determined.

a) *Start-stop modulation*

The ideal instant of a start element is the instant at which this element begins.

The ideal instant of each of the other elements is n times the theoretical unit interval later than the ideal instant of the start element of the same signal, n being the rank of this element in the signal.

The standardized unit interval should be taken as the theoretical unit interval. The interval corresponding to the real mean modulation rate can also be taken, provided that it is specified.

The instant corresponding to the beginning of the start element of a signal should be known as the *reference ideal instant* for this signal.

b) *Isochronous modulation*

An ideal reference instant can be chosen arbitrarily. All the others are deduced from it by intervals equal to the corresponding theoretical significant intervals.

In the absence of any other deciding reason, the ideal reference instant shall be chosen so that the mean value of the deviations with respect to it is equal to zero.

33.04

telegraph distortion (of a modulation or a restitution)

1. A modulation (or restitution) suffers from telegraph distortion when the significant intervals have not all exactly their theoretical durations.

2. A modulation (or restitution) is affected by telegraph distortion when significant instants do not coincide with the corresponding theoretical instants.

33.05

displacement (region)
spread

Time interval at either side of an ideal instant of modulation or restitution, in which occur the actual significant instants of the modulation or restitution.

33.06

degree of individual distortion of a particular significant instant (of a modulation or of a restitution)

Ratio to the unit interval of the displacement, expressed algebraically, of this significant instant from an ideal instant.

This displacement is considered positive when the significant instant occurs after the ideal instant.

The degree of individual distortion is usually expressed as a percentage.

33.07

degree of isochronous distortion

1. Ratio to the unit interval of the maximum measured difference, irrespective of sign, between the actual and the theoretical intervals separating any two significant

instants of modulation (or of restitution), these instants being not necessarily consecutive.

2. Algebraical difference between the highest and lowest value of individual distortion affecting the significant instants of an isochronous modulation. (This difference is independent of the choice of the reference ideal instant.)

The degree of distortion (of an isochronous modulation or restitution) is usually expressed as a percentage.

Note. — The result of the measurement should be completed by an indication of the period, usually limited, of the observation.

For a prolonged modulation (or restitution) it will be appropriate to consider the probability that an assigned value of the degree of distortion will be exceeded.

In accordance with definition 31.23, in practical measurements the unit interval and the theoretical significant intervals considered are those corresponding to the actual average rate of modulation.

APPARATUS FOR ALPHABETIC TELEGRAPHY

34.03

margin of a telegraph apparatus
(or of the local end with its termination)

The maximum degree of distortion compatible with a correct translation when the signals are presented to a receiver under the most unfavourable conditions so far as the composition of the signals and of the distortion is concerned.

The maximum degree of distortion which results in incorrect translation applies without reference to the form of distortion affecting the signals. In other words it is the maximum value of the most unfavourable distortion causing incorrect translation which determines the value of the margin.

34.031

net margin

The margin represented by the degree of distortion indicated in 34.03, when the rate of modulation applied to the apparatus is exactly equal to the standard theoretical rate.

Note. — Delete definition 34.08.

34.091

margin of a synchronous receiver

Margin, as defined in 34.03, when the degree of distortion taken into account is the degree of isochronous distortion.

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SERIES R RECOMMENDATIONS

Telegraph channels

SECTION 1

RECOMMENDATIONS CONCERNING TELEGRAPH DISTORTION

(Mar del Plata, 1968)

RECOMMENDATION R.2

ELEMENT ERROR RATE

(Geneva, 1964)

In practice, the error rate on transitions is not used and, with the development of data transmission, it is the notion of element error rate that has come into use.

In general, the expression " element error rate " is used with the meaning of " error rate on unit elements ". Although this equivalence of meaning is acceptable for isochronous signal trains, this is not so for start-stop signal trains; in fact, there may be elements in start-stop signal trains whose duration is different from that of the unit elements (for example, the stop element of a start-stop signal in accordance with alphabet No. 2).

For these reasons, the C.C.I.T.T. *unanimously declares the view:*

1. that the following definitions be adopted:

Element error rate

The ratio of the number of incorrectly received elements to the number of emitted elements.

Unit element error rate for isochronous modulation

The ratio of the number of incorrectly received unit elements to the number of emitted unit elements;

2. that, for start-stop signal trains, the notion of character error rate be used (definition 33.19 of the *List of definitions*, the title being amended as follows: " Error rate on characters ");

3. that, when error rates are measured to assess the quality of a communication, the original message acting as a reference for the calculation of the error rate shall be considered as being free of error;

4. that measurement of the element error rate assumes that it has been possible to record the elements received in such a way that they can be recognized as being correctly or incorrectly recorded. As the result of an error rate, measurement thus depends on the recording system at the end of the connection; this system must be specified when the results of the element error rate are given. Whenever possible the element error rate should be measured at the output of the regenerating device which normally precedes the translation device; the signals should be translated for checking purposes.

RECOMMENDATION R.4

METHODS FOR THE SEPARATE MEASUREMENTS OF THE DEGREES OF VARIOUS TYPES OF TELEGRAPH DISTORTION

(New Delhi, 1960)

For separate measurement of the degree of characteristic distortion, bias distortion and fortuitous distortion affecting a telegraph modulation or restitution, the following is recommended:

1. Measure the degree of overall distortion (at the actual mean modulation rate) on text, for instance on the text of Recommendation R.51 (called SQ9 text).

Let Δ be the measurement obtained.

2. Measure the degree of distortion on reversals at the modulation rate used in measurement 1.

Let Δ_1 be the measurement obtained.

Δ_1 is the sum of the bias and fortuitous distortions.

By using a compensator fitted to the distortion-measuring equipment, for example a compensating winding on the distortion meter relay, reduce the degree of distortion reading obtained to its minimum value.

Let this figure be δ.

For practical purposes δ is the fortuitous distortion.

$\Delta_1 - \delta$ is, for practical purposes, the bias distortion.

3. Keep the distortion meter adjusted as for the measurement of δ. Measure the degree of distortion at the actual mean modulation rate on text (text SQ9, for instance).

Let Δ' be the reading.

$\Delta' - \delta$ is, for practical purposes, the characteristic distortion.

Notes. — 1. This method gives approximate results; it is possible that the equation $\Delta_1+\Delta'-\delta=\Delta$ may not be exactly satisfied.

2. The method can be applied by using either an isochronous distortion-measuring set or a start-stop distortion-measuring set.

3. The fact that the separate measurement of degrees of different types of distortion is said to be possible and that a method is recommended for such a measurement does not mean that separate measurements of the degrees of different types of distortion are to be recommended when international routine maintenance measurements are carried out.

RECOMMENDATION R.5

OBSERVATION CONDITIONS RECOMMENDED FOR ROUTINE MEASUREMENTS OF DISTORTION ON INTERNATIONAL TELEGRAPH CIRCUITS

(New Delhi, 1960, amended at Geneva, 1964, and at Mar del Plata, 1968)

The C.C.I.T.T.,

in view of Recommendations R.51, R.54 and R.55,

considering

that, for the measurement of the degree of distortion of signals on an international telegraph circuit, it is necessary to specify the best condition of observation in order to be sure that the measurement obtained gives a good indication of what the performance of the circuit will be during periods of normal traffic;

that the observation conditions should be such that their duration or their complexity does not unduly increase the load on the maintenance services;

that certain administrations, to determine these conditions, have carried out statistical measurements of the degree of individual start-stop distortion using distortion analysers, the results of which seem to be in agreement,

unanimously declares the view

that the tests should be carried out at nominal modulation rates of 50, 75, 100 and 200 bauds, depending on the type of circuits concerned;

that the text transmitted during measurements should be that of Recommendation R.51;

that the degree of transmitter distortion of test signals should not exceed 1%;

that, during normal maintenance tests, the duration of the observation should correspond to the examination of at least 800 significant instants, whatever the type of distortion meter used, isochronous or start-stop; at a modulation rate of 50 bauds this results in an observation period of about 30 seconds; at other modulation rates, the observation should last about 20 seconds;

that the observation time should be divided into two more or less equal parts: one part during which the significant instants in advance of their theoretical position could be observed and the other part during which the significant instants coming later than their theoretical position could be observed.

RECOMMENDATION R.9

HOW THE LAWS GOVERNING DISTRIBUTION OF DISTORTION SHOULD BE ARRIVED AT

(Geneva, 1964)

For the sake of comparative studies of degrees of distortion, it would be well if the procedures for measurement of distortion, and the layout of results, could be standardized. The distortion in question is:

1. start-stop individual,
2. isochronous individual,
3. start-stop.

The degree of isochronous distortion is of no great practical interest, since it is the individual isochronous distortion which, when isochronous distortion is present, supplies all the useful information. Hence it is not proposed to include the degree of isochronous distortion in this recommendation.

For these reasons, the C.C.I.T.T. *unanimously declares the following view:*

1. *Start-stop individual distortion*

As regards start-stop individual distortion, the distribution curves will be plotted by means of a statistical distortion analyser; the width of the measurement steps should make it possible to take measurements with steps of 1%, 2%, 4%, 8%. A measurement will cover about 20 000 transitions (measurement duration of about 15 minutes at 50 bauds: three transitions on the average per start-stop alphabetic signal).

The results will be shown on the graphs on the linear scale with distributional representation, or on the normal probability scale with cumulative representation, the ordinates being the probabilities and the abscissae the degree of distortion.

For individual distortion, the curves will give negative (early) and positive (late) distortion.

For more detailed studies, the number of transitions to be examined may be higher than 20 000, the number depending on the chosen probability that the nominal figure will be exceeded.

2. *Isochronous individual distortion*

There is the difficulty of synchronism between the transmitter and the distortion analyser, when the measurements are made at two different points; moreover, the average propagation time of the signals is to be taken into consideration when loop measurements are made.

The methods of measuring and presenting the results will be the same as for the preceding case, but the transmitter and the analyser will have to be synchronized as accurately as possible, taking into account the distortion values to be measured.

3. *Start-stop distortion*

This is a matter of the (maximum) degree noted during a measurement; it is then necessary to decide on the length of the sample to be measured; the text to be measured will be composed at random; the measurement at 50 bauds will last 30 seconds, distributed as in the fifth paragraph of Recommendation R.5.

Distribution curves of these degrees of start-stop distortion will be drawn as a function of the number of samples.

RECOMMENDATION R.11

CALCULATION OF THE DEGREE OF DISTORTION OF A TELEGRAPH CIRCUIT IN TERMS OF THE DEGREES OF DISTORTION OF THE COMPONENT SECTIONS

(New Delhi, 1960, amended at Geneva, 1964)

In general the isochronous standardized test distortion (references 33-07 and 33-12 of the *List of definitions*) of a telegraph circuit consisting of a number n of links in tandem lies between the arithmetic sum and the square root of the sum of the squares of the degrees of distortion of the individual links,

$$\sum_{i=1}^{n} \delta_i > \delta > \sqrt{\sum_{i=1}^{n} \delta_i^2}$$

n being the number of sections in tandem.

The few exceptions to this rule which have been observed related to extremely long circuits (for example, four links, each of approximately 3500 km looped at voice-frequency at the distant end to give the equivalent of four links (each 7000 km go and return) and a total length of approximately 28 000 km on cable and open-wire carrier telephone channels).

For such purposes as the planning of networks, the degree of distortion of a telegraph circuit consisting of n channels or links in tandem in the telex service (where a great number of channels will be interconnected at random) is given fairly approximately by:

$$\delta_{\text{inherent}} = \sum_{n}^{1} \delta_c + \sqrt{\sum_{1}^{n} (\delta_{\text{bias}})^2 + \sum_{1}^{n} (\delta_{\text{irreg.}})^2}$$

Similarly, for the combination of a transmitter and a telegraph circuit consisting of n channels or links in tandem in the telex service, the degree of distortion is given fairly approximately by:

$$\delta_{\text{text}} = \sum_{1}^{n} \delta_c + \sqrt{\delta_t^2 + \delta_v^2 + \sum_{1}^{u} (\delta_{\text{bias}})^2 + \sum_{1}^{n} (\delta_{\text{irreg.}})^2}$$

where

δ_{inherent} = the probable degree of inherent start-stop distortion on standardized text,
δ_{text} = the probable degree of gross start-stop distortion in service,
δ_c = the degree of characteristic start-stop distortion of a single channel or link,

δ_t = the degree of synchronous start-stop distortion of the transmitter,

δ_v = the degree of start-stop distortion due solely to the difference between the mean transmitter speed and the standardized speed. (The difference to be considered is equal to six times the mean difference for one element.)

δ_{bias} = the degree of asymmetrical (bias) distortion of one channel measured using 1 : 1 or 2 : 2 signals (either 1 : 1 or 2 : 2 signals should be used according to which is normally employed for adjusting the channels),

$\delta_{irreg.}$ = the degree of fortuitous distortion of one channel measured using 1 : 1 or 2 : 2 signals.

The values of distortion (with exception of δ_c) inserted in the foregoing formulae must have the same probability of being exceeded (p).

The degree of characteristic distortion δ_c of a channel is fairly constant for each type of voice-frequency channel and can be determined in laboratory tests.

Nevertheless, the maximum degree of characteristic distortion is reached for only about 20% of the signals of international telegraph alphabet No. 2.

Empirical values for δ_c can be obtained with reasonable accuracy by using methods recommended by Recommendation R.4.

The probability of exceeding the degrees of distortion $\delta_{inherent}$ and δ_{text} calculated with the aid of the above formulae is $\frac{20}{100} \times p$.

SECTION 2

DIRECT CURRENT TELEGRAPHY

RECOMMENDATION R.20

TYPES OF INTERNATIONAL TELEGRAPH LINES

(former C.C.I.T. Recommendations B.22 and B.27, Warsaw, 1936, amended at New Delhi, 1960, and at Geneva, 1964)

The C.C.I.T.T.,

considering

that cable lines are better protected from disturbance than aerial lines;
that it will, however, be necessary in certain cases to continue to employ aerial lines,

unanimously declares the view

that for the international telegraph service as much use as possible should be made of the circuits of the long-distance cable system;

considering

that the standardization of the modulation rate of telegraph circuits serves to ensure an economical organization of the international telegraph network,

unanimously declares the view

1. that the telegraph transmission channels should allow the operation of standardized equipment with a modulation rate of 50 bauds;
2. that, for the services using equipment which works at a different modulation rate, administrations should reserve the right of mutual agreement among themselves on the employment of special circuits.

RECOMMENDATION R.21

CHARACTERISTIC FACTOR OF THE QUALITY OF BALANCE

(former C.C.I.T. Recommendation B.4, Brussels, 1948, amended at Geneva, 1956 and 1964)

The C.C.I.T.T.,

considering

that it is the degree of distortion which best characterizes the quality of a telegraphic communication;

that the measurement of telegraphic distortion is now a common practice,

unanimously declares the view

a) that the quality of balance of a duplex telegraph circuit can be characterized by the difference in the degrees of distortion of the signals restituted:

1. when no signals are transmitted on the sending channel;
2. when signals are transmitted over that channel;

b) that meaurements should be made at both ends of the circuit.

Note. — The quality of balance thus characterized is applicable to standardized telegraph systems for which measurements of the degree of distortion are usually made.

RECOMMENDATION R.22

EARTHING OF TELEGRAPH INSTALLATIONS

(former C.C.I.T. Recommendations B.6 and B.7, Warsaw, 1936, amended at Geneva, 1956, and at New Delhi, 1960)

When a local cable is not exposed to any induction phenomena, the earthing of the centre point of the common source of transmission currents may have the advantage of ensuring better balance of the supply voltages of the telegraph circuit with respect to the cable sheath and to other telegraph circuits.

Further, it is advisable not to have any earth connection at any point in a long-distance cable circuit.

For these reasons, the C.C.I.T.T. *unanimously declares the view:*

1. that, when common batteries are used for transmission currents on line circuits, it is advisable to earth the centre point of these batteries in cases when no induction phenomena are to be feared;

that, in the case of a local network cable exposed to induction phenomena, it is advisable to use a separate source with no earthing for each telegraph circuit;

2. that there should be no earth at any point in a telegraph installation or line having metallic connection to a long-distance cable circuit; the connection with a long-distance cable should be made by means of a transformer providing a metallic discontinuity in the telegraph circuit;

3. that if, however, for special reasons it is necessary to earth a line or an installation connected to the conductors of a cable, the following precautions should be taken:

a) the earthing must be carried out in such a way that the balance of the circuits with respect to earth and to adjacent circuits is not disturbed;

b) the breakdown voltage of all the other conductors of the cable together, with respect to the earthed circuit, must be appreciably higher than the highest voltage which could exist between these conductors and the earthed circuit as a result of induction from adjacent power lines;

4. that an investigation must be made of installations already earthed to ascertain whether condition 3 b) will continue to be satisfied in the event that new distribution networks or new electric railway lines are put into operation, in which case suitable measures must be taken.

RECOMMENDATION R.23

STANDARDIZATION OF DIRECT CURRENT TELEGRAPH CIRCUITS EMPLOYING TELEPHONE CABLES

(combined Recommendation of Recommendations R.23, R.24 and R.25, Geneva, 1964)

Note. — This recommendation applies only to the telegraph circuits of two-condition modulation operated at the modulation rate of 50 bauds.

Technical processes exist by which telephone traffic and telegraph traffic can be passed through the same cable either on separate conductors or even on common conductors; by these processes, if the precautions described below are observed, the telephone circuits, including phantom circuits, are to all intents and purposes uninfluenced by the telegraphy as regards both their electrical properties and the flow of traffic.

Even when the cable is subject to the influence of electric power installations (particularly a.c. railway lines), undisturbed telephone and telegraph services can be obtained by the use of devices which have been proved to be effective.

Moreover, the simultaneous use of a long-distance cable for international telephony and telegraphy will be of interest for economic reasons.

For these reasons, the C.C.I.T.T. *unanimously declares the view*

that it is possible to allow in a same cable the co-existence of telephony and d.c. telegraphy, provided that the conditions listed below are fulfilled:

A. Telegraphy and telephony on the common conductors

A.I *Sub-audio telegraphy*

The method of sub-audio telegraphy should not be used for international connections (Decision of the VIth Plenary Assembly of the C.C.I.T., Brussels, 1948).

A.II *Telegraphy on single or double phantom circuits*

1. For the excitation of relays and the transmission of signals, a working current and a resting current of equal intensity in steady state, but in opposite directions, should be used;

As a general rule, arrangement will be in differential duplex; however, in certain special cases, particularly those of telephone cables with unidirectional transmission, operation will be carried out by separate channels for the two directions of transmission;

The excitation current of the receiving relay will be between 4 and 8 milliamperes for telegraphy on phantom and double phantom circuits;

The e.m.f. introduced by the telegraph transmitter into the circuit containing the cable conductors must not exceed 50 volts.

2. Where a resistance of 30 ohms, substituted for the cable conductors, is placed across the terminals of this telegraph transmitter, the current flowing through this resistance must not exceed 50 milliamperes.

This limit is raised to 100 milliamperes if the cable is fitted with coils having a powdered-iron core or a core of some other material with equally satisfactory characteristics.

3. Noise produced by all the telegraph apparatus on a telephone circuit must not exceed, at the point of relative level of —1.0 neper or —8.7 decibels and with an impedance of 600 ohms, a value which corresponds to a psophometric e.m.f. of 1 millivolt. To fulfil this condition, it is advisable to insert low-pass filters in the transmission on all telegraph circuits operated by direct current. This limit may have to be lowered when the telephone circuit is already subject to considerable disturbance from an adjacent power-line.

4. The simultaneous telegraph installations must not introduce unbalance relative to earth in the telephone circuits (*Directives for the protection of telecommunication lines against the harmful effects of industrial power-lines*).

5. The increase in crosstalk produced by the simultaneous telegraphy installations in the telephone circuits must not exceed a value corresponding to a decrease of 0.5 neper or 4.34 decibels in the near-end crosstalk attenuation.

6. The circuits used for programme transmission, for voice-frequency telegraphy, or for phototelegraphy should preferably not be used for single or double phantom telegraph circuits.

B. TELEGRAPHY AND TELEPHONY CO-EXISTENT ON SEPARATE CONDUCTORS

1. Case in which the telegraph uses coil-loaded conductors which may afterwards be used for telephony:

The conditions set out above under A.II 1, 2 and 3 must be fulfilled.

2. Case in which the telegraph uses unloaded conductors:

The conditions set out above under A.II 3 only must be fulfilled.

C. Common conditions for equipment and supervisory equipment

Equipment will be constructed in such a way that one may easily and speedily:

— replace the source of current by a resistance equal to the internal resistance of that source;

— insert, during operation, an apparatus for measuring distortion;

— change lines and apparatus by means of jacks and plugs.

Supervisory equipment should allow the following operations to be accomplished in the minimum time:

— emission of symmetrical alternations at the modulation rate of 50 bauds;

— measurement in steady state of the effective operating currents, receiving relays and currents coming from transmitting relays;

— measurement of currents in local circuits;

— if necessary, determination of data concerning the quality of the circuit balance according to Recommendation R.21.

RECOMMENDATION R.26

STANDARDIZATION OF AERIAL TELEGRAPH CONDUCTORS

(former C.C.I.T. Recommendation B.28, Warsaw, 1936)

The C.C.I.T.T.,

considering

that it is desirable to standardize the characteristics of international telegraph conductors;

that the tests made with the object of obtaining circuits not subject to contact and to variations of insulation by using wires provided with insulation other than rubber and paper have not given satisfactory results;

that the use of wires insulated by rubber would not guarantee the perfect handling of traffic for a very long period and would increase expenses;

that the use of wires insulated by paper and lead would greatly increase costs,

unanimously declares the view

1. that, for aerial conductors used in the international telegraph service, it is desirable to employ copper or bronze wires answering the following specifications:

	Diameter at least mm	Tensile strength at least kg/mm^2	Resistivity at 20 degrees centigrade maximum microhms/cm
Copper	3	40	1.820
Bronze	2.5	60	2.780

2. that it is not desirable to replace open wires by insulated wires with the aim of improving the electrical properties of the conductors.

SECTION 3

VOICE-FREQUENCY TELEGRAPHY

RECOMMENDATION R.30

TRANSMISSION CHARACTERISTIC OF INTERNATIONAL VOICE-FREQUENCY TELEGRAPH LINKS

(Mar del Plata, 1968)

1. Standardized carrier systems with 4-kHz and 3-kHz spacing permit homogeneous voice-frequency telegraph systems providing the following capacities of voice-frequency telegraph channels:

	50-baud 120-Hz spacing	100-baud 240-Hz spacing	200-baud 360-Hz spacing	200-baud 480-Hz spacing
4 kHz	24	12	8 (not normally used)	6
3 kHz	22	11	7	5

2. Audio-frequency circuits with heavy or semi-heavy loading permit 12-channel 50-baud systems; circuits with lighter loading permit 18 channels at 50 bauds.

3. Four-wire links are to be preferred for voice-frequency telegraphy.

4. The composition of a four-wire link for voice-frequency telegraphy differs from that of a telephone circuit in that there are no terminating sets, signalling equipment and echo suppressors.

5. With two-wire links, a duplex arrangement would not be feasible since the links could not be balanced with the necessary precision to avoid mutual interaction. If the low frequencies are used for transmission in one direction and high frequencies for the other direction, a two-wire link can be used for voice-frequency telegraphy.

6. The conditions of use of international voice-frequency telegraph links are described in detail in new Recommendation H.22 (*White Book*, Volume III).

RECOMMENDATION R.31

STANDARDIZATION OF AMPLITUDE-MODULATED VOICE-FREQUENCY TELEGRAPH SYSTEMS, FOR A MODULATION RATE OF 50 BAUDS

(combined Recommendation of Recommendations R.31, R.32 and R.34, Mar del Plata, 1968)

The C.C.I.T.T.

unanimously declares the following view:

1. It is advisable to adopt, for amplitude-modulated voice-frequency telegraph systems and for a modulation rate not exceeding 50 bauds, the series of frequencies formed by odd multiples of 60, the lowest frequency being 420 Hz.

Channel position	Frequency Hz	Channel position	Frequency Hz
1	420	13	1860
2	540	14	1980
3	660	15	2100
4	780	16	2220
5	900	17	2340
6	1020	18	2460
7	1140	19	2580
8	1260	20	2700
9	1380	21	2820
10	1500	22	2940
11	1620	23	3060
12	1740	24	3180

This numbering is valid whatever use is made of the channel (e.g. traffic channel, pilot channel, etc.) or the method employed to obtain the line frequencies, e.g. by group modulation.

2. In the case of systems on telephone channels with a spacing of 3-kHz operating according to the standardized frequency series, channel positions 23 and 24 cannot be used.

3. The frequencies applied to the telephone circuit which is used as the voice-frequency telegraph bearer circuit should not deviate by more than 6 Hz from the nominal value when the telegraph channels supplied are operating over a telephone circuit composed exclusively of audio-frequency sections, and not more than 3 Hz in other cases.

4. The power levels of carrier waves transmitted on the line and measured successively in as short a period as possible should not differ from one another by more than 0.2 neper (1.74 dB) when they are operating on a constant impedance.

5. The power of each of the carrier waves transmitted on the line should not vary in operation by more than ± 0.1 neper (± 0.87 dB) when it operates on a constant impedance.

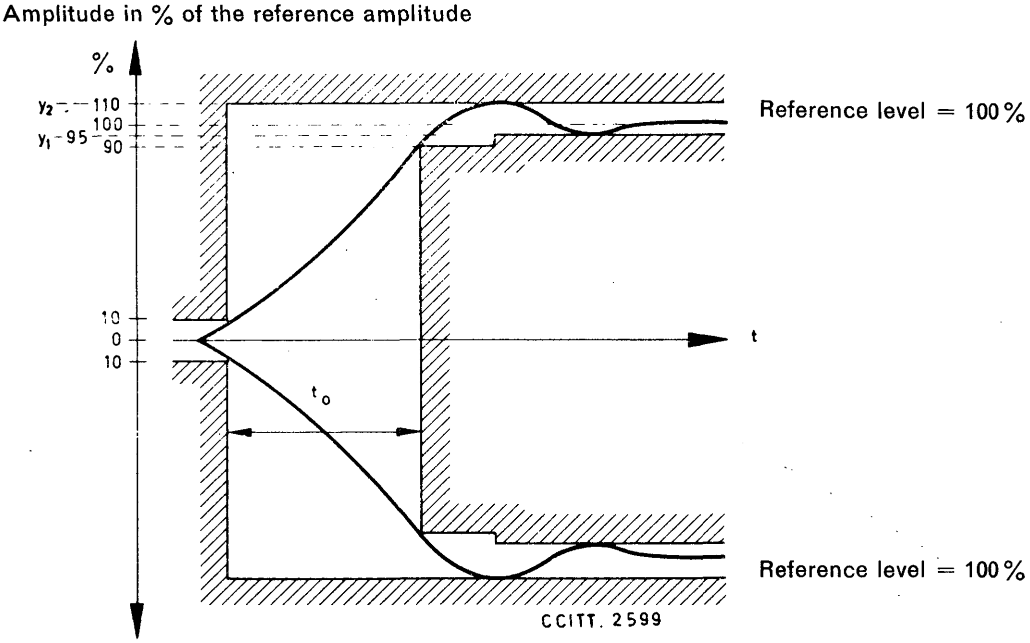


FIGURE 1 — **Diagram of toleraces to asses the signal-wave form sent in amplitude-modulated voice-frequency telegraphy cystems**

6. The amplitude of the signals transmitted should remain within the tolerances of Figure 1 in which the values t_0, y_2 *and* y_1 are fixed as follows:

t_0 = 11 milliseconds
y_1 = 95%
y_2 = 110%

Receivers with rapid-action level correction should not be sensitive to secondary pulses following the signal pulse provided that the amplitude of the signal emitted does not exceed the reference level by more than 10% and that the reference level does not exceed the normal level by 1.2 neper (10.4 dB). (This provision applies only to new systems.)

7. a) If 1 to 1 reversals at frequency f_p corresponding to the modulation rate are sent over a channel with mid-frequency F_0, the voltage at frequency $F_0 \pm 3 f_p$ must not exceed 3% of the nominal voltage of frequency F_0 and the voltage at the frequencies $F_0 \pm 5 f_p$ must not exceed 0.4% of the nominal voltage of frequency F_0.

Note. — These tolerances will be required only for future systems. Administrations should try as far as possible to use systems satisfying these tolerances, on international relations.

b) The unbalance of the emitted signal should not be greater than ±4% (methods of measuring this unbalance are described in Supplements Nos. 11 and 12 of the *Blue Book*, Vol. VII). This tolerance takes account of the limit in paragraph 7.c) for new systems.

c) For new systems, the static relay should introduce a difference of not less than 5 nepers (45 dB) between the two signalling conditions. (For existing systems the limits are 3.5 nepers or 30 dB.)

In the event of failure of the control current in the sending static relay, the attenuation of the residual signal relative to this nominal level should be at least 3.1 nepers (27 dB). This attenuation of the signal need not occur immediately on the failure of the control current,

8. Systems should be able to tolerate slow level variations of at least ± 6 dB (0.67 Np); administrations should equip systems which are unable to tolerate such variations with a common amplifier to enable them to tolerate at least variations of $\pm$ 6 dB (0.67 Np).

9. The permissible limit for the power of the telegraph current on each telegraph channel when a continuous tone is being transmitted is given in the table.

TABLE

Normal limits for the power per telegraph channel in amplitude-modulated voice-frequency telegraph systems

Voice-frequency telegraph system	Allowable power per telegraph channel at a point of zero relative level when sending a continuous marking signal		
	in micro-watts	nepers	decibels
12 telegraph channels or less	35	−1.67	−14.5
18 telegraph channels	15	−2.1	−18.3
24 telegraph channels	9	−2.35	−20.45

Note. — These limits are such that the maximum instantaneous voltage will not exceed that of a sinusoidal voltage with a power of 5 milliwatts at a point of zero relative level. This power is the maximum permissible for voice-frequency circuits.

10. The audio-frequency is transmitted to line when " stop " polarity (condition Z) is sent.

11. When a signal the frequency of which is equal to the nominal frequency of the channel, and whose level is 2.1 nepers (18.3 dB) below the normal signal level of the channel, is applied to the detector of a 24-channel voice-frequency telegraph system, the receiving relay should not respond.

12. It must be possible to subject any channel to a test without withdrawing from service a channel other than the return channel of the circuit planned.

13. In graded harmonic frequency telegraphy, it is desirable that the same frequencies be used separately for circuits established on different successive sections of a four-wire circuit.

14. In graded harmonic frequency telegraphy, the attenuation of the filters which pass a group of frequencies must, in the suppressed frequency band, be higher by at least 4 nepers than that shown in the transmission band.

15. In graded harmonic frequency telegraphy, in order to facilitate local tests, the frequencies used for communications set up between two international offices in one direction should also be used in the opposite direction, if possible.

RECOMMENDATION R.35

STANDARDIZATION OF FREQUENCY-SHIFT MODULATED VOICE-FREQUENCY TELEGRAPH SYSTEMS FOR A MODULATION RATE OF 50 BAUDS

(former C.C.I.T. Recommendation B.48, Geneva, 1956, amended at New Delhi, 1960, Geneva, 1964, and Mar del Plata, 1968)

The C.C.I.T.T. *unanimously declares the following view:*

1. The nominal modulation rate should be standardized at 50 bauds.

2. For the nominal mean frequencies, the series formed by the odd multiples of 60 Hz should be adopted, the lowest frequency being 420 Hz in accordance with Recommendation R.31, paragraph 1, the mean frequency F_0 being defined as the half-sum of the two characteristic frequencies corresponding to the permanent start polarity F_A and stop polarity F_Z.

3. The mean frequencies at the sending end should not deviate from their nominal value by more than 2 Hz.

4. The unbalance due to the modulation process $\delta = 2 \frac{F'_0 - F_t}{F'_A - F'_Z}$ should not exceed 3%. (This limit is provisional and could be revised if necessary.)

where F'_A and F'_Z are the two characteristic frequencies measured;

F'_0 is the mean static frequency measured $= \frac{F'_A + F'_Z}{2}$

The frequency F'_0 must be equal to the nominal mean frequency F_0 to within 0.1 Hz.

F_t is the mean dynamic frequency measured with 1/1 rectangular signals during 10 seconds.

Measurement should be made applying to the input of the transmitter 1/1 rectangular signals with the build-up and hangover time below 1 μs and with the unbalance below 0.1%.

In the event that in service the transmitter is controlled by an electro-mechanical relay (with a certain transit time), the measurement should also be made with that type of relay inserted between the signal generator 1/1 and the input to the transmitter.

Both forms of measurements need not necessarily be included in the maintenance procedure but should be included in laboratory type tests.

5. The difference between the two characteristic frequencies (corresponding to the start and the stop conditions) should be 60 Hz, although a difference of 70 Hz may be used by agreement between the administrations concerned.

6. The tolerance permitted in this difference should be at most ±3 Hz.

7. The total average power transmitted to the telephone line by all the channels of a system is normally limited to 135 microwatts at a point of zero relative level. This sets, for the average power of a telegraph channel (at a point of zero relative level), the limits given in Table 1.

TABLE 1

Normal limits for the power per telegraph channel in frequency-modulated voice-frequency telegraph systems

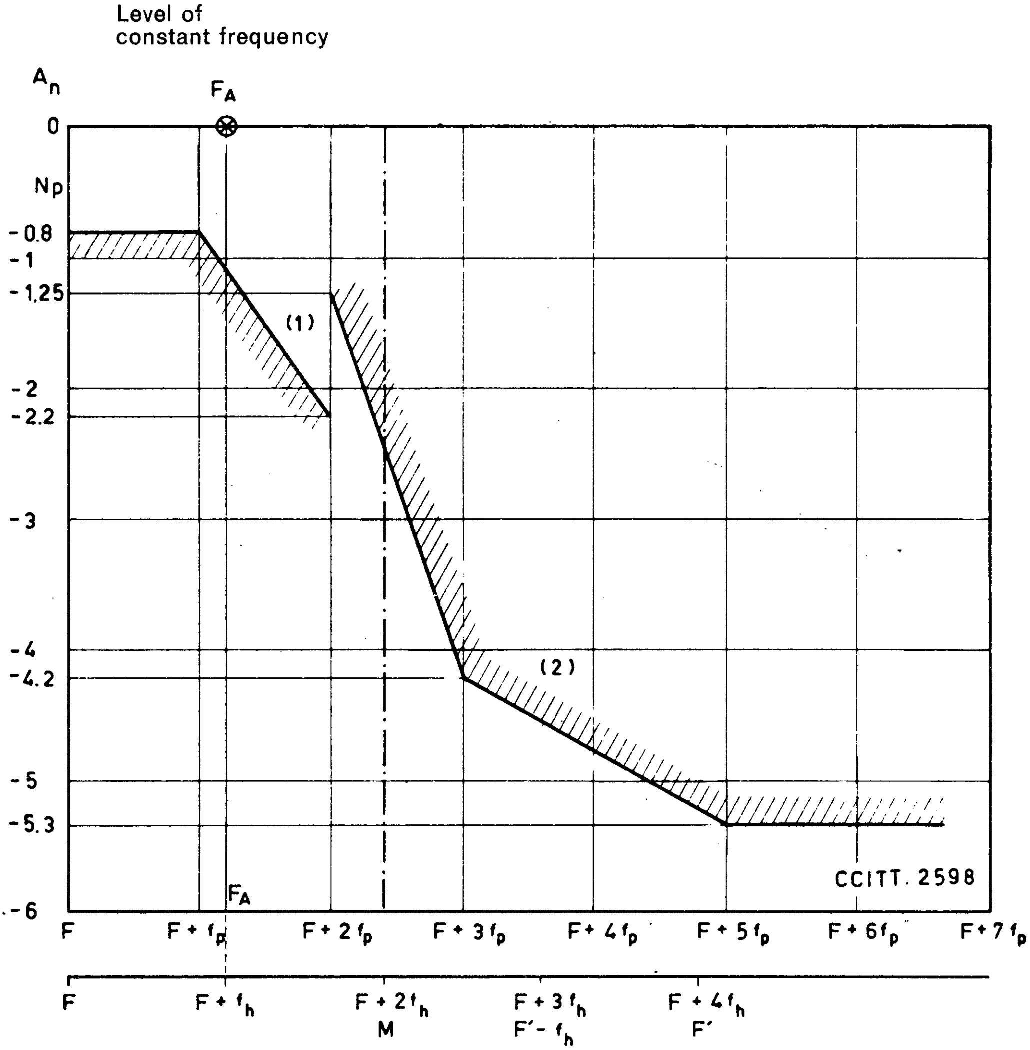
Voice-frequency telegraph system	Allowable power per telegraph channel at a point of zero relative level		
	in microwatts	in an absolute power level	
		nepers	decibels
12 telegraph channels, or less	11.25	−2.25	−19.5
18 telegraph channels	7.5	−2.45	−21.25
24 telegraph channels	5.6	−2.6	−22.5

8. In operation, the levels of the signals corresponding to continuous stop polarity and continuous start polarity should not differ by more than 0.2 neper (1.7 dB) in the same channel. Both of these levels must lie between +0.2 neper (+1.7 dB) and −0.2 neper (−1.7 dB) with reference to the level given in Table 1.

9. The frequency for the transmitted condition corresponding to the start polarity is the higher of the two characteristic frequencies and that corresponding to the stop polarity is the lower.

10. In the absence of telegraph current controlling the channel modulator, a frequency should be transmitted, within ±5 Hz of the frequency normally transmitted for the start polarity. This frequency need not be sent immediately after interruption of the control current.

11. The frequency spectrum of the emitted signal, when transmitting 1/1 signals at the modulation rate of $2 f_p$ (f_p=frequency of modulation) should be in accordance with the limits specified in Figure 1; in this diagram it shows the levels of the spectra of different components with respect to the amplitude of the non-modulated carrier as ordinates and the frequencies as abscissae.



F = carrier frequency of a channel
f_p = frequency of modulation = 25 Hz
f_h = frequency shift = 30 Hz

F' = carrier frequency of the adjacent channel
M = centre line between adjacent channels

Curve 1 = Lower limit in the pass band
Curve 2 = Upper limit in the stop band

FIGURE 1. — **Frequency spectrum for 1:1 signals in frequency-modulated 50 bund-120 Hz spacing voice-frequency telegraph systems.**

12. The receiving equipment should operate satisfactorily when the receiving level falls to 2 nepers (17.4 dB) below the nominal level. The receiving equipment should have been restored to start polarity when the receiving level has fallen to 2.7 nepers (23.5 dB) below the nominal level.

The nominal level is the level resulting from the choice of power per channel (Table 1) depending upon the number of channels (12, 18 or 24) on the circuit.

Choice of the level to control an alarm is left to individual administrations.

13. On delivery by the manufacturer of 50-baud frequency-modulated voice-frequency telegraph equipment, the following values must not be exceeded for the degree of distortion on a telegraph channel.

These values correspond to closed circuit measurements, made with the audio-frequency line terminals of the sending and receiving equipments connected together through an artificial line. Before the series of measurements taken in accordance with Recommendation R.51, the levels are adjusted to their normal values, the mean frequencies are checked to see whether they are within ± 2 Hz of their nominal value (point 3 of the Recommendation) and the difference between the two characteristic frequencies is within the permitted tolerance of less than 3 Hz (point 6 of the Recommendation). Bias distortion is eliminated by adjustment in the channel receivers. The other channels of the system are modulated with unrelated signals when the effect of inter-channel interference is to be included in the measurement. These " unrelated signals " can conveniently be 1:1 signals from different generators at approximately 50 bauds but not synchronous to each other or to the signal on the channel under test.

a) the transmission levels being normal, the artificial line introducing no frequency drift, but the measured channel being subject to fortuitous distortion due to interchannel interference: 5% for the degree of inherent isochronous distortion;

b) the level being maintained constant, but at a value different from the normal level, for all constant levels between 1 neper (8.7 dB) above the normal reception level and 2 nepers (17.4 dB) below the normal reception level, the other conditions being the original measurement condition: 7% for the degree of inherent isochronous distortion;

c) in the presence of interference by a single sine-wave frequency equal first to one and then to the other characteristic frequency, with a level of 2.3 nepers (20 dB) below the signal level, the other conditions for the start of measurements being maintained: 12% for the degree of inherent isochronous distortion (i.e. total distortion including the increase due to the interfering frequency, not distortion due to the interfering frequency alone);

d) by introducing a frequency drift (Δf Hz) of the signals, during transmission through the artificial line, Δf being not more than 5, and the initial condition of the test otherwise being preserved: $(5+2.5\ \Delta f\ \text{Hz})\%$ for the degree of inherent isochronous distortion; the measurements shall be made after the transient effects of changing frequency have ceased.

14. Frequency drifts on modern telephone circuits are generally less than 2 Hz. Hence, it is not necessary to recommend frequency drift control.

For circuits on which a maximum frequency drift of not greater than ± 2 Hz cannot be guaranteed, compensation seems necessary. Two methods can be used:

— compensation for each channel up to about 15 Hz;

— compensation for all the channels by using a pilot. In this case, the receiving end must be able to request and obtain a pilot frequency. Administrations should agree among themselves on the advisability of sending the pilot and the choice of frequency. 3300 Hz or, preferably, 300 Hz are recommended, with a tolerance of ±1 Hz. The mean power emitted at the relative zero point on this frequency should not exceed that recommended for a telegraph channel in the case of a 24-channel group, i.e. −2.6 Np (−22.5 dB).

15. The number of significant conditions of the modulation is fixed at two; this number may be increased, if necessary, by agreement between the administrations concerned.

RECOMMENDATION R.35 *bis*

50-BAUD WIDEBAND VOICE-FREQUENCY TELEGRAPH SYSTEMS

Voice-frequency telegraph systems for 50-baud channels standardized by the C.C.I.T.T. are described in Recommendations R.31 (for amplitude modulation) and R.35 (for frequency modulation). Systems which comply with these recommendations are those normally recommended by the C.C.I.T.T.

However, it may sometimes be advisable to use a voice-frequency telegraph system for a speed of 50 bauds in which the channels have wider spacing than in systems complying with Recommendations R.31 and R.35.

The use of channels with a spacing of more than 120 Hz for a modulation rate of 50 bauds offers certain advantages in the following cases:

1. on connections with not much traffic (which it is not intended to increase to more than 12 channels for a long time to come);
2. on connections where channels are required to have less distortion than on channels established in accordance with Recommendations R.31 and R.35;
3. as far as maintenance is concerned, wideband equipment requires less attention.

In particular, if telephone circuits carrying voice-frequency telegraph systems are unstable, the use of wideband channels together with f.m. is recommended.

Moreover, if systems are standardized so that only one modulation method is used, the cost of equipment should be lower.

For these reasons, the C.C.I.T.T. *unanimously declares the view* that when administrations agree to set up a 50-baud voice-frequency telegraph system with spacing of more than 120 Hz, the voice-frequency telegraph equipment should have the following characteristics:

1. Voice-frequency telegraph systems for wideband 50-baud channels should be homogeneous systems using frequency modulation only.
2. Equipment in conformity with Recommendation R.37 is recommended for this purpose.

RECOMMENDATIONS R.36, R.37, R.38 A, R.38 B

REPORT ON VOICE-FREQUENCY TELEGRAPH CHANNELS FOR MORE THAN 50 BAUDS

(Common introductive report on Recommendations R.36, R.37, R.38 A and R.38 B)
(Geneva, 1964, amended at Mar del Plata, 1968)

The C.C.I.T.T. has examined characteristics for telegraph circuits for more than 50 bauds. It noted that the following modulation rates:

75 bauds
100 bauds
150 bauds
200 bauds

had been envisaged. The C.C.I.T.T. considers that the types of channels to be provided should not correspond to such a detailed subdivision, for two reasons:

the rate of 75 bauds can obviously be used over a 100-baud channel and, in some cases, over a 50-baud channel; similarly, the rate of 150 bauds can obviously be used over a 200-baud channel and, in some cases, over a 100-baud channel;

the lease rates envisaged are such that differences in tariffs between 75-baud and 100-baud channels or between 150-baud and 200-baud channels will be relatively slight.

The C.C.I.T.T. therefore proposes to create so-called 100-baud channels and 200-baud channels, in addition to the 50-baud channels that have already been standardized.

Note. — The channel performance at the modulation rate of 75 bauds on one link of the standardized f.m. 120-Hz spacing system (R.35) is quite satisfactory. When a circuit is consisting of two or more channels in tandem, the use of regenerative repeater may be required: to judge this it is advisable to refer to Recommendation R.57 and to admit that the limit values which appear in this recommendation are applicable to the use of 50-baud channels for 75 bauds. However, the C.C.I.T.T. confirms the basic principle that the standard transmission channel for the rate of 75 bauds is a 100-baud channel which is standardized in Recommendation R.37 and not a 50-baud channel. Such a use of 50-baud channel is recommendable only in a special case, due to bandwidth economy, use of long-distance submarine cables, other line conditions, etc.

Very different possibilities of use for these channels should be envisaged:

— start-stop transmission or synchronous transmission;

— tandem operation of several channels;

— use of point-to-point circuits, circuits with broadcast or switched circuits;

— integration into the world network;

— data transmission.

The signal regeneration devices will not be constituent elements of the channel, for their presence prevents any flexibility as regards assignment of the channel for various uses.

With regard to channels for 200 bauds, it has been agreed that the spacing of such channels should normally be 480 Hz because of the advantages of 480-Hz spacing compared with 360-Hz spacing with regard to distortion and the cost of equipment.

But when the advantage of having a greater number of telegraph channels on the same bearer circuit is considered essential by the administrations—which will generally be the case for 3-kHz band circuits on long submarine cables—the use of 360-Hz spacing systems between 200-baud telegraph channels is justified.

For that reason the following four recommendations have been adopted:

a) *Recommendation R.36*—co-existence of 50-baud/120-Hz channels, 100-baud/240-Hz channels, 200-baud/360-Hz or 480-Hz channels on the same voice-frequency telegraph system.

b) *Recommendation R.37*—Standardization of frequency-modulated voice-frequency telegraph systems for a modulation rate of 100 bauds.

c) *Recommendation R.38 A*—Standardization of frequency-modulated voice-frequency telegraph systems for a modulation rate of 200 bauds with channels spaced at 480 Hz.

d) *Recommendation R.38 B*—Standardization of frequency-modulated voice-frequency telegraph systems for a modulation rate of 200 bauds with channels spaced at 360 Hz, usable on long intercontinental bearer circuits generally used with a 3-kHz spacing.

Recommendation R.36 therefore applies to heterogeneous systems, and Recommendations R.37, R.38 A, R.38 B to homogeneous systems.

For the homogeneous systems referred to by Recommendations R.37, R.38 A and R.38 B, only frequency modulation is recommended.

RECOMMENDATION R.36

CO-EXISTENCE OF 50-BAUD/120-Hz CHANNELS, 100-BAUD/240-Hz CHANNELS, 200-BAUD/360-Hz OR 480-Hz CHANNELS ON THE SAME VOICE-FREQUENCY TELEGRAPH SYSTEM

(New Delhi, 1960, amended at Geneva, 1964)

a) *Common views*

a.1 Channels with higher modulation rates (100 or 200 bauds) must be capable of being inserted in systems of amplitude-modulated 50-baud/120-Hz channels conforming to recommendations concerning them respectively as well as in systems of f.m. 50-baud/120-Hz channels (conforming to Recommendation R.35). However, it is preferable that these high-speed channels should, as far as possible, be placed in an f.m. system (conforming to Recommendation R.35).

However, 200-baud/360-Hz channels can be set up only on systems established on bearer circuits having a spacing of 3 kHz.

a.2 If there exist 50-baud channels on a mixed system, the distortion limits for the 50-baud channels on homogeneous 50-baud channel systems will have to be respected; hence, 100-baud and 200-baud channel equipment will have to be designed to this end; if this is not possible, the power levels on the 100-baud and 200-baud channels will have to be reduced.

a.3 The 100- and 200-baud channels should have performances comparable to that which could be obtained in a homogeneous system, as specified in Recommendations R.37, R.38 A, R.38 B, provided that the condition indicated under a.2 above is respected. They should, in particular, satisfy points 13 a) of Recommendation R.37, and points 12 a) of Recommendations R.38 A, R.38 B respectively.

a.4 The mean power transmitted in the line at a point of zero relative level is normally limited to 135 microwatts for all the channels in the system.

The mean normal power for each channel should not exceed:

9 μW	for a 50-baud/120-Hz channel operated with amplitude modulation;
5.6 μW	for a 50-baud/120-Hz channel operated with frequency modulation (Table 1 of Recommendation R.35);
11.25 μW	for a 100-baud/240-Hz channel, provided the condition mentioned under a.2 is respected;
19.2 μW	for a 200-baud/360-Hz channel, provided the condition mentioned under a.2 is respected;
22.4 μW	for a 200-baud/480-Hz channel, provided the condition mentioned under a.2 is respected.

b) *Combined use of channels with 240-Hz spacing and channels with 120-Hz spacing*

Channels with 240 Hz spacing should be installed in the following preferred order: 12 (if possible), 11, 10, 9, 8, 7, . . . The channel numbers are in accordance with Recommendation R.37 (100-baud channels with 240-Hz spacing).

c) *Combined use of 200-baud channels with 360-Hz spacing and channels with 120-Hz or 240-Hz spacing*

c.1 The characteristics of these channels with high modulation rates are defined in Recommendations R.37 on 100-baud channels with 240-Hz spacing and R.38 B on 200-baud channels with 360-Hz spacing.

c.2 The 200-baud/360-Hz channels should be installed in the following preferred order: 5, 4, 6, 3, 2, 1 instead of the corresponding 50-baud channels. The channel numbers are in accordance with Recommendation R.38 B.

c.3 In combined systems using channels with three different modulation rates, the order indicated in c.2 should be used in preference to that indicated in b.

d) *Combined use of 200-baud channels with 480-Hz spacing and channels with 120-Hz or 240-Hz spacing*

d.1 Combination of channels with 240-Hz spacing and channels with 480-Hz spacing.

Channels with 480-Hz spacing should be installed in the following preferential order: 4, 3, 5, 2, 6.

d.2 Combination of channels with 120-Hz spacing and channels with 480-Hz spacing. In this case, the order indicated above in d.1 is applicable.

Note. — In co-operation with a system using 6-channel group modulation, the preferred order would be: 4, 3, 6 (if possible), 1.

d.3 In combined systems using channels with three different modulation rates, the order indicated in d.1 should be used in preference to that indicated in b.

RECOMMENDATION R.37

STANDARDIZATION OF FREQUENCY-SHIFT MODULATED VOICE-FREQUENCY TELEGRAPH SYSTEMS FOR A MODULATION RATE OF 100 BAUDS

(Geneva, 1964, amended at Mar del Plata, 1968)

1. The nominal modulation rate is standardized at 100 bauds.

2. The nominal mean frequencies are: $480+(n-1)$ 240 Hz, n being the channel serial number. The mean frequency is defined as the half-sum of the characteristic frequencies corresponding to the start polarity and stop polarity.

3. The mean frequencies at the sending end should not deviate by more than ± 3 Hz from their nominal value.

4. The difference between the two characteristic frequencies in the same channel is fixed at 120 Hz.

5. The maximum tolerance on this difference should be ± 4 Hz.

6. The unbalance due to the modulation process $\delta = 2\,\dfrac{F'_0 - F_t}{F'_A - F'_Z}$ should not exceed 3%. (This limit is provisional and could be revised if necessary.)

Where F'_A and F'_Z are the two characteristic frequencies measured;

F'_0 is the mean static frequency measured $= \dfrac{F'_A + F'_Z}{2}$

The frequency F_0 must be equal to the nominal mean frequency F_0 to within 0.1 Hz.

F_t is the mean dynamic frequency measured with 1/1 rectangular signals during 10 seconds.

Measurement should be made applying to the input of the transmitter 1/1 rectangular signals with the build-up and hangover time below 1 μs and with the unbalance below 0.1%.

In the event that in service the transmitter is controlled by an electro-mechanical relay (with a certain transit time), the measurement should also be made with that type of relay inserted between the signal generator 1/1 and the input to the transmitter.

Both forms of measurement need not necessarily be included in the maintenance procedure but should be included in laboratory type tests.

7. The mean power per channel at relative zero level should be 11.25 microwatts at the most.

8. In service, the levels of the signals corresponding to continuous stop polarity and continuous start polarity should not differ by more than 0.2 neper (1.7 dB) in the same channel. Both of these levels must be between ± 0.2 neper (± 1.7 dB) with reference to the level of point 7.

9. The frequency for the transmitted condition corresponding to the start polarity is the higher of the two characteristic frequencies and that corresponding to the stop polarity is the lower.

10. In the absence of a channel-modulator control telegraph current a frequency shall be transmitted which shall be within ± 10 Hz of the frequency normally transmitted for the " start " polarity. It is not necessary for this transmission to take place immediately after the control current has been cut.

11. The frequency spectrum of the emitted signal, when transmitting 1:1 signals at the modulation rate of $2 f_p$ (f_p=frequency of modulation) should be in accordance with the limits specified in Figure 1; in this diagram it shows the levels of the spectra of different components with respect to the amplitude of the non-modulated carrier as ordinates and the frequencies as abscissae.

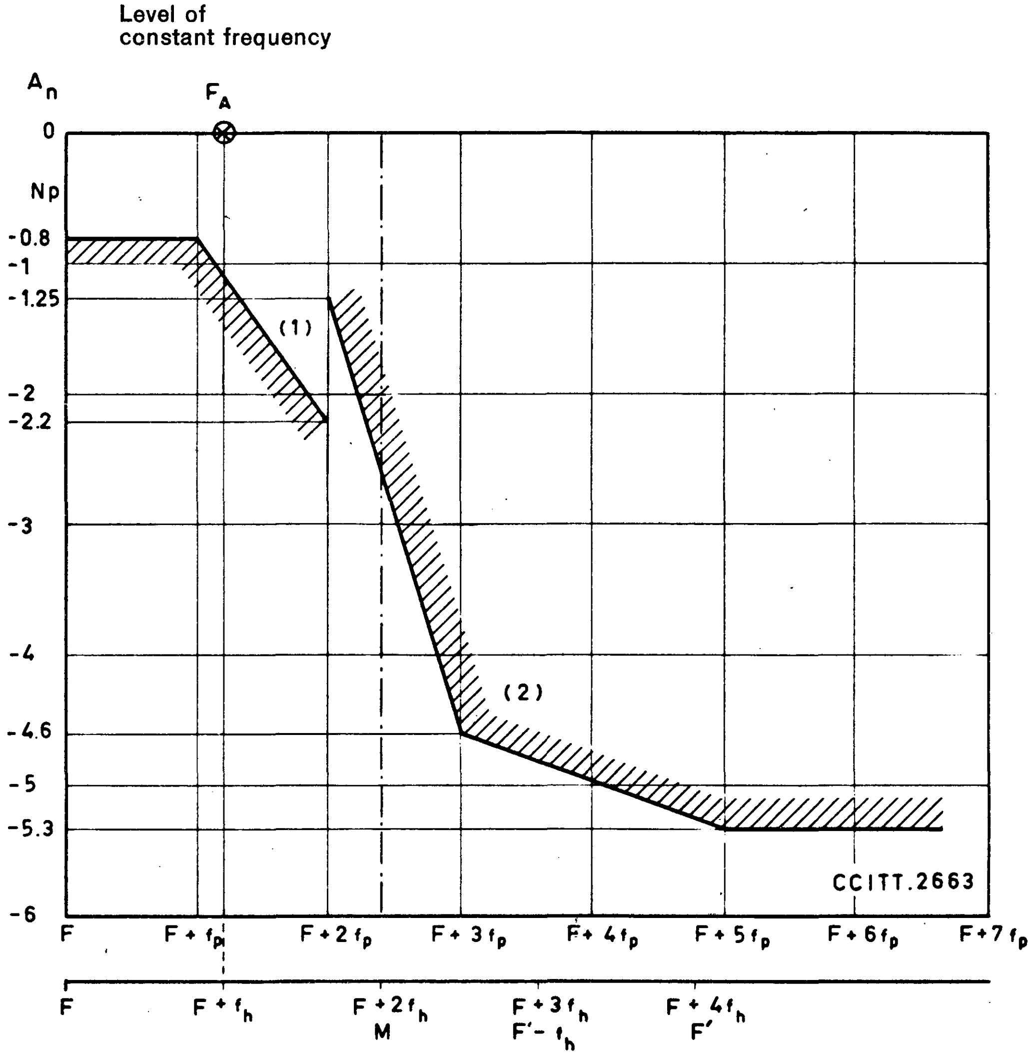
12. The receiving equipment should operate satisfactorily when the receiving level falls to 2 nepers (17.4 dB) below the nominal level. The receiving equipment should have been restored to start polarity when the receiving level has fallen to 2.7 nepers (23.5 dB) below the nominal level.

The alarm-control level is left to the choice of each administration.

13. On delivery by the manufacturer of 100-baud f.m. v.f. telegraph equipment, the following values must not be exceeded for the degree of distortion on a telegraph channel.

These values correspond to closed circuit measurements, made with the audio-frequency line terminals of the sending and receiving equipments connected together through an artificial line. Before the series of measurements taken by following the text of Recommendation R.51, the levels are adjusted to their normal values, the mean frequencies are checked to see whether they are within ± 3 Hz of their nominal value (point 3 of the Recommendation) and the difference between the two characteristic frequencies is within the permitted tolerance of less than ± 4 Hz (point 5 of the Recommendation).

Bias distortion is eliminated by adjustment in the channel receivers. The other channels of the system are modulated with unrelated signals when the effect of inter-channel interference is to be included in the measurement. These " unrelated signals " can



F = carrier frequency of a channel
f_p = frequency of modulation
f_h = frequency shift

M = centre line between adjacent channels
F' = carrier frequency of the adjacent channel

Curve 1 = Lower limit in the pass band
Curve 2 = Upper limit in the stop band

FIGURE 1. — **Frequency spectrum for 1:1 signals in frequency-modulated 100 baud-240 Hz and 200 baud-480 Hz spacing voice-frequency telegraph systems**

conveniently be 1 : 1 signals from different generators at approximately 100 bauds but not synchronous to each other or to the signal on the channel under test.

a) The transmission levels being normal, the artificial line introducing no frequency drift, but the measured channel being subject to fortuitous distortion due to interchannel interference: 5% for the degree of inherent isochronous distortion;

b) the level being maintained constant, but at a value different from the normal level, for all constant levels between 1 neper (8.7 dB) above the normal reception level and 2 nepers (17.4 dB) below the normal reception level, the other conditions being the original measurement conditions: 7% for the degree of inherent isochronous distortion;

c) in the presence of interference by a single sine-wave frequency equal to the one and then to the other characteristic frequency, with a level of 2.3 nepers (20 dB) below the signal level, the other conditions for the start of measurements being maintained: 12% for the degree of inherent isochronous distortion (i.e. total distortion including the increase due to the interfering frequency, not distortion due to the interfering frequency alone);

d) by introducing a frequency drift (Δf Hz) of the signals, during transmission through the artificial line, Δf being not more than 5, and the initial condition of the test otherwise being preserved: $(5+1.3\ \Delta f\ \text{Hz})\%$ for the degree of inherent isochronous distortion; the measurements should be made after the transient effects of changing frequency have ceased.

14. Frequency drifts on modern telephone circuits are generally less than 2 Hz. Hence, it is not necessary to recommend frequency drift control.

For circuits on which a maximum frequency drift of not greater than ± 2 Hz cannot be guaranteed, compensation seems necessary. Two methods can be used:

- compensation for each channel up to about 15 Hz;
- compensation for all the channels by using a pilot. In this case, the receiving end must be able to request and obtain a pilot frequency. Administrations should agree among themselves on the advisability of sending the pilot and the choice of frequency. 3300 Hz or, preferably, 300 Hz are recommended, with a tolerance of ± 1 Hz. The mean power emitted at the relative zero point on this frequency should not exceed that recommended for a telegraph channel in the case of a 24-channel group, i.e. —2.6 nepers (—22.5 dB).

15. The number of significant conditions of the modulation is fixed at two; this number may be increased, if necessary, by agreement between the administrations concerned.

RECOMMENDATION R.38 A

STANDARDIZATION OF FREQUENCY-SHIFT MODULATED VOICE-FREQUENCY TELEGRAPH SYSTEMS FOR A MODULATION RATE OF 200 BAUDS WITH CHANNELS SPACED AT 480 Hz

(Geneva, 1964, amended at Mar del Plata, 1968)

Note. — This is the standardized system for operation at 200 bauds.

1. The nominal modulation rate is fixed at 200 bauds.

2. The nominal mean frequencies must be $600+(n-1)$ 480 Hz, n being the number of the channel. The mean frequency is defined as half the sum of the characteristic frequencies corresponding to the start and stop polarities.

3. The mean frequencies on the transmission side must not deviate by more than ± 4 Hz from their nominal value.

4. The difference between the two characteristic frequencies in the same channel is fixed at 240 Hz.

5. The maximum tolerance on this difference must be ± 6 Hz.

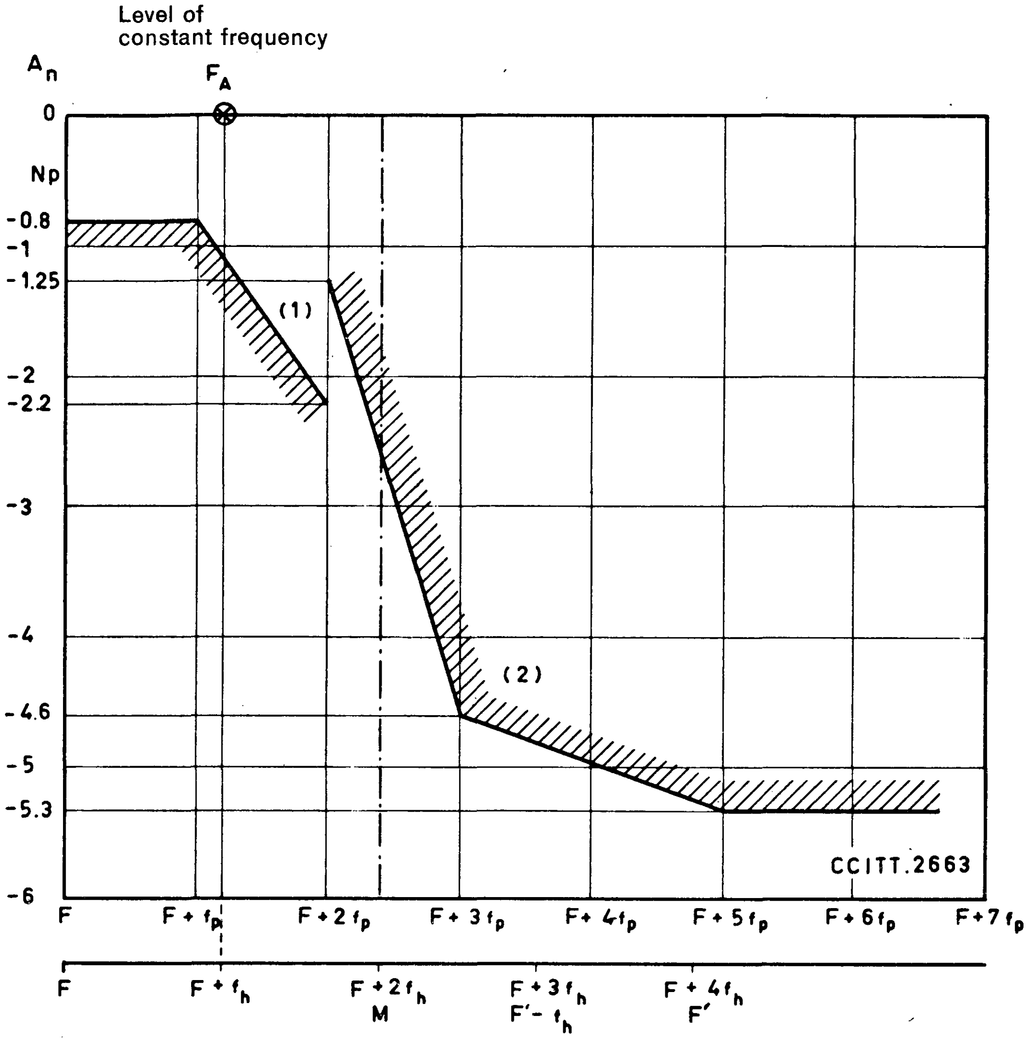
6. The mean power per channel at relative zero level should not be more than 22.4 microwatts.

7. In service, the levels of the permanent " start " polarity signals and the permanent " stop " polarity signals must not vary by more than 0.2 neper (1.7 dB) on the same channel. These two levels will have to lie between +0.2 neper (+1.7 dB) and −0.2 neper (−1.7 dB) in relation to the level mentioned in point 6 above.

8. The " start " polarity frequency is the higher of the two characteristic frequencies, and the " stop " polarity frequency is the lower one (see Recommendation V.1, Volume VIII of the *White Book*).

9. In the absence of a channel-modulator control telegraph current, a frequency shall be transmitted which shall be within ± 20 Hz of the frequency normally transmitted for the " start "polarity. It is not necessary for this transmission to take place immediately after the control current has been cut.

10. The frequency spectrum of the emitted signal, when transmitting 1 : 1 signals at the modulation rate of $2 f_p$ (f_p = frequency of modulation) should be in accordance with the limits specified in Figure 1; in this diagram it shows the levels of the spectra of different components with respect to the amplitude of the non-modulated carrier as ordinates and the frequencies as abscissae.



F = carrier frequency of a channel
f_p = frequency of modulation
f_h = frequency shift
M = centre line between adjacent channels
F' = carrier frequency of the adjacent channel

Curve 1 = Lower limit in the pass band
Curve 2 = Upper limit in the stop band

Figure 1. — **Frequency spectrum for 1:1 signals in frequency-modulated 100 baud-240 Hz and 200 baud-480 Hz spacing voice-frequency telegraph systems**

11. The receiving equipment should operate satisfactorily when the receiving level falls to 2 nepers (17.4 dB) below the nominal level. The receiving equipment should have been restored to start polarity when the receiving level has fallen to 2.7 nepers (23.5 dB) below the nominal level.

The alarm-control level is left to the choice of each administration.

12. On delivery by the manufacturer of 200-baud/480-Hz f.m. v.f. telegraph equipment, the following values must not be exceeded for the degree of distortion on a telegraph channel.

These values correspond to closed circuit measurements, made with the audio-frequency line terminals of the sending and receiving equipments connected together through an artificial line. Before the series of measurements taken by following the text of Recommendation R.51, the levels are adjusted to their normal values, the mean frequencies are checked to see whether they are within ± 4 Hz of their nominal value (point 3 of the Recommendation) and the difference between the two characteristic frequencies is within the permitted tolerance of less than ± 6 Hz (point 5 of the Recommendation).

Bias distortion is eliminated by adjustment in the channel receivers. The other channels of the system are modulated with unrelated signals when the effect of inter-channel interference is to be included in the measurement. These " unrelated signals " can conveniently be 1 : 1 signals from different generators at approximately 200 bauds but not synchronous to each other or to the signal on the channel under test.

a) The transmission levels being normal, the artificial line introducing no frequency drift, but the measured channel being subject to fortuitous distortion due to interchannel interference: 5% for the degree of inherent isochronous distortion.

b) The level being maintained constant, but at a value different from the normal level, for all constant levels between 1 neper (8.7 dB) above the normal reception level and 2 nepers (17.4 dB) below the normal reception level, the other conditions being the original measurement conditions: 7% for the degree of inherent isochronous distortion.

c) In the presence of interference by a single sine-wave frequency equal first to the one and then to the other characteristic frequency, with a level of 2.3 nepers (20 dB) below the signal level, the other conditions for the start of measurements being maintained: 10% for the degree of inherent isochronous distortion (i.e. total distortion including the increase due to the interfering frequency, not distortion due to the interfering frequency alone).

d) By introducing a frequency drift (Δf Hz) of the signals during transmission through the artificial line, Δf in Hz being not more than 10, and the initial conditions of the test otherwise being preserved: $(5+0.7\ \Delta f\ \text{Hz})\%$ for the degree of inherent isochronous distortion; the measurements should be made after the transient effects of changing frequency have ceased.

13. Frequency drifts on modern telephone circuits are generally less than 2 Hz. Hence, it is not necessary to recommend frequency drift control.

For circuits on which a maximum frequency drift of not greater than ± 2 Hz cannot be guaranteed, compensation seems necessary. Two methods can be used:

— compensation for each channel up to about 15 Hz;

— compensation for all the channels by using a pilot. In this case, the receiving end must be able to request and obtain a pilot frequency. Administrations should agree among themselves on the advisability of sending the pilot and the choice of frequency. 3300 Hz or, preferably, 300 Hz are recommended, with a tolerance of

±1 Hz. The mean power emitted at the relative zero point on this frequency should not exceed that recommended for a telegraph channel in the case of a 24-channel group, i.e. −2.6 nepers (−22.5 dB).

14. The number of significant conditions of the modulation is fixed at two; this number may be increased, if necessary, by agreement between the administrations concerned.

RECOMMENDATION R.38 B

STANDARDIZATION OF FREQUENCY-SHIFT MODULATED VOICE-FREQUENCY TELEGRAPH SYSTEMS FOR A MODULATION RATE OF 200 BAUDS WITH CHANNELS SPACED AT 360 Hz USABLE ON LONG INTERCONTINENTAL BEARER CIRCUITS GENERALLY USED WITH A 3-kHz SPACING

(Geneva, 1964)

1. The frequency-modulated voice-frequency telegraph systems, with a spacing of 360 Hz between the mean frequencies, can accommodate seven channels. In the case of telephone bearer channels with 4-kHz spacing, channel position 8 can be used.

2. The nominal modulation rate is fixed at 200 bauds.

3. The nominal mean frequencies must be $540+(n-1)$ 360 Hz, n being the position number of the channel. The mean frequency is defined as half the sum of the characteristic frequencies corresponding to the start and stop polarities.

4. The mean frequencies on the transmission side must not deviate by more than ±3 Hz from their nominal value.

5. The difference between the two characteristic frequencies in the same channel is fixed at 180 Hz.

6. The maximum tolerance on this difference must be ±4 Hz.

7. The mean power per channel at relative zero level should not be more than 19.2 microwatts.

8. In service, the levels of the permanent " start " polarity signals and the permanent " stop " polarity signals must not vary by more than 0.2 neper (1.7 dB) on the same channel. These two levels will have to lie between +0.2 neper (+1.7 dB) and −0.2 neper (−1.7 dB) in relation to the level mentioned in point 7 above.

9. The " start " polarity frequency is the higher of the two characteristic frequencies, and the " stop " polarity is the lower one (see Recommendation V.1, Volume VIII of the *White Book*).

10. In the absence of a channel-modulator control telegraph current, a frequency shall be transmitted which shall be within ± 10 Hz of the frequency normally transmitted for the " start " polarity. It is not necessary for this transmission to take place immediately after the control current has been cut.

11. The receiving equipment should operate satisfactorily when the receiving level falls to 2 nepers (17.4 dB) below the nominal level. The receiving equipment should have been restored to start polarity when the receiving level has fallen to 2.7 nepers (23.5 dB) below the nominal level.

The alarm-control level is left to the choice of each administration.

12. On delivery by the manufacturer of 200-baud/360-Hz f.m. v.f. telegraph equipment, the following values must not be exceeded for the degree of distortion on a telegraph channel.

These values correspond to closed circuit measurements, made with the audio-frequency line terminals of the sending and receiving equipments connected together through an artificial line. Before the series of measurements taken by following the text of Recommendation R.51, the levels are adjusted to their normal values, the mean frequencies are checked to see whether they are within ± 3 Hz of their nominal value (point 4 of the Recommendation) and the difference between the two characteristic frequencies is within the permitted tolerance of less than ± 4 Hz (point 6 of the Recommendation).

Bias distortion is eliminated by adjustment in the channel receivers. The other channels of the system are modulated with unrelated signals when the effect of interchannel interference is to be included in the measurement. These " unrelated signals " can conveniently be 1 : 1 signals from different generators at approximately 200 bauds but not synchronous to each other or to the signal on the channel under test.

a) the transmission levels being normal, the artificial line introducing no frequency drift, but the measured channel being subject to fortuitous distortion due to interchannel interference: 6% for the degree of inherent isochronous distortion;

b) the level being maintained constant, but at a value different from the normal level, for all constant levels between 1 neper (8.7 dB) above the normal reception level and 2 nepers (17.4 dB) below the normal reception level, the other conditions being the original measurement conditions: 8% for the degree of inherent isochronous distortion;

c) in the presence of interference by a single sine-wave frequency equal first to the one and then to the other characteristic frequency, with a level of 2.3 nepers (20 dB) below the signal level, the other conditions for the start of measurements being maintained: 15% for the degree of inherent isochronous distortion (i.e. total distortion including the increase due to the interfering frequency, not distortion due to the interfering frequency alone);

d) by introducing a frequency drift (Δf Hz) of the signals during transmission through the artificial line, Δf being not more than 10; and the initial conditions of the test otherwise being preserved: $(6+1.2\ \Delta f\ \text{Hz})\%$ for the degree of inherent isochronous distortion; the measurements should be made after the transient effects of changing frequency have ceased.

Comparative table of values for the degree of tolerable distortion on telegraph channels with various modulation rates

Distortion (%)	Recommendations				
	R.35 (50 bauds 120 Hz)	R.35 *bis* (50 bauds 240 Hz)	R.37 (100 bauds 240 Hz)	R.38 A (200 bauds 480 Hz)	R.38 B (200 bauds 360 Hz)
With the normal reception level	5		5	5	6
In the case of slow level variation of + 1 Np (+ 8.7 dB) to −2 Np (−17.4 dB) with respect to the normal reception level	7		7	7	8
In the presence of interference by a single sine-wave frequency equal to either of two characteristic frequencies with a level of 2.3 Np (20 dB) below the signal level of the test channel	12		12	10	15
With introduction of a frequency drift $\Delta f Hz$ of the signals	$(5+2.5\Delta f)$		$(5+1.3\Delta f)$	$(5+0.7\Delta f)$	$(6+1.2\Delta f)$

13. Frequency drifts on modern telephone circuits are generally less than 2 Hz. Hence, it is not necessary to recommend frequency drift control.

For circuits on which a maximum frequency drift of not greater than ±2 Hz cannot be guaranteed, compensation seems necessary. Two methods can be used:

— compensation for each channel up to about 15 Hz;

— compensation for all the channels by using a pilot. In this case, the receiving end must be able to request and obtain a pilot frequency. Administrations should agree among themselves on the advisability of sending the pilot and the choice of frequency. The frequency 300 Hz is recommended, with a tolerance of ±1 Hz. The mean power emitted at the relative zero point on this frequency should not exceed that recommended for a telegraph channel in the case of a 24-channel group, i.e. —2.6 nepers (—22.5 dB).

14. The number of significant conditions of the modulation is fixed at two; this number may be increased, if necessary, by agreement between the administrations concerned.

RECOMMENDATION R.39

VOICE-FREQUENCY TELEGRAPHY ON RADIO CIRCUITS

(former C.C.I.T. Recommendation B.49, Geneva, 1956, amended at Geneva, 1964, and at Mar del Plata, 1968)

It is necessary to distinguish between the case in which the radio frequency used is below approximately 30 MHz, and the case in which the radio frequency used is greater than approximately 30 MHz.

A. Radio circuits the frequency of which is below approximately 30 MHz

1. In the case of radio circuits whose frequency is less than approximately 30 MHz, it appears that the use of amplitude-modulated voice-frequency telegraph systems, as defined by C.C.I.T.T. Recommendation R.31, cannot be recommended.

In such a case, the nature of the telephone channels available for telegraph operation may vary widely according to the radio system used, and several systems of telegraph transmission are available (e.g. two or four tone telegraph systems, frequency-change modulated systems, etc.).

2. However, frequency-shift systems are in use on many routes and the frequency-exchange method of operation is in use on long routes suffering from severe multipath distortion.

3. Synchronous telegraphy operating at approximately 100 bauds [1].

Radiotelegraph channels which operate synchronously at a modulation rate of 96 bauds and employ automatic error correction are being increasingly used.

Table 1

Central frequencies of voice-frequency frequency-shift telegraph channels with a channel separation of 170 Hz and a modulation index of about 0.8

(Frequency deviation: ± 42.5 Hz or ± 40 Hz)

Channel position	Central frequency (Hz)	Channel position	Central frequency (Hz)
1	425	8	1615
2	595	9	1785
3	765	10	1955
4	935	11	2125
5	1105	12	2295
6	1275	13	2465
7	1445	14	2635
		15	2805

[1] C.C.I.R. Recommendation 436.

The channel arrangement shown in Table 1 is preferred for voice-frequency multi-channel frequency-shift systems operating at a modulation rate of approximately 100 bauds over h.f. radio circuits.

For frequency-exchange systems, the central frequencies of Table 1 should be used, and should be paired in the manner found to be best suited to the propagation conditions of the route. (A typical arrangement would take alternate pairs giving 340 Hz between tones.)

4. *Start-stop telegraphy at 50 bauds*

For several years, various administrations have had in service, on certain selected circuits, equipment with a channel spacing of 120 Hz the central frequencies and frequency deviations of which are in agreement with C.C.I.T.T. Recommendation R.35. The central frequencies of these systems are given in Table 2.

TABLE 2

Central frequencies of voice-frequency frequency-shift telegraph channels with a channel separation of 120 Hz and a modulation index of about 1.4

(Frequency deviation ±35 Hz or ±30 Hz)

Channel position	Central frequency (Hz)	Channel position	Central frequency (Hz)
1	420	11	1620
2	540	12	1740
3	660	13	1860
4	780	14	1980
5	900	15	2100
6	1020	16	2220
7	1140	17	2340
8	1260	18	2460
9	1380	19	2580
10	1500	20	2700

B. RADIO CIRCUITS THE FREQUENCY OF WHICH IS GREATER THAN APPROXIMATELY 30 MHz

1. *Use of voice-frequency telegraphy on line-of-sight radio-relay links*

These studies were conducted by Special Study Group C; the aim was to make it possible to use standardized v.f. systems, or at least standardized frequency-modulation systems, on line-of-sight radio links.

If the provisions of Recommendation G.222 (Volume III, *White Book*) are applied, there is no need to provide any special recommendation for use of voice-frequency telegraph systems conforming to Recommendation R.35 over line-of-sight radio-relay links.

This would be the same for the use of systems conforming to Recommendations R.36, R.37, R.38 A and R.38 B.

2. *Use of voice-frequency telegraphy on forward scatter radio-relay systems*

Joint Special Study Group C took note of C.C.I.R. Recommendation 397-1 (Oslo, 1966). It understands that, to meet telephone transmission requirements, radio-relay links using tropospheric scatter will be equipped with such diversity systems that telegraph transmission should be satisfactory. This takes account of the fact that tropospheric-scatter radio-relay systems defined in paragraph 3 of the above-mentioned Recommendation can be used in certain conditions only, as mentioned in Note 4 to that Recommendation.

SECTION 4

SPECIAL CASES OF ALTERNATE CURRENT TELEGRAPHY

RECOMMENDATION R.40

CO-EXISTENCE IN THE SAME CABLE OF TELEPHONY AND SUPRA-ACOUSTIC TELEGRAPHY

(former C.C.I.T. Recommendation B.17, Brussels, 1948, amended at Geneva, 1951)

The C.C.I.T.T.,

considering

that this process provides only one telegraph channel, in addition to the telephone channel, and that it can be applied only in comparatively few cases (lightly loaded, or unloaded circuits, which cannot be used for multi-channel carrier telephony);

that in such cases, the administrations and private operating agencies concerned could in most cases by common agreement contemplate the possibility of making use of some other more suitable process, which would provide, in addition to the audio telephone channel, more than one telegraph channel,

unanimously declares the view

that the use of supra-acoustic telegraphy should not prejudice the quality of transmission over the adjacent telephone channel and that, in particular, it should not limit the band of frequencies necessary for good speech reproduction (300 to 3400 Hz at least).

RECOMMENDATION R.41

UTILIZATION OF THE INTERCHANNEL FREQUENCY BAND OF CARRIER TELEPHONE CIRCUITS FOR TELEGRAPH TRANSMISSION

(former C.C.I.T. Recommendation B.18, Geneva, 1951, amended at New Delhi, 1960)

The C.C.I.T.T. *unanimously declares the view*

that in the present state of technical development the utilization for telegraph communication of the interchannel frequency band of telephone channels on cable carrier systems is neither technically nor economically desirable.

RECOMMENDATION R.42

NON-SIMULTANEOUS TRANSMISSION OF TELEPHONY AND TELEGRAPHY ON LEASED INTERNATIONAL TELEPHONE CIRCUITS

(former C.C.I.T. Recommendation B.19, Geneva, 1951, amended at Arnhem, 1953, and at Geneva, 1956 and 1964)

Note. — This recommendation applies to telegraphy using a.m. and f.m. The modulation rate may be 50 bauds or more.

The C.C.I.T.T.,

considering

that the C.C.I.T.T. has issued recommendations on the subject of alternate transmission of telegraphy or telephony on leased international telephone circuits (vide C.C.I.T.T., *Blue Book*, Volume III, Recommendation H.21),

unanimously declares the following view:

1. The mean frequency of 1500 Hz is recommended for private telegraph transmissions between telephone stations permanently connected by leased international circuits.

2. For the steady telegraph emission of a continuous tone, a maximum power of 0.3 mW (corresponding to an absolute power level of —0.6 neper, or about —5 dB) at a point of zero relative level is allowed.

When leasing an international telephone circuit that might be used for such telegraph transmissions, it is advisable to ensure, by measurements, that this limit is not exceeded.

Administrations and private operating agencies concerned are responsible, as regards their own national networks, for taking the necessary precautions to avoid interference to their domestic telephone services from such telegraph transmissions. Such precautions may consist in limiting the telegraph transmission power or the duration of use of telegraphy, or may concern the method of telegraph transmission.

3. Voice-frequency ringing sets on telephone circuits leased for private telegraph transmissions between two permanently connected telephone stations must be insensitive to telegraph signals. It has been observed that one existing type of ringing set is sensitive to them, but measures may be taken to correct such ringing sets so that there is no great difficulty for the frequency chosen.

4. The maximum limit of 250 milliseconds adopted for the hangover time of echo suppressors on international telephone circuits does not appear long enough to suppress (even partially) the transmission of the answer-back signals when start-stop apparatus reply.

RECOMMENDATION R.43

SIMULTANEOUS COMMUNICATION BY TELEPHONE AND TELEGRAPH ON A TELEPHONE CIRCUIT

(former C.C.I.T. Recommendation B.50, Geneva, 1956, amended at Geneva, 1964)

The C.C.I.T.T.,

considering

1. that the exceptional use of a leased telephone circuit for simultaneous communication by telephone and telegraph is envisaged in Recommendations D.1 and H.32 of the C.C.I.T.T. (*White Book*, Volumes II and III respectively);

2. that standardization of the characteristics of apparatus permitting simultaneous use of a telephone circuit for telephony and telegraphy is not justified, but that it is necessary to limit the power of the signals transmitted and to avoid the use of frequencies that will interfere with any telephone signalling equipment which may remain connected to the telephone circuit;

3. that new demands for the allocation of particular frequencies for special purposes frequently arise and the number of frequencies used for any one purpose should not be unnecessarily multiplied,

unanimously declares the view

1. that in the case of the simultaneous use of a telephone circuit for telephony and telegraphy, the telegraph signal, if continuously transmitted, should be maintained at or below a level of −1.5 nepers (−13.0 dB) at a point of zero relative level;

2. that not more than three such telephone circuits should be included in any one primary group of 12 telephone circuits nor more than 15 in any one coaxial cable system;

3. that the telegraph signals transmitted must not interfere with any signalling apparatus that may remain connected to the telephone circuit,

and notes

that some administrations have permitted the use for simultaneous telephony and telegraphy of the frequencies 1680 Hz and 1860 Hz both by amplitude and by frequency-shift modulation.

RECOMMENDATION R.44

6-UNIT SYNCHRONOUS TIME-DIVISION 2-3-CHANNEL MULTIPLEX TELEGRAPH SYSTEM FOR USE OVER F.S.V.F.T. CHANNELS SPACED AT 120 Hz FOR CONNECTION TO STANDARDIZED TELEPRINTER NETWORKS

(Mar del Plata, 1968)

The C.C.I.T.T.,

considering

1. that synchronous modulation enables a larger number of telegraph channels to be constituted by time-subdivision of a standardized telegraph channel (Recommendation R.35);

2. that such an increase may be of interest in the case of long submarine cables of the telephone type in view of the resulting economies;

3. that, in addition to the signals of international alphabet No. 2, transmission of the selection and supervisory signals is essential when incorporating the telegraph channels thus provided into the international switching network;

4. that it is desirable to allow for the provision of half-rate and quarter-rate channels;

5. that correct phase-relationship should be established and also maintained automatically;

6. that systems using 5- and 6-unit codes have been proposed,

unanimously declares the view

that, where the synchronous multiplex system uses a 6-unit binary code, the equipment should be constructed to the following standards (administrations may of course by mutual agreement use a different system with a 5-unit code such as that described in Supplement No. 8 to this Volume).

1. *Telegraph modulation*

i) the character period should be 145 5/6 ms.

ii) the multiplexing should provide for the derivation of either 2 or 3 time-division channels from each v.f.t. channel. The aggregate modulation rate will be 82 2/7 bauds for a 2-channel multiplex and 123 3/7 bauds for a 3-channel multiplex.

Generally it is found that v.f.t. systems conforming to Recommendation R.35 will operate satisfactorily at 82 2/7 bauds, but to ensure satisfactory operation at 123 3/7 bauds, it is necessary to employ characteristic distortion compensation (CDC) at the receiving end of the voice-frequency telegraph channel.

iii) the time-derived channels shall be interleaved element by element to form the aggregate signal.

2. *Connection to start-stop circuits*

The channel imputs shall be capable of accepting signals from start-stop apparatus conforming to Recommendation S.3 (except item 4). The channel output should be start-stop with a modulation rate of 50 bauds. Standards of performance are given in paragraph 9.

3. *Alphabet*

Combinations 1-31 of the C.C.I.T.T. 5-unit alphabet No. 2 shall each be preceded by an A-condition element, while the continuous start and continuous stop conditions shall utilize the 6-unit combinations AAAAAA and ZZZZZZ respectively. The remaining combination No. 32 shall be preceded by a Z element.

The alphabet should be as follows:

Character	*5-unit international code No. 2*	*6-unit international code No. 4*
A	ZZAAA	AZZAAA
B	ZAAZZ	AZAAZZ
C	AZZZA	AAZZZA
D	ZAAZA	AZAAZA
E	ZAAAA	AZAAAA
F	ZAZZA	AZAZZA
G	AZAZZ	AAZAZZ
H	AAZAZ	AAAZAZ
I	AZZAA	AAZZAA
J	ZZAZA	AZZAZA
K	ZZZZA	AZZZZA
L	AZAAZ	AAZAAZ
M	AAZZZ	AAAZZZ
N	AAZZA	AAAZZA
O	AAAZZ	AAAAZZ
P	AZZAZ	AAZZAZ
Q	ZZZAZ	AZZZAZ
R	AZAZA	AAZAZA
S	ZAZAA	AZAZAA
T	AAAAZ	AAAAAZ
U	ZZZAA	AZZZAA
V	AZZZZ	AAZZZZ
W	ZZAAZ	AZZAAZ
X	ZAZZZ	AZAZZZ
Y	ZAZAZ	AZAZAZ
Z	ZAAAZ	AZAAAZ
Carriage return	AAAZA	AAAAZA

SPECIAL CASES

Character	*5-unit international code No. 2*	*6-unit International code No. 4*
Line feed	AZAAA	AAZAAA
Letters	ZZZZZ	AZZZZZ
Figures	ZZAZZ	AZZAZZ
Space	AAZAA	AAAZAA
Character No. 32	AAAAA	ZAAAAA
Continuous A condition (alpha)	—	AAAAAA
Continuous Z condition (beta)	—	ZZZZZZ
Phasing signal	—	ZZAAZZ

4. *Grouping of multiplex systems*

A common phasing control can be used for a number of multiplex systems carried by different channels of the same v.f.t. system. A group of multiplexes shall comprise a maximum of six systems. Some time-derived channels shall be capable of being further divided to provide sub-channels. The various channels should be identified by a figure denoting the number of the multiplex system within the group of six, i.e. 1-6 followed by a letter denoting the channel within that system, i.e. A, B or C. Thus the complete channel numbering will be as follows:

Multiplex system/channel

$$\left.\begin{array}{l}\text{1A, 2A, 3A, 4A, 5A, 6A}\\ \text{—, 2B, 3B, 4B, 5B, 6B}\\ \text{1C, 2C, 3C, 4C, 5C, 6C}\end{array}\right\}\text{ full rate}$$

(1B is not available as a full-rate channel—see paragraph 7)

Each A channel should be full character rate only.

Each B channel should be capable of full character rate and subdivision (except 1B, which is permanently subdivided).

The full-rate channels A and B in the case of 2-channel multiplexing, or A, B and C in the case of 3-channel, should be multiplexed on an element-interleaved basis in the following sequence:

A1, B1, A2, B2 etc. for 2-channel operation (where A1 is the first element of channel A etc.)

A1, B1, C1, A2, B2, C2, etc. for 3-channel operation.

5. *Subdivision of channels*

All full character-rate channels B (except 1B) and C should be capable of subdivision into quarter character-rate channels, and into multiples of quarter-rate, i.e. one half-rate, using two quarter-rate channels.

(Although theoretically three-quarter rate channels could be provided, controlled by means of pulses from the multiplex equipment, provision of this facility is not recommended.)

The sub-channels should be identified basically in the same manner as the full-rate channels with the addition of a numeral denoting the quarter-rate channel, i.e. 1-4. In the case of half-rate channels, the numbers of the two quarter-rate channels used for it should be shown, i.e. 1/3 or 2/4. Thus the complete sub-channel numbering will be as follows:

Multiplex system/channel/sub-channel

1B1, 2B1, 3B1, 4B1, 5B1, 6B1.	1C1, 2C1, 3C1, 4C1, 5C1, 6C1	quarter rate
1B2, 2B2, 3B2, 4B2, 5B2, 6B2.	1C2, 2C2, 3C2, 4C2, 5C2, 6C2	
1B3, 2B3, 3B3, 4B3, 5B3, 6B3.	1C3, 2C3, 3C3, 4C3, 5C3, 6C3	
— , 2B4, 3B4, 4B4, 5B4, 6B4.	1C4, 2C4, 3C4, 4C4, 5C4, 6C4	

(1B4, phasing control only)

1B1/3, 2B1/3, 3B1/3, 4B1/3, 5B1/3, 6B1/3	half rate
— , 2B2/4, 3B2/4, 4B2/4, 5B2/4, 6B2/4	
(1B2/4 not available)	
1C1/3, 2C1/3, 3C1/3, 4C1/3, 5C1/3, 6C1/3	
1C2/4, 2C2/4, 3C2/4, 4C2/4, 5C2/4, 6C2/4	

The sub-channels 1, 2, 3 and 4 shall be operated in the following character sequence:

A B1 A B2 A B3 A B4 A B1, etc. for 2-channel operation.

A B1 C1 A B2 C2 A B3 C3 A B4 C4 A B1 C1, etc. for a 3-channel operation.

All the sub-channels shall be transmitted with the same polarity except those of channel 1B which should be inverted.

6. *Transposition pattern*

To avoid inadvertent cross-connections between channels when the system is out of phase, element transpositions should be allocated to the channels and sub-channels as follows:

Channel	A	1 2 3 4 5 6	Sub-channel 1
"	B	1 3 2 4 5 6	
"	C	1 2 4 3 5 6	

Channel	A	1 2 3 5 4 6	Sub-channel 2
"	B	1 2 3 4 6 5	
"	C	1 4 3 2 5 6	

Channel A	1 2 5 4 3 6	Sub-channel 3
" B	1 2 3 6 5 4	
" C	1 5 3 4 2 6	

Channel A	1 2 6 4 5 3	Sub-channel 4
" B	1 6 3 4 5 2	
" C	1 6 5 4 3 2	

Full character-rate and half character-rate channels should take that sequence which is allocated to their lowest-numbered sub-channel, i.e. a full character-rate channel should take the sequence for its sub-channel 1, a half character-rate sub-channel using sub-channels 1 and 3 should take the sequence for its sub-channel 1, and a half character-rate sub-channel using sub-channels 2 and 4 should take the sequence for its sub-channel 2.

The element transpositions shall be carried out in the permanent wiring to the start-stop input and output units so that each of these units may be used in any position without alteration.

7. *Phasing*

Provision should be made for:

a) automatic phasing, automatically initiated (normal working condition);

b) automatic phasing, manually initiated;

c) manual phasing.

One quarter-rate channel of the group (1B4) should be permanently allocated for phasing control purposes, and should continuously send the character ZZAAZZ (the phasing signal).

Automatic initiation of phasing should occur when three successive phasing signals have not been recognized.

Automatic phasing may be in steps of one element per expected reception of the phasing signal, i.e. every four transmission cycles (583 ms), or alternatively a method which will carry out rephasing in one operation thus reducing the time spent on phasing. Phasing shall automatically cease when the phasing signal is recognized on the phasing sub-channel receiving unit.

Visual indication of the correct reception of the phasing signal should be given.

8. *Telex and gentex signalling*

The multiplex equipment should be capable of accepting C.C.I.T.T. types A, B and C signals and shall sensibly reproduce them with minimum delay or change.

It is especially desirable to transmit the signals used for calling and call confirmation with the minimum delay in order to minimize the probability of simultaneous seizure from both ends where circuits are used for bothway working.

To meet this requirement of minimum delay it is necessary that both the normal character storage inherent in a random arrival system should be by-passed during the free-line condition and the incoming signal from telex should be inspected at the most frequent intervals possible, with element interleaving between channels. Thus effectively the line input circuit is connected directly to the multiplex aggregate, and is inspected at intervals of 24 11/36 ms causing an element of this length and input polarity to be transmitted over the aggregate signal path. At the receiving end this element would be distributed to the appropriate channel and produce an element of like polarity at the output. The result of this is to transmit elements of 24 11/36 ms of a polarity determined by the channel input.

With the character store by-passed in this way the transmission of pulse signals, which may be signalling or dialling, during the setting up of a telex call is also permitted. The character store must, however, be switched into use prior to the transmission of teleprinter characters whether these are signalling or traffic.

The method of switching start-stop stores into the connection depends on the type of signalling and it may vary with the direction of calling. Normally each direction of signalling may be considered separately and the stores can be switched into the connection within a period less than one character length of the inversion to stop polarity being recognized, but with calls to type B dial selection systems switching must be deferred until such conversion has occurred on both signalling paths.

It seems desirable to guard against short spurious pulses on the input line being reproduced as a full element; pulses of up to 8-10 ms should therefore be rejected. Thus pulses would result as follows:

Input to system	*Multiplex aggregate*	*Output from system*
0-9 (±) ms of either polarity	No pulse	No pulse
9(±1) — 33 11/36 ms	1 element 24 11/36 ms	For A polarity 45 ms For Z polarity 33 ms
33 11/36 — 57 11/18 ms	2 elements 48 11/18 ms	Both polarities 48 11/18 ms

An alternative method of producing pulses, as follows, would be acceptable:

0-9 (±1) ms	No pulse	For A polarity, 45 ms
9(±1) — 24 11/36 ms	1 element (24 11/36 ms)	For Z polarity, 33 ms
24 11/36 — 48 11/18 ms	1 element (24 11/36 ms) or 2 elements (48 11/18 ms)	Both polarities 48 11/18 ms
48 11/18 — 72 11/12 ms	2 elements (48 11/18 ms) or 3 elements (72 11/12 ms)	Both polarities 72 11/12 ms

Dial pulse trains when received within the speed and ratio limits specified in Recommendation U.2 should be regenerated within the bypass unit, to be retransmitted by the multiplex equipment when the store is by-passed with a minimum duration of Z polarity of 32-34 ms and that of A polarity of 44-46 ms. Two or more elements of either

A or Z polarity should be transmitted as multiples of 24 11/36 ms and within the ratio limits specified should not exceed 73 ms for Z polarity and 98 ms for A polarity.

The type B call confirmation or proceed-to-select signal when received by the multiplex equipment within the limits specified by Recommendation U.1 should, on retransmission by the multiplex equipment, fall within the limits of 32-50 ms. The interval of A polarity between call-confirmation and proceed-to-select signals should be not less than 60 ms.

In order to discriminate between the various type B backward path signals and to preserve their duration within acceptable limits it may be necessary to delay their transmission. This delay should be kept to a minimum in all cases.

9. *Standards of performance*

a) The stability of the master oscillator controlling the timing of each group should not be worse than $\pm$ 1 part in 10^{-6}.

b) The degree of isochronous distortion of the aggregate output should not exceed 3%. The degree of synchronous start-stop distortion of the channel output should not exceed 3%.

c) The receiving input margin for both the aggregate and start-stop channel input should not be less than $\pm$ 45%.

d) The maximum speed error for the start-stop output signals should not be greater than $\pm$ 0.5%.

10. *Miscellaneous facilities*

It should be arranged that when phase is lost the output of the multiplex channels becomes a continuous condition. When a channel is used for telex, the continuous condition should be A. When a channel is used for other services the condition may be Z if required.

With the exception of character No. 32, the 6-unit equivalents to the characters of alphabet No. 2 have the first element of condition A. If the first element is received erroneously as condition Z, the character need not be rejected but may be passed to the channel output.

Note. — The requirements to be met by synchronous multiplex equipment for telex and gentex operation are defined in Recommendation U.24.

RECOMMENDATION R.49

INTERBAND TELEGRAPHY OVER OPEN-WIRE 3-CHANNEL CARRIER SYSTEMS

(New Delhi, 1960)

It is considered necessary to introduce, for international traffic, an open-wire carrier system which uses common line repeaters for telephone and interband telegraph channels.

This is important for some administrations which desire to have a small number of telegraph channels (up to six) without having to use a *standard* voice-frequency telegraph system on one of the telephone circuits, thereby effecting an economy, as all the telephone circuits are retained entirely for telephone traffic.

The arrangement of line frequencies so far as the telephone channels are concerned should be as specified in Volume III of the *White Book* (Recommendation G.361).

For these reasons, the C.C.I.T.T. *unanimously declares the following view:*

1. Four interband telegraph channels, for a modulation rate of 50 bauds, can be set up over an open-wire carrier system by the use of line repeaters common to the telephone channels and the telegraph channels provided that the system in question conforms to C.C.I.T.T. Recommendation G.361 B (*White Book*, Volume III).

2. The nominal frequencies of these four telegraph channels are as follows:

a) *Low-frequency direction of transmission:*

3.22—3.34—3.46 and 3.58 kHz.

b) *High-frequency direction of transmission:*

ba) telephone channels occupying the frequency band 18 and 30 kHz:
30.42—30.54—30.66 and 30.78 kHz;

bb) telephone channels occupying the frequency band 19 and 31 kHz:
18.22—18.34—18.46 and 18.58 kHz.

3. When in-band signalling is employed on the telephone channels (as opposed to out-band signalling outside the 4-kHz bandwidth), it becomes possible to provide two additional telegraph channels having the following nominal frequencies:

a) *Low-frequency direction of transmission*

3.70 and 3.82 kHz.

b) *High-frequency direction of transmission*

ba) telephone channels occupying the frequency band 18 and 30 kHz:
30.18 and 30.30 kHz;

bb) telephone channels occupying the frequency band 19 and 31 kHz:
18.70 and 18.82 kHz.

4. In those cases where, as a result of agreement between the administrations concerned, the system employs an upper pilot of 17 800 kHz, the following frequencies may be used as alternatives to those specified in paragraphs 2.bb) and 3.bb) above. This alternative arrangement permits, in certain types of systems, a more economical modulation process:

31.42—31.54—31.66 and 31.78 kHz, instead of 18.22—18.34—18.46 and 18.58 kHz, also 31.18 and 31.30 kHz instead of 18.70 and 18.82 kHz.

5. This Recommendation applies to amplitude-modulated telegraphy and to frequency-modulated telegraphy.

6. It is not considered desirable to standardize absolutely the power transmitted to the line as this may be dependent upon the conditions on the open-wire route. Under favourable conditions a recommendable value for the power on each telegraph channel would be − 2.35 Np (− 20 dB) referred to one milliwatt at a point of zero relative level.

For amplitude modulation the tolerance on the sent frequency will be $\pm$ 6 Hz and for frequency modulation the tolerances given in Recommendation R.35 will apply.

In tests made on the local end, equipments should meet the distortion conditions described in Recommendation R.50, point 2, of the C.C.I.T.T. for amplitude modulation, and those described in Recommendation R.35, point 13, for frequency modulation.

7. The correspondence between the significant conditions described in paragraph 10 of Recommendation R.31 and paragraph 9 of Recommendation R.35 applies to these channels for interband telegraphy.

SECTION 5

TRANSMISSION QUALITY

RECOMMENDATION R.50

TOLERABLE LIMITS FOR THE DEGREE OF ISOCHRONOUS DISTORTION OF 50-BAUD TELEGRAPH CIRCUITS EXCLUDING APPARATUS

(former C.C.I.T. Recommendation B.24, Arnhem, 1953)

The C.C.I.T.T.,

considering

that, to facilitate the study of plans for the establishment of international telegraph circuits, it is convenient to set limits for the degree of isochronous distortion of the telegraph circuits and channels;

that, for whatever purpose normally used, these circuits should be capable of use with start-stop apparatus;

that, in certain cases, limits have been set by Recommendations R.57 and R.58 for the isochronous distortions of the trunk sections of circuits and for that of voice-frequency telegraph channels,

unanimously declares the view

1. that circuits should be established and maintained in such a manner that the degree of isochronous distortion will not exceed 28%, whether they are equipped with regenerative repeaters or not;

2. that the degree of isochronous distortion of each channel which may form part of a circuit should be as small as possible, and should not in any case exceed 10%.

RECOMMENDATION R.51

DETERMINATION OF THE STANDARDIZED TEXT FOR DISTORTION TEST OF THE ELEMENTS OF A COMPLETE CIRCUIT

(former C.C.I.T. Recommendation B.32, Warsaw, 1936, amended at Geneva, 1956)

The C.C.I.T.T.,

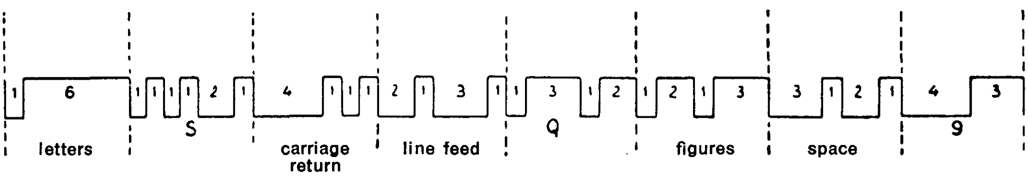
considering

that, for a precise definition of the degree of distortion in service permitting the comparison of results of measurements obtained under similar conditions in different places, it is advisable to standardize the wording of the text which should be transmitted for the test;

that it is best to choose a text which can be received directly by start-stop apparatus and which also presents a sequence of the combinations recognized as those which generally cause the maximum distortion,

unanimously declares the view

that the text to transmit in the course of measurements of the degree of distortion in service should be the following:



this text corresponds to the following sequence of signals emitted by a start-stop apparatus, letters, S, carriage return, line feed, Q, figures, space, 9;

and considering, on the other hand,

that, in maintenance adjustments and in the various distortion measurements that may arise in the study of lines and equipment, it would be necessary to make use of a single apparatus offering the possibility of transmitting the different combinations of signals recognized as the most practical for this purpose;

that the unification of the list of these combinations would permit comparison of results obtained in various places,

unanimously declares the view

that it is appropriate to recommend the construction of special transmitters for distortion measurements which could transmit, with one or the other polarity:

1. the specified text for the measurement of the degree of distortion;

2. a continuous sequence of reversals, the duration of each element being that of the unit interval corresponding to the anticipated telegraph modulation rate;

3. a continuous sequence of reversals, the duration of each element being double the unit interval corresponding to the anticipated telegraph modulation rate;

4. a continuous sequence of signals, each formed by an emission of a duration equal to that of the unit interval, followed by an emission of a kind distinct from the first and of equal duration to that of six unit intervals.

RECOMMENDATION R.52

STANDARDIZATION OF AN INTERNATIONAL TEXT FOR THE MEASUREMENT OF THE MARGIN OF START-STOP APPARATUS

(former C.C.I.T. Recommendation B.33, Brussels, 1948, amended at Geneva, 1964)

The C.C.I.T.T. *unanimously declares the view*

1. that it is not necessary to standardize an international text for the measurement of the margin of a teleprinter;

2. that nevertheless it would be of interest to recommend to the operating administrations the use of either of the following texts according to choice:

VOYEZ LE BRICK GÉANT QUE J'EXAMINE PRÈS DU WHARF

THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG

RECOMMENDATION R.53

PERMISSIBLE LIMITS FOR THE DEGREE OF DISTORTION ON AN INTERNATIONAL 50-BAUD/120-Hz SPACING V.F. TELEGRAPH CHANNEL (FREQUENCY AND AMPLITUDE MODULATION)

(former C.C.I.T. Recommendation B.36, 1951, amended at Arnhem, 1953, at Geneva, 1964 and at Mar del Plata, 1968)

The C.C.I.T.T.,

considering

that the numerous tests made on v.f. telegraph equipment in service now make it possible to establish limits for the degree of distortion outside which a v.f. telegraph channel must be regarded as being out of order;

that these tests should be made with reversals and with standard text at the modulation rate used for adjustment;

that, when equipment is put into service and when it is adjusted, the minimum distortion should be sought and therefore limits for the degree of distortion need not be established in this case,

unanimously declares the view

1. that the degree of bias distortion of reversals on an international voice-frequency telegraph channel at the modulation rate employed for adjustment should not exceed a value corresponding to 4% at the standard modulation rate of 50 bauds;

2. - that the degree of isochronous distortion in service of an international v.f. telegraph channel on the standardized text should not exceed 10%, and that the degree of inherent start-stop distortion, in service conditions, on standardized text, should not exceed 8%.

These limits, except where otherwise stated, apply to a modulation rate of 50 bauds and take account of the accuracy of the measuring equipment.

They are provisional and may be amended according to the technical development of v.f. telegraphy and of studies of telegraph distortion.

RECOMMENDATION R.54

CONVENTIONAL DEGREE OF DISTORTION TOLERABLE FOR STANDARDIZED START-STOP 50-BAUD SYSTEMS

(former C.C.I.T. Recommendation B.51, Geneva, 1956, amended at Geneva, 1964, and at Mar del Plata, 1968)

1. In telegraph communications used in the general service, in the telegraph subscribers' service and for leased circuits, over land lines and submarine cables, using 5-unit start-stop apparatus at the modulation rate of 50 bauds, a maximum admissible rate of error of 3 per 100 000 alphabetic telegraph signals transmitted is recommended by Recommendation F.10.

2. At present, interruptions of the telephone circuit account for a much higher error rate than that recommended by the C.C.I.T.T.

3. To fix the objectives to be reached to curb interruptions and noise in v.f. telegraphy bearer circuits, it is of interest to indicate how this tolerable error rate of 3 per 100 000 telegraph signals can be distributed among the telegraph equipment and the telephone circuits bearing the telegraph systems.

4. Telegraph apparatus, particularly the transmitter and the receiver, are themselves liable to fortuitous failures and it is difficult to distinguish between errors due to these causes and errors due to the fact that the probability that the degree of telegraph distortion will exceed the receiver margin cannot be ignored.

5. But in planning telegraph circuits, it may be convenient to limit the conventional degree of gross start-stop distortion of complete circuits (including telegraph transmitting apparatus) to the nominal margin of the receiving apparatus.

6. Moreover, if the individual degree of distortion at apparatus input exceeds the margin by about once in 100 000, the measurements show that the combined effect of telegraph distortion and fortuitous apparatus failures is manifested by an error rate of about 2 per 100 000 telegraph signals [1].

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[1] The result is that the error rate due to interruptions and noise on telephone circuits carrying telegraph systems should not exceed 1 per 100 000.

For these reasons, the C.C.I.T.T. *unanimously declares the view*

1. that the conventional degree of distortion should be the individual degree of distortion whose probability of being exceeded is 1 in 100 000;

2. that theoretical and planning studies should be carried out in such a way that the conventional degree of distortion at the receiver input is not more than the nominal margin.

Note 1. — The notion of conventional degree of distortion is useful above all for theoretical studies and planning.

Note 2. — For the relation between conventional degree of distortion and practical measurements, reference should be made to Supplements No. 4 (Federal Republic of Germany) and No. 5 (Poland) appearing on pages 301-314, *Blue Book*,Volume VII, and the annex to Question 7/IX (France) published on page 209 of the same Volume.

RECOMMENDATION R.55

CONVENTIONAL DEGREE OF DISTORTION

(Geneva, 1964)

The conventional degree of distortion is (definition 33.14 from the *List of definitions*):

The degree of distortion the probability of exceeding which, during a prolonged observation, equals a very small assigned value.

Note. — The assigned value should be specified for each case of utilization.

For standardized start-stop 50-baud systems, the assigned value is 1 per 100 000 (Recommendation R.54).

To facilitate the use of the conventional degree of distortion and the comparison of studies and plans that have been established with the aid of the conventional degree, it is useful for the probability of being exceeded assigned to the conventional degree to be the same for all telegraph systems (including data transmissions), unless another probability of being exceeded has been assigned to the conventional degree of distortion for special studies.

For these reasons, the C.C.I.T.T. *unanimously declares the view*

that, unless otherwise specified by the administrations and recognized private operating agencies concerned, the conventional degree of distortion is the degree of distortion whose probability of being exceeded is 1 in 100 000;

that the conventional degree of distortion applies to individual distortion.

RECOMMENDATION R.57

STANDARD LIMITS OF TRANSMISSION QUALITY TO BE APPLIED IN PLANNING INTERNATIONAL POINT-TO-POINT TELEGRAPH COMMUNICATIONS AND SWITCHED NETWORKS BY MEANS OF START-STOP APPARATUS (AT 50 BAUDS)

(former C.C.I.T. Recommendation B.25, 1951, amended at Arnhem, 1953, and at New Delhi, 1960; see also Recommendation R.58)

Administrations must agree on the composition of the international section and the national sections before setting up an international point-to-point telegraph circuit.

For the interconnection of switched public or private national networks a distribution plan of telegraph distortion between national networks and international circuits connecting the international terminal exchanges is required.

For this purpose, provisional standards, based on the results of practical experience and on studies of the composition of telegraph distortion, should be laid down for administrations.

On well-maintained channels, with modulation at the standard rate of 50 bauds, the following values should not normally be exceeded on the trunk sections (see Recommendations R.53 and R.75).

Number of channels in tandem within the trunk circuit (excluding the local section at each end)	The limit of bias distortion on reversals at the modulation rate employed for adjustment shall be equivalent to the following values at 50 bauds	Limit of the degree of isochronous distortion on standardized text	Limit of the degree of inherent start-stop distortion, in service on standardized text
1	4%	10%	8%
2	7%	18%	13%
3	10%	24%	17%
4	12%	28%	21%
5			25%

(The above values are valid whether the channels are amplitude-modulated or frequency-modulated.)

For the above reasons, the C.C.I.T.T. *unanimously declares the following view:*

a) [1] In planning international point-to-point telegraph communications, administrations should use the following standard limits valid for start-stop apparatus and for

[1] Although the figures in Recommendation R.57 are for planning purposes, they do not correspond to conventional degrees of distortion but to routine measurements.

50-baud channels conforming to the recommendations of the C.C.I.T.T. and set up by amplitude-modulation or frequency-modulation;

1. Limit of the degree of gross start-stop distortion, measured by a start-stop distortion measuring set at the beginning of the trunk section of the circuit (i.e. at the point where the circuit enters the long-distance line telegraph equipment) and including the effect of the emission distortion of the transmitting apparatus 12%

2. Limit of the degree of isochronous distortion on standardized text in the trunk section of the connection:

   When one voice-frequency telegraph channel is used for the communication 10%
   When two voice-frequency telegraph channels are used for the communication 18%
   When three voice-frequency telegraph channels are used for the communication 24%
   When four voice-frequency telegraph channels are used for the communication 28%

or [1]

2 *bis*. Limit of degree of inherent start-stop distortion on standardized text of the trunk section of the connection:

   When one voice-frequency channel is used for the communication . . . 8%
   When two voice-frequency channels are used for the communication . . 13%
   When three voice-frequency channels are used for the communication . . 17%
   When four voice-frequency channels are used for the communication . . 21%
   When five voice-frequency channels are used for the communication . . 25%

3. Limit of the degree of the gross start-stop distortion, measured by a start-stop distortion measuring set, which can be present in signals at the input of the extension circuit [2] of the connection 30%

b) These standards take no account of the possibility of including regenerative repeaters in circuits;

c) These standards presuppose that the distortion introduced by the local section of the circuit is negligible, and that, should that not be so, administrations should agree amongst themselves on the degree of distortion admissible in the various sections of the communication, and on the number of voice-frequency telegraph channels which can be used;

d) Administrations should use them, in order to agree on the maximum number of voice-frequency telegraph channels which may compose the international section of a circuit and in order to determine the characteristics of their national networks due to be connected to the networks of other countries, on the understanding that the isochronous distortion in service, originated by the trunk section, may not in any circumstances exceed 28%.

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[1] The limits for the degrees of isochronous and start-stop distortions indicated under 2 and 2 *bis* do not establish a law of correspondence between the degree of isochronous distortion and the degree of start-stop distortion; this law of correspondence depends on the composition of the distortion (relative importance of characteristic and fortuitous distortions).

[2] Definition 32.04: **(physical) extension circuit (tail)**

The permanent connection extending a telegraph station to a nearby centre, giving access to the long-distance network.

RECOMMENDATION R.58

STANDARD LIMITS OF TRANSMISSION QUALITY FOR THE GENTEX AND TELEX NETWORKS

(New Delhi, 1960, amended at Geneva, 1964)

To permit the sharing of responsibility for the maintenance of a high standard of transmission between countries participating in the establishment of switched connections, it is necessary to specify limiting values of distortion at the international terminal exchanges.

On the other hand, to enable national switched networks to be interconnected, it is necessary to have a distribution plan of the telegraph distortion between national networks and the international junction circuits connecting up the international switching centres (international terminal switching centres).

The following diagram (Figure 1) shows the points of entry and exit of the national network and the ends of the international junction circuit.

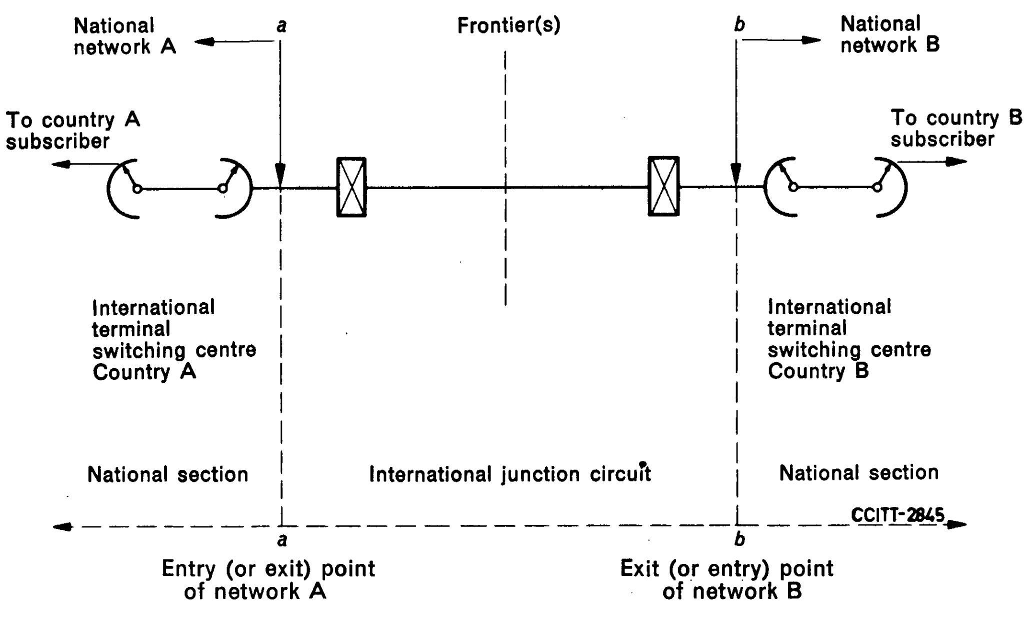


FIGURE 1

It is difficult to lay down standards applicable both to small and to large national networks.

However, it has been possible to fix limit values for large countries and they could apply to the great majority of telex subscriber stations or gentex stations taking part in the international service.

For the above reasons, the C.C.I.T.T. *unanimously declares the following view:*

1. The following standards of transmission quality are observed for the interconnection of 50-baud national networks set up by means of telegraph channels and start-stop apparatus in accordance with C.C.I.T.T. recommendations (national gentex or telex networks):

a) degree of gross start-stop distortion in service (i.e. including the effect of distortion due to the sending apparatus and the exchanges at the point of exit of the national network): not more than 22%;

Note. — When a terminal country of an international connection possesses an intercontinental transit centre, that transit centre is considered as forming part of the national network.

b) degree of inherent start-stop distortion of the international junction circuit: not more than 13%.

Note 1. — In establishing the 13% limit for the degree of start-stop distortion in the international junction circuit, account has been taken of the fact that, in a world telex or gentex chain, the junction circuit might quite often consist of 2 v.f. channels in tandem. If the international junction circuit is established on a single channel, the 8% limit mentioned in Recommendation R.57 is applicable to that circuit.

Note 2. — No limit for distortion on the entry of the national network at the receiving end was indicated in Recommendation R.58; the values mentioned in 1 a) and 1 b) are adequate for planning purposes.

2. Although the degrees of distortion to be inserted in the recommendations relative to the planning of networks are normally conventional degrees of distortion, the maximum values mentioned under 1 correspond to the results which would be provided by the routine measurements carried out in accordance with Recommendation R.5.

3. These limit values are applicable to large countries which are directly connected without switching in a transit country. The stations taking part in the international service which cannot satisfy condition 1 a will have to be specially equipped, for example with distortion correctors.

4. Small countries (defined as countries in which all stations can be reached with not more than one long-distance telegraph circuit in the national network) will have to try to obtain values less than the maximum of 22% for the measurements corresponding to 1 a.

5. The standard limits mentioned under 1 can also apply to private switched networks.

SECTION 6

CORRECTION OF SIGNALS

RECOMMENDATION R.60

CONDITIONS TO BE FULFILLED BY REGENERATIVE REPEATERS FOR START-STOP SIGNALS OF ALPHABET No. 2 (EXCEPT WHERE RECOMMENDATION R.61 IS APPLICABLE)

(former C.C.I.T. Recommendation B.20, 1952, amended at Geneva, 1956 and 1964, and at Mar del Plata, 1968)

The C.C.I.T.T.,

considering

that the duration of the transmitting cycle of terminal start-stop apparatus should be at least 7.4 units for apparatus operating at 50 and 75 bauds, 7.5 units for apparatus operating at 100 bauds;

that the effective net margin should be greater than:

35% for signals sent by a transmitter having a nominal cycle equal to or greater than 7 units (in case of operation at 50 or 75 bauds);

30% for signals sent by a transmitter having a nominal cycle equal to or greater than 7.2 units (in case of operation at 100 bauds);

unanimously declares the view

1. that regenerative repeaters for start-stop signals should operate at the nominal modulation rate of the signals that they are required to regenerate with a speed tolerance in service of ± 0.5%;

2. the effective synchronous margin should be at least 40%;

3. that the degree of synchronous start-stop distortion (see Definition 33.10) of the retransmitted signals should not exceed 5%;

4. that the significant instants corresponding to the beginning of the start signals emitted by the regenerative repeater should in no case be separated by less than:

7-unit intervals (in case of operation at 50 or 75 bauds),
7.2-unit intervals (in case of operation at 100 bauds).

RECOMMENDATION R.61

CONDITIONS TO BE FULFILLED BY REGENERATIVE REPEATERS EMPLOYED FOR 7-UNIT START-STOP TRANSMISSION WITH A MODULATION RATE OF 50 BAUDS

(former C.C.I.T. Recommendation B.21, 1951, amended at Geneva, 1956)

The C.C.I.T.T.,

in view of Recommendation R.62 regarding the siting of regenerative repeaters in international telex circuits:

in view of Recommendation S.3 on the transmission cycle of start-stop apparatus;

considering

that, as there are at present large numbers of start-stop instruments having a 7-unit transmission cycle, it is necessary to define the conditions to be satisfied by 7-unit regenerative repeaters;

that, since it is unlikely that the growth of the international telex network will demand the use of regenerative repeaters on transit international trunk circuits for some years, the regeneration of 7-unit signals need only concern those administrations having start-stop instruments which transmit 7-unit signals,

Note. — Administrations are recommended to withdraw any apparatus which does not transmit at the rate of 7.5 (or a minimum of 7.4) units for the international service as far as possible, owing to the difficulty of regenerating 7-unit start-stop signals when they are sent automatically.

unanimously declares the view

that the duration of the stop element should never be less than 18 milliseconds, and consequently the mean speed must be:

a) either the theoretical speed, with a tolerance of $\pm 0.1\%$, in which case it is necessary to employ a device to control the duration of the stop signal;

b) or the mean speed of the transmitter, with a suitable tolerance, in which case such a device is unnecessary;

that the degree of gross start-stop distortion of the retransmitted signals, including the stop signal, should be less than 10%;

that the synchronous margin should not be less than 40%;

that it seems desirable to permit dialling pulses to bypass the regenerative repeater when the transmission of these pulses has to be envisaged, but that the study of this question should, however, continue;

that the arrangements to be adopted for the present for the transmission of dialling pulses should be bilaterally agreed between the administrations concerned;

that the regenerative repeaters should be capable of retransmitting the various supervisory signals employed in switching systems (except that when arrangements are made for the dialling pulses to bypass the regenerative repeater it could equally be unnecessary for certain of the supervisory signals to be transmitted by the regenerative repeater).

RECOMMENDATION R.62

SITING OF REGENERATIVE REPEATERS IN INTERNATIONAL TELEX CIRCUITS

(former C.C.I.T. Recommendation B.26, 1951, amended at Geneva, 1956 and 1964, and Mar del Plata, 1968)

The C.C.I.T.T.,

considering

that insufficient experience has been acquired in the use of regenerative repeaters;

that it nevertheless seems desirable to lay down a provisional rule governing the siting of regenerative repeaters, with a view to the preparation of plans for international telegraph communications by switching;

that it would also appear desirable that the signals transmitted by an international terminal exchange should not be affected by a higher degree of distortion than those recommended in Recommendations R.57 and R.58,

unanimously declares the view

that, when the transmission quality demands it, administrations agree with one another on the necessity for inserting regenerative repeaters and for taking the necessary steps so that the location chosen ensures that the expenses are equally shared between the administrations and is appropriate to the organization of their telex and general switching networks and to the quality of transmission which it is possible to provide on complete connections;

that in the automatic intercontinental telex and gentex transit network (see Recommendation F.68), in case regeneration is not inherently provided by time-division multiplex equipment, start-stop regenerative repeaters shall be provided in the receive path of the connection at the intercontinental transit centre.

Note. — Start-stop regenerative repeaters and time-division multiplex equipment according to C.C.I.T.T. Recommendations are suitable only for normal (50 bauds, 5-unit code) telex and gentex operation. Special uses of the automatic intercontinental transit network (cf. section 7 of Recommendation U.11), involving other codes and speeds, raise problems which have to be investigated.

SECTION 7

TELEGRAPH MAINTENANCE

RECOMMENDATION R.70

DESIGNATION OF INTERNATIONAL TELEGRAPH CIRCUITS

(former C.C.I.T. Recommendation B.29, 1951, amended at Arnhem, 1953, and at Mar del Plata, 1968)

The C.C.I.T.T. *unanimously declares the view*

that international telegraph circuits should be designated:

a) first, by the localities of terminal offices, arranged in alphabetical order according to the spelling of the country;

b) by an indication of the service using the circuit according to the following table:

1. general telegraph service circuit (the general telegraph service is defined in 01.14);

   i) point-to-point circuit or circuit used for messages switching: TG
   ii) trunk circuit (definition 35.12) of the public switching network (gentex): TGX
   iii) subscriber's line (definition 35.11) from a telegraph office to its switching equipment: TGA

2. telex circuit (including circuits common to the telex and gentex services): TX

3. special circuits for private or special services:

   i) point-to-point circuit or circuit used for message switching: TGP
   ii) switched circuit or multi-point network circuit (broadcasting network, conference, omnibus (definition 32.44) circuits): TXP

4. service circuits:

   i) point-to-point circuit: TS
   ii) omnibus or selective ringing circuit section: TXS
   iii) pilot channel for voice-frequency telegraph systems: TT

c) by a serial number, using a separate continuous series for each group of circuits.

Note. — To avoid confusion in the case of TGP and TXP circuits, the designation originally assigned to a leased circuit should not be re-assigned to a new circuit until a period of at least two years has elapsed.

RECOMMENDATION R.70 *bis*

NUMBERING OF VOICE-FREQUENCY TELEGRAPH CHANNELS

(Mar del Plata, 1968)

In view of the introduction in the international service of voice-frequency telegraph channels operated at various nominal modulation rates and having different pass-band spacing, and since the same (heterogeneous) system may include channels with different characteristics, it has become necessary to evolve a method of numbering voice-frequency telegraph channels.

This numbering method must make it possible to recognize:

— the type of modulation (amplitude or frequency) on the channel;

— the nominal modulation rate and average channel spacing;

— the position of the channel in the frequency range.

It must also be such that, in a heterogeneous system, any change in the composition of the channels does not change the numbers of the channels already set up in the system. The transformation of a homogeneous system into a heterogeneous one should not alter the numbers of the channels which are retained.

The C.C.I.T.T. therefore *unanimously declares the view:*

— that the channels in an international voice-frequency telegraph system should be numbered as follows:
numbers 001 to 024: channels with 120-Hz spacing, amplitude modulation;
numbers 101 to 124: channels with 120-Hz spacing, frequency modulation;
numbers 151 to 165: channels with 170-Hz spacing, frequency modulation;
numbers 201 to 212: channels with 240-Hz spacing, frequency modulation;
numbers 301 to 307: channels with 360-Hz spacing, frequency modulation;
numbers 401 to 406: channels with 480-Hz spacing, frequency modulation.

— that the number assigned to a channel should be selected from the series applicable to the type of channel and should correspond to its position in the multiplex table.
An example of this procedure is given in the following table.

Scheme of numbering of frequencies and multiplex

Mean frequency (Hz)	420	540	660	780	900	1020	1140	1260	1380	1500	1620	1740	1860	1980	2100	2220	2340	2460	2580	2700	2820	2940	3060	3180	According to Rec. R.31 } 50 bauds/ Rec. R.35 } 120 Hz
Channel No.	001 101	002 102	003 103	004 104	005 105	006 106	007 107	008 108	009 109	010 110	011 111	012 112	013 113	014 114	015 115	016 116	017 117	018 118	019 119	020 120	021 121	022 122	023 123	024 124	

Mean frequency (Hz)	480	720	960	1200	1440	1680	1920	2160	2400	2640	2880	3120	Recommendation R.37 50 bauds } 100 bauds } 240 Hz
Channel No.	201	202	203	204	205	206	207	208	209	210	211	212	

Mean frequency (Hz)	600	1080	1560	2040	2520	3000	Recommendation R.38 A 200 bauds/480 Hz
Channel No.	401	402	403	404	405	406	

Mean frequency (Hz)	540	900	1260	1620	1980	2340	2700	3060	Recommendation R.38 B 200 bauds/360 Hz
Channel No.	301	302	303	304	305	306	307	308	

Mean frequency (Hz)	420	540	660	780	900	1020	1140	1260	1560	2040	2340	2460	2640	2880	3120	One example of the application of Recommendation R.36 2 channels-200 bauds/480 Hz 3 channels-100 bauds/240 Hz 10 channels-50 bauds/120 Hz
Channel No.	101	102	103	104	105	106	107	108	403	404	117	118	210	211	212	

RECOMMENDATION R.71

ORGANIZATION OF THE MAINTENANCE OF INTERNATIONAL TELEGRAPH CIRCUITS

(former C.C.I.T. Recommendation B.30, Brussels, 1948, amended 1951 and at Geneva, 1956)

The C.C.I.T.T.,

considering

that, in order to ensure satisfactory co-operation between administrations and private telegraph operating agencies interested in the maintenance of international telegraph circuits, and in order to ensure the maintenance of satisfactory transmission in the international telegraph service, it is necessary to unify the essential action to be taken for the establishment and maintenance of international telegraph circuits,

unanimously declares the view

1. that periodical maintenance measurements should be taken on international v.f. telegraph systems, and that documents relating to such measurements should be exchanged;

2. that the responsibilities for the maintenance of satisfactory transmission, and (as and when necessary) the removal of faults on an international v.f. telegraph system should be assumed by one of the terminal stations of the system.

The terminal station in question to be known as the *system control staiton.*

The said station to be appointed for the purpose by the administrations and private telegraph operating agencies concerned on the occasion of the establishment of the v.f. telegraph system concerned.

The system control station to be entrusted with co-ordination of the execution of the maintenance measurements to which paragraph 1 above relates;

3. that the responsibilities for the maintenance of satisfactory transmission, and (as and when necessary) the removal of faults on an international telegraph system should be allocated between the different stations concerned as indicated below.

One station of the circuit should assume the principal responsibility for the maintenance of satisfactory service on the circuit.

The station in question should be known as the *controlling testing station.*

This station should be equipped with testing equipment to enable it to make telegraph transmission measurements and in this connection it exercises an executive control over all the other stations on the circuit.

It should be appointed by agreement between the administrations concerned on the occasion of the establishment of the telegraph circuits concerned.

It should be, wherever possible, one of the terminal stations of the circuit, save in so far as otherwise agreed by the services concerned.

For example, in the case of v.f. telegraph circuits, the controlling testing station should be one of the terminal voice-frequency telegraph stations as nominated by common agreement between the administrations concerned.

The controlling station is responsible for co-ordinating all operations required when there is a breakdown in the circuit. It keeps a record of all circuit breakdowns.

To facilitate supervision, a reference number must be allocated to each breakdown reported.

When a fault comes to the notice of another station on the circuit, this station should take steps to secure suitable action on the part of other stations concerned; but the controlling testing station is nevertheless responsible for ensuring that the fault is cleared as soon as possible.

The controlling testing station should be in a position to furnish all requisite information in reply to enquiries on the subject of faults—e.g. in regard to the time of any fault, the location of the fault, the orders given for dealing with it and the times of restoration of the circuit.

In order, however, to increase the flexibility of the organization and the rapidity of the removal of faults, the controlling testing station will confine itself in each foreign country to securing the co-operation of a *station* to be known as the *sub-control* station of the circuit.

The sub-control station should assume, within its own territory, the responsibilities indicated above in the case of the controlling testing station and should therefore be equipped with testing equipment to enable it to make telegraph transmission measurements.

Such delegation of responsibility shall not affect the authority of the controlling testing station, with which the primary responsibility for the maintenance of satisfactory service on the circuit will continue to rest.

The sub-control station shall be appointed by the technical service of the administration concerned.

It shall furnish detailed information to the controlling testing station regarding faults occurring in its own country.

Administrations or private recognized telegraph operating agencies shall be free to organize the maintenance measurements on those portions of international point-to-point circuits and switched connections (including apparatus) which lie wholly within their control, but the methods adopted should be not less efficacious than those recommended for international circuits.

To facilitate the control of tests, circuits shall be divided into *test sections* (parts of a circuit between two telegraph stations). Each section shall be under the control of a *testing station* responsible for the localization and removal of faults on the section concerned. The testing station shall furnish detailed information as to the faults occurring in the section under its control to the sub-control station (or, if necessary, the controlling testing station).

In the case of v.f. telegraph channels, each channel shall constitute a test section. The testing station will in this case be the principal v.f. telegraph station at the end of the section concerned.

RECOMMENDATION R.72

PERIODICITY OF MAINTENANCE MEASUREMENTS TO BE CARRIED OUT ON THE CHANNELS OF INTERNATIONAL VOICE-FREQUENCY TELEGRAPH SYSTEMS

(former C.C.I.T. Recommendation B.34, 1951, amended at New Delhi, 1960, and at Geneva, 1964)

The C.C.I.T.T.,

considering

that, for such supervision, maintenance measurements on international voice-frequency telegraph channels are necessary,

unanimously declares the view

1. that maintenance measurements be carried out on international voice-frequency telegraph channels once every three months (once every six months for 50-baud channels spaced at 240 Hz conforming to Recommendation R.35 *bis*);

2. that there is no need to carry out measurements more frequently on channels making up long circuits or circuits used in switching network;

3. that when it is observed that the number of maladjustments is too high, supplementary measurements would be performed by agreements between administrations concerned.

RECOMMENDATION R.73

MAINTENANCE MEASUREMENTS TO BE CARRIED OUT ON V.F. TELEGRAPH SYSTEMS

(former C.C.I.T. Recommendation B.35, 1951, amended at New Delhi, 1960, at Geneva, 1964, and at Mar del Plata, 1968)

The C.C.I.T.T.,

in view of Recommendation R.72 on the periodicity of maintenance measurements to be made on international v.f. telegraph channels;

considering

that it should be clearly laid down what maintenance measurements are indispensable to ensure the correct operation of v.f. telegraph channels,

unanimously declares the view

1. that maintenance measurements and any necessary adjustments of *amplitude-modulated* v.f. channels should be made in the following order:

a) the power supply voltages;

b) the value of the frequency transmitted to line by the channel;

c) the output level of each " send " filter in condition Z and in condition A;

d) the output level of each " send " filter after the control current has been interrupted;

e) the output level of each " receive " filter in condition Z;

f) the degree of distortion with symmetrical 1/1 or 2/2 signals (It would be advisable for this measurement to be made at the levels: normal, maximum and minimum. All the modifications of level should be made after the " receive " filter); the measurement and adjustments may be first carried out on local and then on line, or on line only, so as to minimize the degree of distortion;

g) the receiving relay if any (if the results obtained at point f should make this desirable);

h) the threshold of the receiver;

i) the degree of distortion, in accordance with the method described in Recommendation R.5 and bearing in mind part A of Recommendation R.74;

2. that maintenance measurements and any necessary adjustments of *frequency-modulated* v.f. telegraph channels should be made in the following order:

a) the power supply voltages;

b) the values of the frequencies transmitted to line by the channel;

c) the frequency emitted after the control current has been interrupted;

d) the output levels of each " send " filter for the characteristic frequencies A and Z;

e) the output levels of each " receive " filter for the characteristic frequencies A and Z, if possible;

f) the frequency drift, if the channel is used for this measurement (see below);

g) the degree of distortion with symmetrical 1/1 or 2/2 signals; the measurement and adjustment should be first carried out on local and then on line, or on line only, so as to minimize the degree of distortion;

h) the receiving relay, if any;

i) the threshold of the receiver (at blocking);

j) the degree of distortion, in accordance with the method described in Recommendation R.5 and bearing in mind part A of Recommendation R.74.

The measurement referred to in f above must be carried out to check, where necessary, whether there is any frequency drift on the voice-frequency telegraph bearer circuit by measuring the pilot frequency when the system is operated with one; otherwise, administrations should agree to measure a characteristic frequency at the output of the line for a mutually determined channel.

The result of this measurement will be compared with the result of the measurement made when this frequency is sent; the difference will show any drift due to transmission on the v.f. system bearer circuit;

3. that, unless otherwise specified, the measurements should be effected at the nominal modulation rate of the channel (50, 100 or 200 bauds).

However, if a 100-baud channel is operated with a rate of 50 bauds, in accordance with Recommendation R.35 *bis*, the measurements should be effected at the rate of 50 bauds and adjustments made if the limits mentioned for 50 bauds in Recommendation R.57 are no longer respected;

4. that the results of the measurements made on the international channels should be exchanged directly by telegraph or telephone between the measuring stations, at the request of one of these stations;

5. that since maintenance work is a cause of interference on circuits in service, maintenance measurements would be made outside busy hours as far as possible;

6. that when maintenance measurements are carried out on circuits in operation, every precaution would be taken according to Recommendation R.76 to avoid disturbances.

RECOMMENDATION R.74

CHOICE OF TYPE OF TELEGRAPH DISTORTION MEASURING APPARATUS

(former C.C.I.T. Recommendation B.52, Geneva, 1956, amended at Geneva, 1964)

The C.C.I.T.T.,

in view of Recommendation R.90,

A. *considering*

1. that measurements of isochronous distortion made with the text specified in Recommendation R.51 are normally applied only to telegraph channels;

2. that it may in principle be desirable to measure the distortion of telegraph channels in terms of start-stop distortion;

3. that all important terminals of voice-frequency telegraph systems are equipped with isochronous distortion measuring equipment and that their replacement by start-stop instruments would be expensive,

unanimously declares the view

1. that, for the maintenance of telegraph channels, isochronous distortion measuring sets should normally be used;

2. that administrations may nevertheless, by common consent, use for this purpose start-stop distortion measuring sets;

B. *considering also*

1. that measurements of the quality of start-stop signals cannot normally be made without start-stop distortion measuring sets;

2. that the planning and establishment of telegraph networks are to be judged in terms of conventional degrees of start-stop distortion, and that degrees of start-stop distortion may also prove to be the best basis for calculations of the summation of degrees of distortion and for calculation of conventional start-stop distortion,

unanimously declares the view

that all international switching and testing centres (I.S.T.C.s) should be equipped with start-stop distortion measuring apparatus.

RECOMMENDATION R.75

MAINTENANCE MEASUREMENTS ON INTERNATIONAL SECTIONS OF INTERNATIONAL TELEGRAPH CIRCUITS

(former C.C.I.T. Recommendation B.44, Arnhem, 1953, amended at New Delhi, 1960)

The C.C.I.T.T.,

in view of Recommendations R.50, R.57 and R.90,

considering

1. that, for the technical supervision of international telegraph circuits, it is necessary to make periodic measurements of distortion on their international sections when they are made up of two or more channels;

2. that certain administrations consider it desirable to have available apparatus for making simple measurements automatically and periodically, giving an indication of the performance rating and transmitting an alarm when this rating exceeds the limits permitted for automatic switched channels,

unanimously declares the view

1. that it is desirable to make distortion measurements every three months on the international sections of international telegraph circuits made up of at least two channels;

2. that these measurements should be made at a modulation rate of 50 bauds

a) with reversals,
b) with standard text according to Recommendation R.51;

3. that the following values for the inherent distortion in service (extracted from Recommendation R.57) must not be exceeded on the international section of a telegraph circuit:

Number of channels in tandem within the international section	The limit of bias distortion on reversals at the modulation rate employed for adjustment shall be equivalent to the following values at 50 bauds	Isochronous distortion with standardized text	Inherent start-stop distortion with standardized text
2	7%	18%	13%
3	10%	24%	17%
4	12%	28%	21%
5	—	—	25%

Note. — The above values are valid whether the channels are amplitude-modulated or frequency-modulated.

4. that these values do not take into account the possibility of inserting regenerative repeaters in the international section;

5. that these values can be regarded only as provisional and the study of them should be continued;

6. that, in future, measurements made with the apparatus mentioned above (item 2 of the consideranda) will no doubt make it possible to eliminate the maintenance measurements referred to in the previous paragraphs.

Note. — The columns giving the limits for degrees of isochronous distortion and start-stop distortion on the test are not intended to establish a law of relationship between the degrees of start-stop distortion of the degrees of isochronous distortion; this law of relationship depends on the constitution of the distortion (relative importance of characteristic and random distortions).

RECOMMENDATION R.76

RESERVE CHANNELS FOR MAINTENANCE MEASUREMENTS ON CHANNELS OF INTERNATIONAL V.F. TELEGRAPH SYSTEMS

(former C.C.I.T. Recommendation B.38, 1951, amended at Geneva, 1964)

The C.C.I.T.T.,

considering

that it is desirable that maintenance measurements on the channels of international voice-frequency telegraph systems should disturb communications as little as possible,

unanimously declares the view

that, whenever possible, measurements on a working channel of a voice-frequency telegraph system should be carried out only after the channel concerned has, if necessary, been replaced by a spare channel;

and to this end, the C.C.I.T.T. considers that it is desirable that one channel should be reserved for this purpose in each voice-frequency telegraph system.

When this change is not possible, the channel user will be informed in advance that measurements or tests are about to be carried out on his circuit.

RECOMMENDATION R.77

USE OF BEARER CIRCUITS FOR VOICE-FREQUENCY TELEGRAPHY

(former C.C.I.T. Recommendation B.39, Brussels, 1948, amended at New Delhi, 1960, and at Mar del Plata, 1968)

A. COMPOSITION AND NOMENCLATURE

Figure 1 illustrates the composition of an international voice-frequency telegraph system and the nomenclature used.

A. THE INTERNATIONAL VOICE-FREQUENCY TELEGRAPH SYSTEM

1. This is the whole of the assembly of apparatus and lines, including the terminal voice-frequency telegraph equipment. In Figure 1 the system illustrated provides 24 duplex international telegraph circuits but other numbers of telegraph circuits can be provided,

2. *The international voice-frequency telegraph bearer circuit*

2.1 Four-wire telephone type circuits are used as bearer circuits for voice-frequency telegraphy. The circuit comprises two unidirectional transmission paths, one for each direction of transmission, between the terminal voice-frequency telegraph equipments.

2.2 The voice-frequency telegraph bearer circuit consists of an international line together with any terminal national sections connecting the international line to the voice-frequency telegraph terminal equipment and may be constituted entirely on carrier channels (on symmetric pair, coaxial pair or radio-relay systems) or on audio-frequency lines or combinations of such lines.

2.3 The normal bearer circuits for voice-frequency telegraphy have no terminating units, signalling equipment or echo suppressors.

3. *The international line of a voice-frequency telegraph bearer circuit*

3.1 The international line of a voice-frequency telegraph bearer circuit may be constituted by using a channel in a carrier group or channels in tandem on a number of groups.

National and international sections can be interconnected to set up an international line. See Figure 1 but note that sub-paragraph 3.2 details the preferred method.

The international line could equally well be set up between, for example, only A and C or between C and D, in which case A and C, or C and D would be the terminal international centres.

3.2 Wherever possible an international line for a voice-frequency telegraph bearer circuit should be provided on channels of a single carrier group, thereby avoiding intermediate audio-frequency points. In some cases, such a group may not exist or, for special routing reasons, it may not be possible to set up the international line in the preferred way. In such cases, the international line will consist of channels in tandem on two or more groups with or without audio sections, depending on the line available and the routing requirements.

4. *Terminal national sections connected to the international line of a v.f. telegraph bearer circuit*

In many cases the voice-frequency telegraph terminal equipment is remote from the terminal international centre of the international line (Figure 1), and such cases necessitate the provision of terminal national sections in order to establish international voice-frequency telegraph bearer circuits. These sections may be in short-distance local audio cables, amplified or unamplified, or may be routed in long-distance carrier groups or amplified audio plant as available.

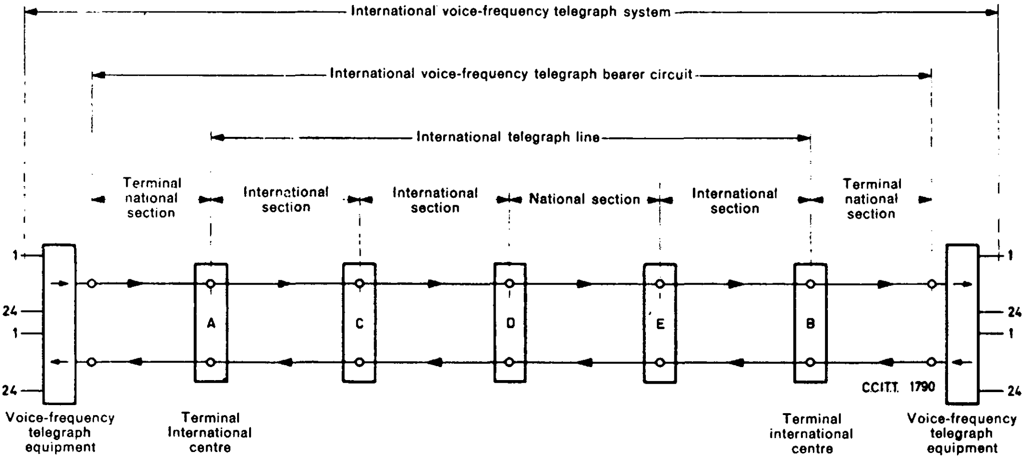


FIGURE 1. — **The components of an international voice-frequency telegraph system**

(at the intermediate centres C, D and E and at the terminal international centres A and B, the signals transmitted are at audio frequencies. At these points it is possible to make measurements.)

B. Reserve arrangements for international voice-frequency telegraph bearer circuits

All necessary action should be taken to enable the duration of interruption of international voice-frequency telegraph bearer circuits to be reduced to a minimum and, for this purpose, it is expedient to standardize some of the methods to be adopted for replacing defective portions on the circuit.

Although it does not appear necessary for these methods to be the same in detail in every country, it would be advisable to reach agreement regarding the general directives to be followed.

The make-up of the reserve voice-frequency telegraph bearer circuits will in general be similar to that of the normal voice-frequency telegraph bearer circuits. However, if the voice-frequency telegraph terminal equipment is not located at the terminal international centres, the line portion of an international telephone circuit can be used to replace only the international line of the voice-frequency telegraph bearer circuit.

1. *Reserve international lines*

1.1 Wherever possible a reserve international line should be provided between the two terminal international centres by means of the international line of an international telephone circuit (between A and B in Figure 1).

1.2 The telephone circuit used as a reserve should be chosen wherever possible so as to follow a different route from that of the normal international line. Where this cannot be done, as much as possible of the circuit or its sections should be alternatively routed.

1.3 If there is a choice, the use of manually-operated circuits as reserve lines for voice-frequency telegraphy is technically and operationally preferable to the use of automatic circuits.

It should be possible after prior agreement between the controlling officers at the international terminal exchanges concerned for an operator to break into a call in progress to advise the correspondents that the circuit is required and that the call should be transferred to another circuit if it lasts longer than six minutes.

1.4 If the reserve telephone circuit is automatic or semi-automatic a direct indication should be given at the changeover point. If it is not available when needed the reserve circuit should be blocked against any further call.

2. *Reserve sections for the sections of the international voice-frequency telegraph bearer circuit*

Where it is not possible to provide reserve international circuits either because there are no suitable telephone circuits or because the number of telephone circuits does not permit the release of a circuit for reserve purposes, reserve sections should be provided wherever possible for each of the component sections. For these sections, national or international telephone lines or, where they exist, spare channels, circuits etc. should be used.

3. *Reserve arrangements for the terminal national sections connecting the voice-frequency telegraph terminal equipment to the international line*

Reserve sections should be provided by means of national telephone circuits or by the use of spare channels, particularly in the case of long sections and of sections forming part of a category B voice-frequency telegraph bearer circuit (see preface to *Blue Book*, Volume IV).

4. *Changeover arrangements from normal to reserve lines*

4.1 When an international telephone line (i.e. part of an international telephone circuit) is used to provide a reserve for the international line (or for one of its sections as mentioned in B.2 above), there should be changeover arrangements to enable the changeover from the normal line to the reserve line to be made as rapidly as possible. The changeover arrangements (Figure 2) should be such that on changeover, all signalling equipment, echo suppressors, etc., associated with the telephone circuit that is used as a reserve for the international line, are disconnected on the line side. When the fault is cleared on the normal line, it should be possible to join it to the signalling equipment, echo suppressors, etc., and put into service as part of the telephone circuit until the agreed time for the restoration of the line to the normal routing.

It is desirable to introduce as little disturbance as possible when changing back from reserve to normal. Arrangements of cords and parallel jacks can be devised to achieve this.

4.2 The changeover arrangements shown in Figure 2 could be applied to sections of the international line mentioned under B.2 above when it is not possible to obtain an overall reserve for the international line. Normal sections and the corresponding reserve sections should be routed via suitable changeover arrangements at the stations concerned.

4.3 Should the alarm indicating that the voice-frequency bearer circuit is faulty be received by a station other than the group control station, this other station shall interrupt the return direction of the alarm channel towards the group control station in order to advise the latter to take the necessary action.

4.4 Making manual, automatic or semi-automatic international telephone circuits available for reserve circuits for voice-frequency telegraphy should be in accordance with the instructions issued and the arrangements made by the respective administrations. Should the normal and reserve lines both be faulty, the technical services of the administration concerned should take immediate joint action to find a temporary remedy.

5. *Designation and marking*

Normal and reserve circuits etc. should be clearly distinguishable from other circuits both from the point of view of designation (see Recommendation M.14) and marking (see Recommendation M.81).

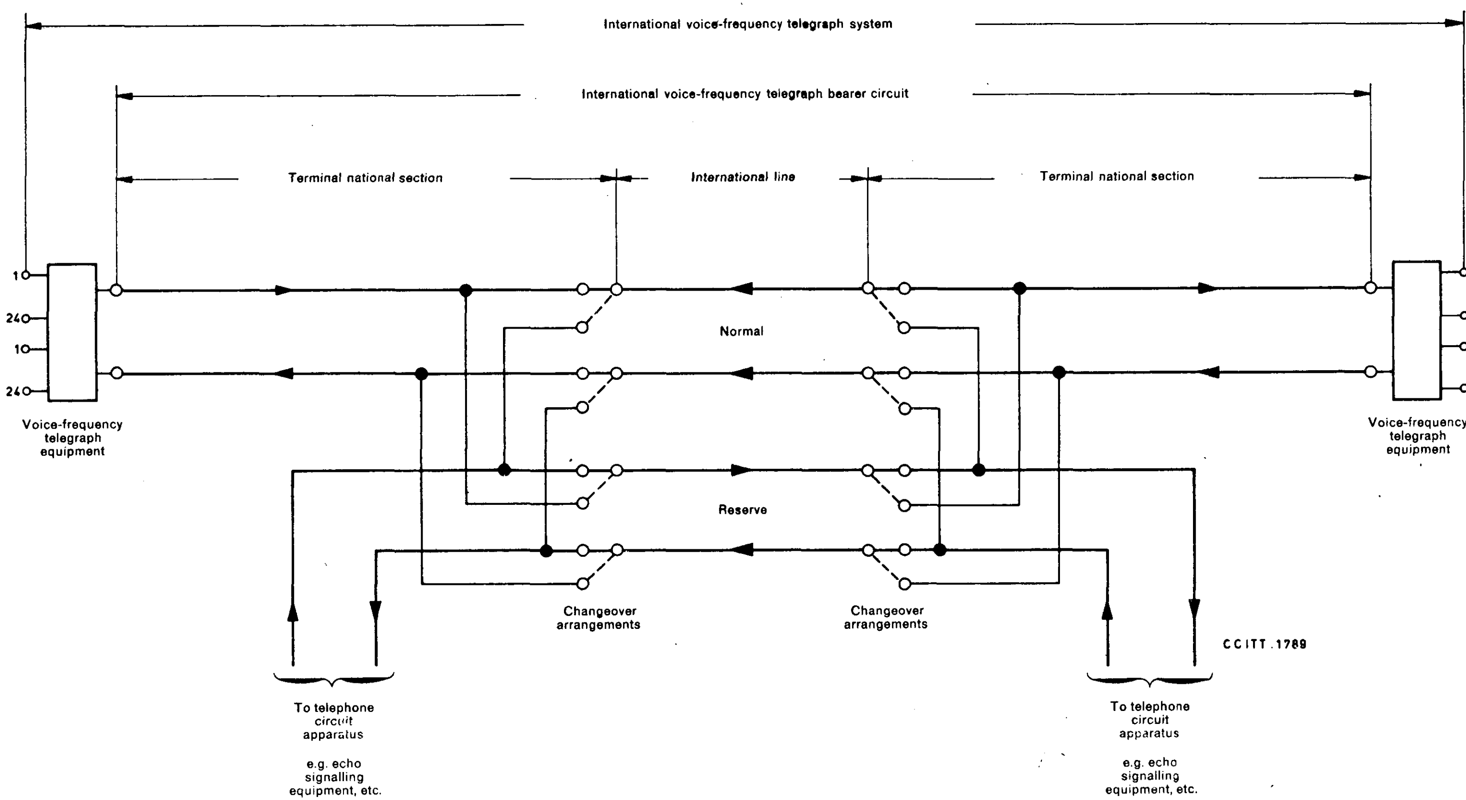


FIGURE 2 — **An example of how an international telephone line can be used as the reserve for the international line of an international voice-frequency telegraph bearer circuit**

RECOMMENDATION R.78

PILOT CHANNEL FOR VOICE-FREQUENCY TELEGRAPH SYSTEMS USING AMPLITUDE MODULATION

(former C.C.I.T. Recommendation B.43, Arnhem, 1953, amended at New Delhi, 1960)

It is suggested to use a pilot channel to give an alarm in the case of an abnormal drop in the receiving level of the telephone bearer circuit in amplitude-modulation systems.

Service channels could have been used as pilot channels for this alarm signal, but since there is not always a service channel in each v.f. group, it is suggested that channels be chosen for the alarm signal.

For these reasons, the C.C.I.T.T. *unanimously declares the view*

1. that it is advisable to use a pilot channel to give the alarm in the case of an abnormal drop in the receiving level of the bearer circuit carrying an amplitude-modulated voice-frequency telegraph system;

2. that the level at which the alarm should work should be fixed by the administration at the receiving end;

3. that the pilot channel should be on frequency 300 Hz, transmitted with a power level corresponding to that of a frequency-modulated channel in accordance with Table 1 of Recommendation R.35;

4. that, if such an arrangement cannot be adopted, the administrations concerned should agree on the use of one of the standardized frequencies for the pilot channel used for alarm purposes.

Note. — The case of frequency-modulated systems is dealt with in Recommendation R.35, point 12.

RECOMMENDATION R.79

AUTOMATIC TESTS OF TRANSMISSION QUALITY ON TELEGRAPH CIRCUITS BETWEEN SWITCHING CENTRES

(Mar del Plata, 1968)

Purpose of automatic tests

1. A maintenance measurement on a telegraph circuit made in the course of routine maintenance measurements takes a relatively long time to carry out and occupies staff at both ends of the circuit. This applies as much to circuits in a satisfactory condition (the majority of cases) as to faulty circuits.

The purpose of automatic testing is to make it possible to perform rapid tests; circuits found to be "satisfactory" in the course of these will not be subjected to full maintenance tests and the maintenance staff can thus concentrate on making full tests of circuits identified as " doubtful " during the rapid tests.

2. Automatic tests should be organized in such a way that at one end at least of the group of circuits under test, no staff is required. This end of the circuit will then be said to be "in the passive position", while the end initiating the tests will be said to be "in the active position " [1].

Circuits tested

3. It must be possible for the end of the circuit in the active position to be connected up automatically with the automatic testing equipment at the passive end. Rapid automatic tests should therefore only be envisaged over circuits connected at the incoming end to an automatic circuit switching centre, i.e. on circuits of the telex and gentex networks.

4. For practical reasons, which will be explained later, tests are limited to circuits connecting two international switching centres; no tests are envisaged for the time being on chains of circuits set up through a transit switching centre.

5. If a trunk circuit system between two centres A and B is divided into groups of circuits made up, say, of a group of circuits used specially for traffic from A to B, a group of circuits used specially for traffic from B to A and a group of both-way circuits, station A can be in the active position only for the both-way circuits and the circuits used specially for traffic from A to B; and, vice versa, station B will be active for tests concerned with traffic from B to A and may also be active on both-way circuits. Both-way circuits will therefore be tested twice as often as specialized circuits.

6. Separate tests must be made in each direction of transmission of the circuit being tested, since, if tests are made in the two directions in tandem, an inadmissible bias distortion on the forward path can be masked by a bias distortion of opposite direction on the backward path.

Test station equipment

7. An automatic measurement station will consist of two main groups of equipment:

a) a transmission unit consisting of a text transmitter TT and a distortion monitor CD. The distortion monitor will be adjusted to a particular degree of distortion, called the decision level, in such a way that if the latter value is exceeded in the signals received during the measurement, the transmission channel being tested will be classified as " doubtful " otherwise it will be classified as " satisfactory ". (To allow for very occasional distortion of a fortuitous nature, a channel will only be classified " doubtful " if the decision level is exceeded *twice* during the measurement.)

[1] Unless stated otherwise, the end of the circuit in the active position will be denoted by the letter A and the end of the circuit in the passive position by the letter B throughout this recommendation.

b) a switching unit for access operations: selection and signalling on the A-to-B circuit to be operated in accordance with the characteristics of switching centre B, checking at station A the call-connected signal originating at station B; receiving the call, transmitting the call-connected signal and the identification signals when the station is in the passive position.

Test text: decision levels and decision signals

8. The text chosen for the tests is given in Recommendation R.51, i.e. the Q9S text emitted in the start-stop mode, with a " stop " element lasting at least 1.4 unit intervals.

9. The choice of the decision level is complicated by the fact that, while most international telex or gentex circuits are made up of a single voice-frequency telegraphy channel, there are also links in which these circuits consist of two voice-frequency telegraphy channels in tandem; international circuits consisting of three inter-connected voice-frequency telegraphy channels in tandem are very rare and can be ignored so far as the organization of automatic maintenance tests is concerned (which means that these circuits cannot be subjected to automatic maintenance tests).

C.C.I.T.T. Recommendations R.57 and R.58 specify the following values for the limit of inherent start-stop distortion on standardized texts:

a) 8% for a switched network circuit consisting of a single voice-frequency telegraphy channel.

b) 13% for a switched network circuit consisting of two voice-frequency telegraphy channels.

Two decision levels are recommended, one corresponding to a above and the other to b. Since automatic measurements are more stringent than measurements made on an oscilloscope by an operator, who might fail to notice a brief peaking in the degree of distortion, and since automatic tests are meant to detect genuinely doubtful circuits, it is recommended that the following decision levels should be adopted:

10% for a)

14% for b).

10. However, on certain circuits set up in modern multi-channel voice-frequency telegraphy systems, the degrees of distortion normally prescribed can be less than the limits specified in Recommendations R.57 and R.58. A test carried out with decision levels of 10% (or 14%) could indicate that a circuit is " satisfactory " whereas in fact it is " doubtful ". In such circuits, measurements may be made with artificial distortion of the signals; the equipment of the text transmitter should include an AR device that introduces an adjustable artificial degree of distortion on the signals transmitted on the forward path; in the active station the decision level in the distortion monitor CD situated on the backward path would then be reduced by the same value as that introduced in the transmission of the signals on the forward path.

This device can be used to make more precise tests with the automatic testing device if this should prove to be necessary.

11. Distortion tests in both directions of transmission should be carried out simultaneously as soon as possible.

12. The test check results made at the passive station will be sent to the active station by means of the following decision signals:

— combination 20 of alphabet No. 2 (letter T) for an affirmative reply (satisfactory channel AB of the circuit);

— combination 22 of alphabet No. 2 (letter V) for a negative reply (doubtful channel AB of the circuit).

Method of access

13. The circuits to be tested will be seized at the output of the switching equipment of A; a seized circuit will be marked " busy " at switching unit A (and at switching equipment B in the case of a both-way circuit).

Station A will call test station B on the circuit seized for the tests in accordance with the selection and signalling system applicable to A-to-B circuits (indications given by country B).

14. In choosing between measurements with a decision level of 10% and measurements with a decision level of 14%, the simplest procedure is to give a station two access codes, one for access to the 10% measuring equipment and the other for access to the 14% measuring equipment.

These access codes must be as short as possible and they should if possible be chosen from among the service position numbers; the codes for access to the distortion monitor should if possible be the same for the telex circuit tests and the same for the gentex circuit tests.

15. Safeguards against seizure of test stations by telex subscribers are recommended.

It is also recommended that calls made in connection with automatic tests should not be recorded by the traffic meters operating on the international circuits.

It would be useful if the outgoing access could be so arranged as to include the supervisory and other elements normally associated with the trunk circuits used for calls to make sure that these elements are not subject to faults liable to have an adverse effect on transmission.

It is considered that normal switching equipment should be used to permit access to the testing equipment at the incoming end of the circuits. This will obviate the need for special access equipment and enable normal signalling functions to be tested in addition to transmission performance.

16. The identification of the station obtained should be checked and test stations should have an answer-back code consisting of:

— one or two letters representing the telex network identification code of the country of the station,

— the letters MAT,

— the figures 10 or 14 depending on whether equipment with a 10% or a 14% decision-level adjustment is involved.

Depending on the characteristics of network B, transmission of the answer-back code will be initiated directly by the incoming call or by automatic command sent by A.

17. After the actual call-connected signal, calling station A will (after sending the " who are you " code if necessary) receive one, two or three blocks of signals sent by network B: identification block, date and hour block, " Who are you " block. The number of blocks depends on the characteristics of network B. Station A should be able to recognize from the circuit to be tested how many blocks it must receive before being able to start the tests.

Test procedure

18. The transmission tests will be carried out with six cycles of Q9S signals; if use is made of predistortion at the active station, the tests on the forward path will be made with three early and three late distortion cycles.

19. After identification of the blocks of signals following reception of the call-connected signal, the active equipment sends the cycles of test signals; on reception of the first of these signals, the passive station begins sending the test cycles. The passive station sends the decision signal after receiving and checking the test signals received and following the transmission of the test signals to the active station. On receiving signal V or T, the active station sends the clearing signal.

20. The automatic tests should take place in a slack period. To prevent collision between two international centres A trying to seize the same passive station B at the same time, an automatic testing schedule should be established by the administrations concerned to enable administrations to have access to a particular passive station one after the other.

21. To make sure that circuits that are busy when due to be tested are not overlooked during automatic testing, the administrations concerned shall agree on when new attempts should be carried out on these circuits.

The C.C.I.T.T. therefore *declares the view that:*

1. Administrations (or recognized private operating agencies) may organize between international switching and testing centres (I.S.T.C.) an automatic maintenance test service for testing the international trunk circuits of telex and gentex networks with automatic switching consisting of one or two multi-channel voice-frequency telegraph links.

2. The tests shall consist of measurements of the degree of gross start-stop distortion made independently in each direction of transmission of the trunk circuit with the test text of Recommendation R.51 (the Q9S text):

letters—S—carriage return—line feed—Q—figures—space—9,

the duration of the stop element of each combination being at least equal to 1.4 unit intervals.

This will normally be transmitted with zero distortion (see also section 12 hereinafter).

3. The tests shall check that, on each transmission channel of the circuit, the degree of gross start-stop distortion measured does not exceed a level called the " decision level ", which is established at:

10% if the channel consists of a single voice-frequency telegraph channel;

14% if the channel consists of two voice-frequency telegraph channels in tandem.

The tolerance for the degree of gross start-stop distortion at the transmission end shall be 0.5% and the tolerance for the decision level shall be ± 0.5%.

A circuit shall be considered doubtful in the rapid tests if the degree of distortion measured on each transmission channel has more than once exceeded the appropriate decision level; otherwise it shall be considered satisfactory.

4. Each test station shall have two access codes, one for access to measurements with a decision level of 10% and another if necessary for access to measurements with a decision level of 14%. These access codes shall be as short as the switching equipment to which the testing station is connected will permit.

5. Each station shall have two identification groups as follows:

a) letters—carriage return—line feed—one or two letters representing the telex network identification code for the country—space—MAT—figures—10 to identify 10% decision-level equipment;

b) as above, but with 14 instead of 10 to identify 14% decision-level equipment.

For networks which have to send an answer-back signal in accordance with Recommendation S.6, the requisite additional signals " letters " will be added.

6. In an I.S.T.C. a station is normally in the passive condition; in this condition it can be seized by an incoming call for automatic tests and can participate in these tests without the intervention of an operator.

If it wishes to initiate automatic tests on an AB circuit (i.e. one permitting a call from centre A to centre B), station A:

i) goes into the active position,

ii) checks that the AB circuit to be tested is not being used for a call, and if it is free, seizes this circuit on the outgoing side of switching equipment A. This seizure of the AB circuit marks the latter as busy at switching centre A,

iii) calls the automatic testing station B in accordance with the selection and signalling system to be used on circuit AB.

7. As soon as station B, in the passive position, is seized by the call, it sends the call-connected signal. If appropriate this will be automatically followed by its identification code (or, alternatively, station A will obtain this by sending the " who are you " signal) and then by " stop " polarity. While this signal is being sent station B connects its text transmitter to channel BA.

Station A will receive the call-connected signal and the identification code; as some B networks also send automatically a sequence of date and hour signals and the " Who are you " sequence, station A must know, depending on the circuit seized, whether it is to receive one, two or three blocks of signals at the beginning of the call; it will check whether the number of blocks received after the call-connected signal corresponds to the number of blocks to be received.

8. Station A will then send, 500 ms (± 20%) after the last character of the last block has been received, six cycles of Q9S signals.

9. As soon as it receives the first Q9S signals, station B shall begin to transmit six cycles of Q9S signals on the BA channel.

10. The distortion monitor of station B will check whether or not the degree of distortion on the text signals received at B has more than once exceeded the decision level. If it has not, station B will send the signal T of start-stop code No. 2 over channel BA. If it has, station B will send signal V of start-stop code No. 2 over the BA channel. 500 ms (± 20%) shall elapse between the end of the reception at B of the last Q9S cycle and the beginning of decision signal V or T.

The distortion monitor of station A will check whether the degree of distortion of the test signals received at A exceeds the decision level more than once. The decision will be indicated locally at A.

11. After receiving signal V or signal T, station A will send the clearing signal to B.

Any call set up for the automatic testing of a circuit shall be automatically cleared if it lasts longer than 30 s.

12. Administrations may, if they wish, make use of automatic maintenance testing equipment for finer distortion measurements. For this purpose, they may, with a station in the active position, artificially predistort the signals sent (transmission distortion). The decision level in the distortion monitor of the active station will be reduced by the value of this predistortion.

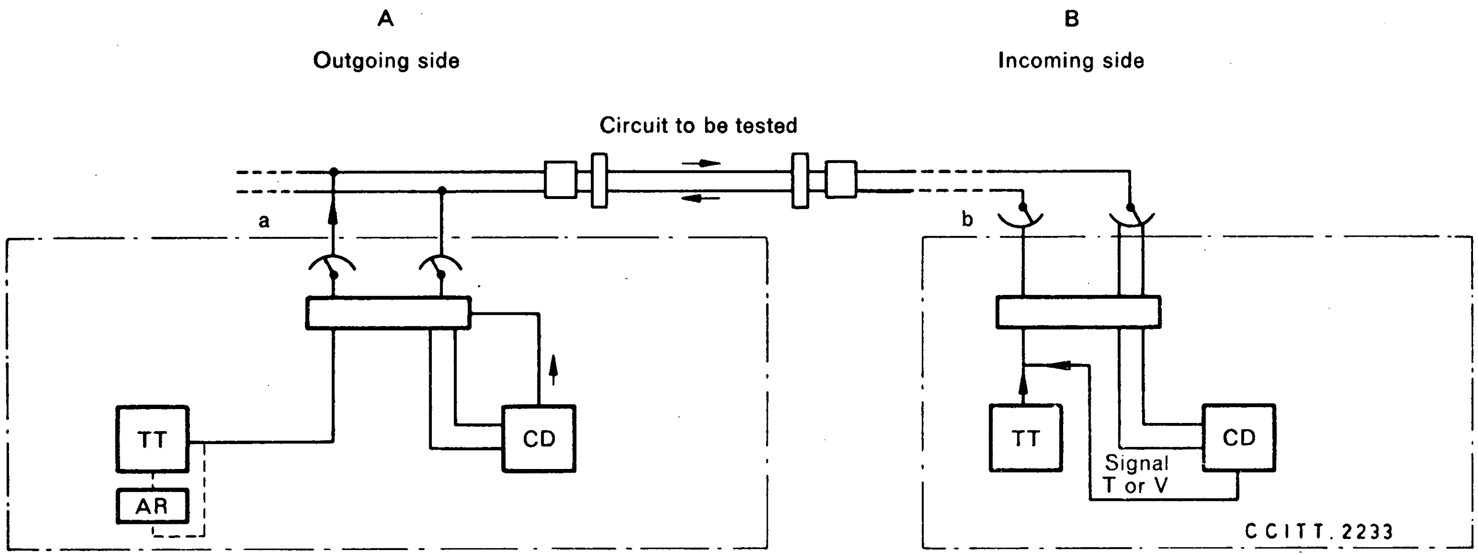
The station in the passive position will not have to intervene.

In a test of this sort, the sending of the test text by the A station will be effected in three Q9S cycles with early transmission distortion followed by three Q9S cycles with late transmission distortion.

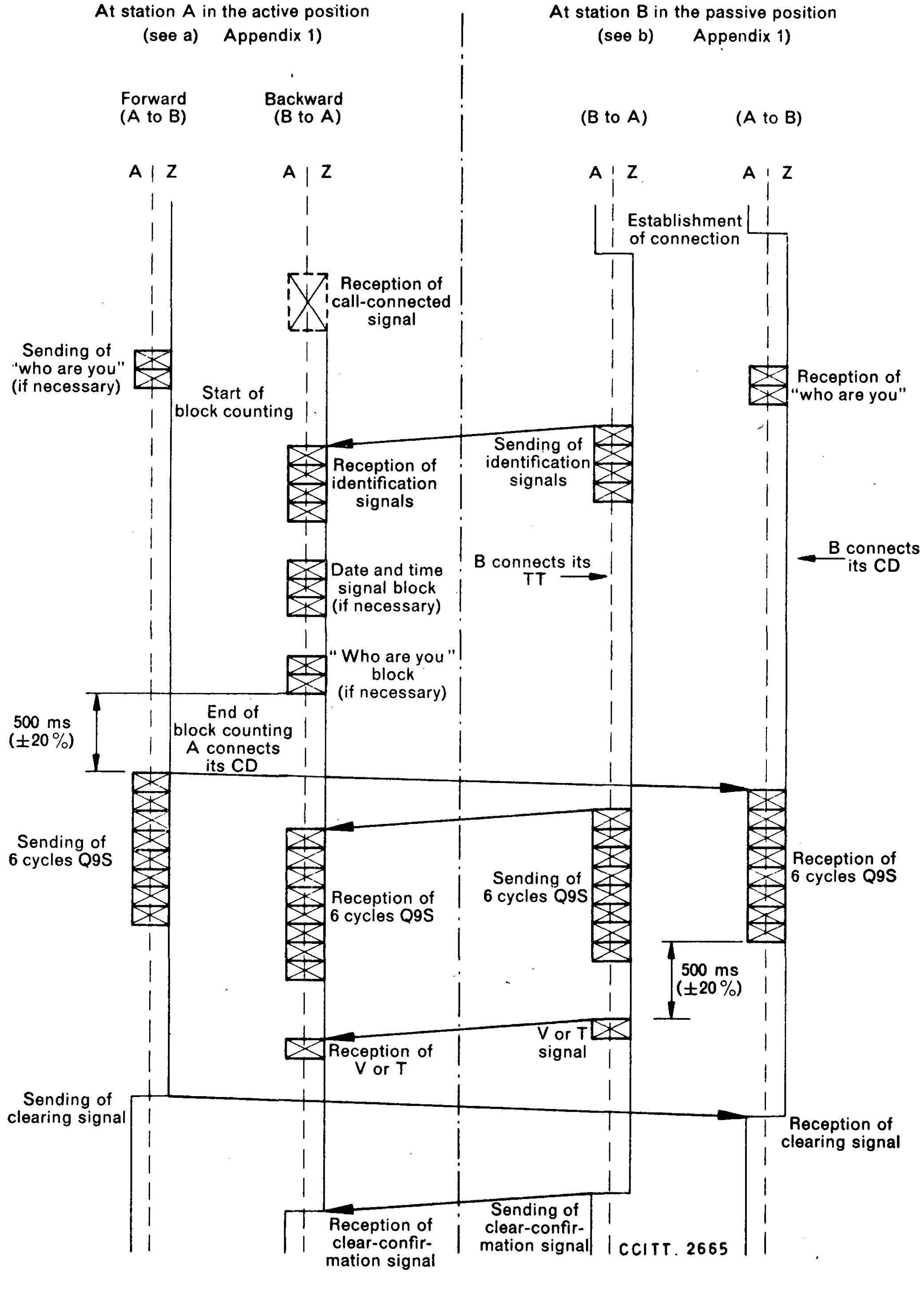
(This Recommendation is the subject of further study: see Question 11/X.)

Note. — Appendix 1 shows a block diagram of the equipment. Appendix 2 contains a time diagram for one test.

Appendix 1 — Automatic control of transmission quality on telegraph circuits



Appendix 2 — Time diagram for automatic maintenance test



RECOMMENDATION R.80

CAUSES OF DISTURBANCES TO SIGNALS IN V.F. TELEGRAPH CHANNELS AND THEIR EFFECT ON TELEGRAPH DISTORTION

(former C.C.I.T. Recommendation B.41, 1951, amended at Arnhem, 1953, and at Geneva, 1956 and 1964)

The C.C.I.T.T.,

considering

that the great majority of international telegraph circuits are routed on v.f. telegraph channels;

that v.f. telegraph channels are liable to disturbance from the following causes:

1. Variations in the voltage and frequency of the source of telegraph carrier frequency due to variations in the power supply, and variations in the signalling load in the case where the carrier source supplies several channels;
2. Abrupt or gradual changes in the transmission equivalent of the telephone circuit;
3. Intelligible crosstalk from other telephone circuits, particularly near-end crosstalk;
4. Unintelligible crosstalk resulting from the cross-modulation of telephone circuits when operated by carrier currents;
5. Noise induced from electrical power and traction systems;
6. Telegraph crosstalk from other telegraph channels, e.g.,
   a) production of odd harmonics of the telegraph carrier frequencies in certain channels falling within the pass-band of other channels;
   b) intermodulation in filter coils, etc.;
7. Variations of power supplies affecting the amplifier and detector of the v.f. telegraph channel and sometimes the receiving relay;
8. The effects of mechanical vibration upon valves (microphonocity) and relays;
9. Bad contacts (e.g. test points and valve bases) and badly soldered joints;
10. Deterioration of component parts, e.g. ageing valves;
11. Failure of power supplies, e.g. on changeover from main to reserve supply;
12. Accidental disconnections made during the course of maintenance and construction works;
13. On overhead lines, effects of atmospheric electricity, frost, etc.;

that the disturbances account for practically all the distortion in telegraph channels, except for characteristic distortion (which is chiefly a function of filter and amplifier-detector design), some bias (due to misadjustment of controls and relays, etc.) and, in the case of the lower frequency channels, the distortion which arises from the low ratio of carrier frequency to signalling frequency;

that many of the causes of disturbance are individually negligible and the more important of the others have been found, in the experience of several administrations, to be capable of elimination by careful maintenance both on the v.f. telegraph equipment and at all points on the telephone circuit;

that the C.C.I.T.T. is also studying the causes of disturbance in telephone circuits and the precautions to be taken to minimize their occurrence;

that the results of the C.C.I.T.T. study will be of great importance to telegraphy;

that, as a result of the considerable investigations already made by certain administrations on the causes of disturbances in telephone and telegraph circuits, the relative order of importance of these causes appears to be approximately as follows:

a) *in the case of telephone circuits:*

high resistance and unsoldered connections;
noisy and microphonic valves, and poor contact between valve pins and valve holders;
working parties engaged on cable operations;
noisy and high-resistance U-links;
changes in line level not compensated at the detector input;
crosstalk;
errors in setting up, for example incorrect equalization, line transformers incorrectly connected, faulty components;

b) *in the case of v.f. telegraph equipment:*

high resistance and unsoldered connections;
valves deteriorated beyond permissible limits;
bad contacts;
faults on power changeover equipment;
frequency error of the carrier supply,

unanimously declares the view

that it is desirable for administrations to undertake investigations of the causes, and frequency of occurrence of disturbances on v.f. telegraph channels routed on the various types of telephone circuit likely to be employed for international telegraph circuits;

that in doing these tests and in order that the results may be of the greatest use to telegraphy and telephony, the incidence of disturbances should be measured according to their duration as follows:

a)	Lasting	less than	1 millisecond		
b)	"	between	1 and	5 milliseconds	
c)	"	"	5 and	10	"
d)	"	"	10 and	20	"
e)	"	"	20 and	100	"
f)	"	"	100 and	300	"
g)	"	more than 300 milliseconds			

that the results should be classified according to the type of telephone circuit, viz. audio or carrier, cable or overhead line.

Measurements of disturbances should be made at the direct current output of the voice-frequency telegraph channel which is under observation.

RECOMMENDATION R.81

MAXIMUM ACCEPTABLE LIMIT FOR THE DURATION OF INTERRUPTION OF TELEGRAPH CHANNELS ARISING FROM FAILURE OF THE NORMAL POWER SUPPLIES

(former C.C.I.T. Recommendation B.40, 1951)

The C.C.I.T.T.,

considering

that in switched telegraph networks an interruption of 0.3 second of the telegraph current would be translated into a release of switches, and that the relays controlling the release are arranged to operate in slightly less than 0.3 second,

unanimously declares the view

that it is desirable that no interruption of the telegraph current should occur as a result of failure of a normal power supply.

If, however, it is impracticable to avoid an interruption, then its duration should in no case exceed 0.15 second.

RECOMMENDATION R.82

APPEARANCE OF FALSE CALLING AND CLEARING SIGNALS IN CIRCUITS OPERATED BY SWITCHED TELEPRINTER SERVICES

(former C.C.I.T. Recommendation B.42, 1951, amended at Arnhem, 1953, and at Geneva, 1964)

The C.C.I.T.T.,

in view of Recommendation R.80, on the causes of disturbances affecting signals in telegraph channels, and their effect on the distortion of telegraph signals;

considering

that precautions should be taken with circuits used in switched teleprinter services to prevent the appearance of parasitic signals which would give rise to false calling and clearing signals;

that special monitoring or indicating devices should be provided on voice-frequency telegraph systems, the channels of which are used for international switched circuits;

that special steps might well be taken to discover the causes of false signals due to transient changes in transmission level or momentary increases in noise level, on voice-frequency telegraph circuits;

that it would be desirable to draw up operating standards in this connection,

unanimously declares the view

that the following precautions should be taken to avoid false calling and clearing signals:

— the security and stability of power supplies and of sources of carrier frequencies, both telegraph and telephone, should be ensured;

— a characteristic marking should be used to denote telegraph and telephone circuits used for the operation of switched teleprinter circuits, both in terminal and intermediate stations;

— precise instructions should be given to staff in order that false entry into the above-mentioned circuits may be avoided;

— the number of non-soldered connections should be reduced as much as possible, together with the number of break points; unsoldered connections, e.g. U links and screw terminals, etc., should be checked with particular care. In this connection, attention is drawn to the methods of inspection by vibration tests;

— the amplitude of level variations of telegraph circuits used for voice-frequency telegraphy should be limited, and abrupt variations in the level should be studiously avoided;

— limit the crosstalk mentioned in Recommendation R.80;

— limit induced voltage caused by electric power of traction system;

— limit the microphonicity of valves in repeaters and of valves used in voice-frequency telegraphy;

— reduce the sensitivity of voice-frequency modulators to disturbing signals;

— avoid, in switched teleprinter services, the use of supervision signals having a short duration in relation to the transitory phenomena due to filters and time-constants in the level-regulators of voice-frequency telegraph systems.

These precautions, inasmuch as they concern telephone circuits used for voice-frequency telegraphy, must be taken simultaneously on normal and reserve circuits.

For the permanent monitoring of voice-frequency telegraph systems the channels of which are used for international switched circuits, it is advisable to use a pilot channel. An alarm should be given to indicate when either the system or the pilot channel is out of order (see Recommendation R.78).

It would be advisable to record the transmission level, in order to discover and localize the causes of the false signals on circuits behaving particularly badly;

It is not yet possible to lay down operating standards in this connection.

RECOMMENDATION R.83

CHANGES OF LEVEL AND INTERRUPTIONS IN VOICE-FREQUENCY TELEGRAPH CHANNELS

(former C.C.I.T. Recommendation B.53, Geneva, 1956, amended at Geneva, 1964)

The C.C.I.T.T.,

considering

1. that an alarming situation for the telegraph service has been created by interruptions on voice-frequency telegraph channels, and by changes of level which have the same effect as interruptions;

2. that the consequences are such that, at present, the error rate which is attributed to voice-frequency telegraph channels is still very far above the tolerable limit fixed by considerations of operational requirements (3 in 100 000 for international communications, including apparatus [1]);

3. that certain administrations have observed an improvement in the situation, and that this improvement seems to result from the measures taken by the telephone services, for instance, systematic percussion tests, precautions in the switching of power supplies, etc.;

4. that it has been confirmed that the number of interruptions is much increased during the normal hours when maintenance staff are present, and is reduced when, despite very heavy traffic, maintenance is suspended, so that the telegraph administrations are now convinced that one of the principal causes of interruptions on telegraph channels is intervention by maintenance personnel and perhaps by operating personnel;

5. that it has also been observed that the number of interruptions appears greater on international circuits than on national circuits,

unanimously declares the view

that the drive against interruptions should be continued vigorously and that, in order to observe the progress of this drive, administrations should continue to make systematic observations of the frequency and duration of interruptions on voice-frequency telegraph channels;

and draws the attention

of the maintenance Study Group of the C.C.I.T.T. especially to the study of practica measures to remedy the situation.

[1] The result is that the error rate due to interruptions and noise on telephone circuits carrying telegraph systems should not exceed 1 per 100 000. (See Recommendation R.54.)

RECOMMENDATION R.90

ORGANIZATION FOR LOCATING AND CLEARING FAULTS IN INTERNATIONAL TELEGRAPH SWITCHED NETWORKS

(former C.C.I.T. Recommendation B.55, Geneva, 1956, amended at New Delhi, 1960)

The C.C.I.T.T.,

considering

that it is desirable that faults affecting communication between stations on international switching networks (e.g. telex and gentex service) should be reported and cleared as quickly as possible;

that it is necessary to unify the essential action to be taken and methods to be employed for locating and clearing faults;

that, for this purpose, it is necessary to determine the essential testing equipment which is to be provided at the switching centres responsible for locating and clearing faults,

unanimously declares the view

1. that it is necessary to set up switching and testing centres (S.T.C.s) as defined by the following:

switching centres equipped with measuring apparatus for testing telex subscribers' and public station lines and equipment and also telegraph channels;

2. that each telex subscriber and each public station in the general switching service should have access to an S.T.C. for the purpose of reporting faults and co-operating in tests;

3. that the international switching and testing centres (I.S.T.C.s) are the S.T.C.s which are also international line-head offices;

4. that all S.T.C.s should be subscribers to the telex network, both for the purpose of receiving fault reports and for communication for maintenance purposes. They should also be provided with a telephone exchange line. The telex and telephone numbers should be furnished to the Secretariat of the C.C.I.T.T. and any subsequent changes should be similarly advised. The Secretariat should have a complete list published and arrange for the issue of amendments thereto at regular intervals. The list should indicate the I.S.T.C.s;

5. that each S.T.C. should be responsible for co-ordinating action in locating and clearing faults on all station lines connected to the exchange and on all trunk circuits for which it is nominated as the controlling office. It should also co-operate with other S.T.C.s in locating faults on connections established through two or more exchanges.

It should carry out a preliminary location of faults by finding out whether they affect channels, switching gear or apparatus. The faults are then accurately located by the engineers responsible for each part of the circuit and the S.T.C. co-operates with them for this purpose: it may assume the direction of the fault-locating procedure should there be disagreement between these services.

Internationally, it is responsible to the S.T.C.s of other countries with which it has telex connections.

The organization of the liaison between the S.T.C. and the different technical services is shown in the following diagram (Figure 1).

The S.T.C.s must check that the performance given by the equipment involved in the switching service, i.e. v.f. channels, switching equipment and apparatus, is satisfactory;

6. that the staff employed at S.T.C.s should be selected with a view to avoiding language difficulties and should be conversant with all types of telegraph equipment used in the switching network, i.e. automatic or manual switching equipment, v.f. telegraph equipment, telegraph machines and regenerative repeaters. The staff need not necessarily

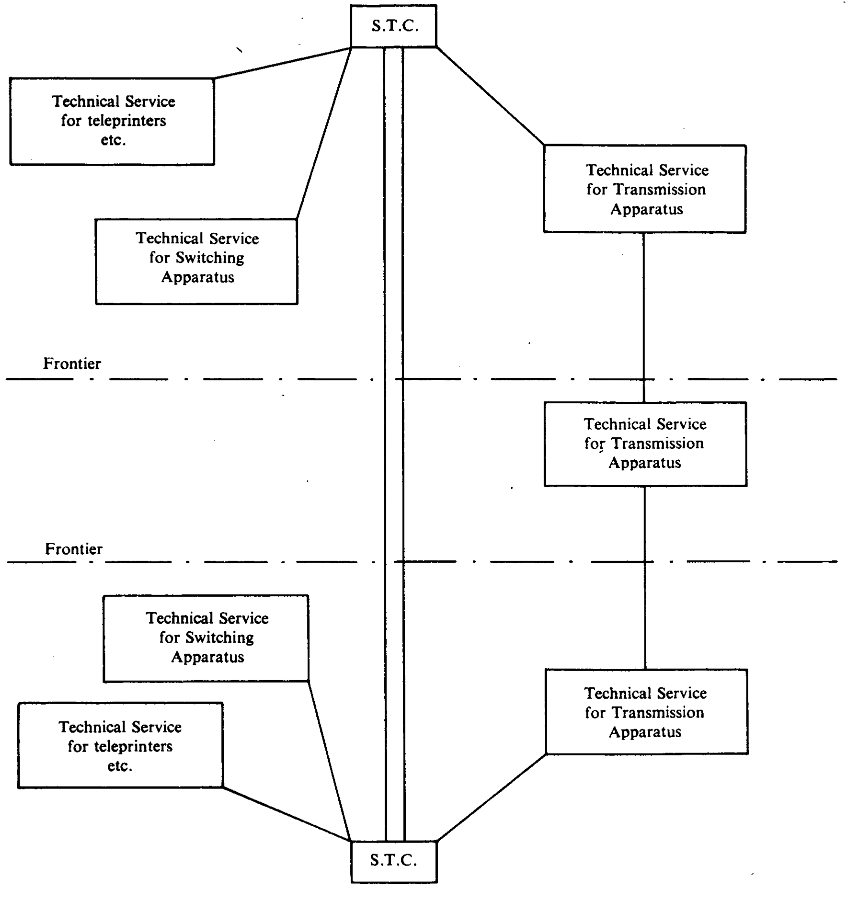


FIGURE 1

be fully competent to maintain all these items of equipment, but should have sufficient knowledge of them to be able to form an appreciation of the effect that faults on any of them may have on a switched connection. In addition, the staff of I.S.T.C.s should have some general knowledge of the types of equipment used in the countries to which they are connected, particularly of the signalling conditions which will be encountered;

7. that each S.T.C. should be provided with the following measuring equipment:

a) A 50-baud start-stop distortion meter;

b) A test transmitter for generating undistorted 50-baud start-stop signals;

c) Apparatus to measure the modulation rate of teleprinters at a distance;

d) Apparatus for measuring the speed and pulse ratio of dials, where appropriate;

e) Apparatus for measurement of the condition of direct current lines; for example, continuity, resistance, insulation.

The arrangements for access to established connections for making test measurements should be such as not to cause interruption or reduce the quality of transmission.

Considering that some administrations have found it desirable to have available at the S.T.C. other items of apparatus to expedite the clearing of faults, all administrations are invited to consider the utility of these devices, namely:

f) Apparatus for measuring teleprinter margin;

g) Recording distortion meters for testing established connections;

h) Apparatus for measuring continuously, periodically and automatically, the distortion on subscribers' lines and apparatus;

8. that the following procedure for reporting, locating and clearing faults should be adopted: faults should be reported to the S.T.C. concerned by the subscribers or operators who have experienced difficulty in operation. In the same way, it would be useful, in order to give the S.T.C.s a full picture of the situation, that the maintenance engineers should inform them of faults noted during the periodic maintenance operations Faults should preferably be signalled by teleprinter, if their nature does not preclude this procedure.

A reference number should be given by the S.T.C. to the subscriber or service notifying the fault. This number can then be quoted in any subsequent enquiries as to the progress of fault clearance.

On account of the difficulties that may arise in the detection of faults on the international section of a communication (due to lack of knowledge of languages, etc.), care should be taken in each country to see that the national sections of the communication, including subscribers' lines and apparatus, are not involved before approaching the S.T.C. of the corresponding country.

Complete holding of a connection which is reported to be faulty should be avoided.

The S.T.C. notified of a fault should therefore begin by ascertaining that it is not located in the national section of the communication and for this purpose should, if necessary, approach the other S.T.C.s of its country concerned in the circuit. The S.T.C. of the distant country is then advised and, in turn, checks the national section routed over its network. The international section of the communication is not checked until the terminal national sections of telegraph circuit have been definitely exonerated. The S.T.C.s in different countries will communicate with one another, either directly or via their I.S.T.C.s, as determined by the administrations concerned.

If the tests of the two local ends fail to reveal any fault conditions, the S.T.C. should report the fault to its I.S.T.C. which will decide what further action, if any, is necessary. As a rule, isolated fault reports would not justify a test of all trunk circuits on a route, and it would be assumed that the condition giving rise to the fault would be cleared on the next routine adjustment. If, however, several fault reports were received, some of which might have been due to a faulty circuit on a particular route, then a special routine test of all the circuits on the route might be justified.

In general, it is considered that the procedure will be broadly the same for manual, semi-automatic and automatic systems.

9. that the abbreviations annexed below should be used in calls exchanged between services responsible for the maintenance of telegraph equipment.

ANNEX
(to Recommendation R.90)

List of service abbreviations for maintenance of telegraph circuits

No.	Français English	Abréviation Abbreviation
	I. *Service général — General service*	
1	Ici .... Here is	ICI . . .
2	Mauvaise transmission sur .... Bad transmission on	BR TR . . .
3	Veuillez donner numéro de référence Please give reference number	QREF
4	Veuillez indiquer résultat Please report result	QRES
5	Numéro référence .... Reference number is	REF . . .
6	Voici le résultat de l'essai effectué sur .... Here is result of test on	RES . . .
7	Appareil en dérangement Machine faulty	DERA
8	Circuit en dérangement Circuit faulty	DER CCT
9	Equipement de position en dérangement Position equipment faulty	DERPS
10	Dérangement relevé Fault now cleared	DERR
11	Aucun dérangement trouvé No fault found	NDER
12	Veuillez transmettre message d'essai avec .... % de distorsion sur................................. Please send test message with .... % distortion on	TESTD . . . SVP
13	Veuillez mesurer la distorsion sur .... et indiquer le résultat Please measure distortion on...................... and report result	QDIS . . .
14	Appelez-moi dans .... minutes s'il vous plaît Please call me in .... minutes	RAP . . . MNS SVP

No.	Français English	Abréviation Abbreviation
15	Je vous rappellerai dans .... minutes I shall recall you in .... minutes	RAP . . . MNS
16	La distorsion sur .... est de .... % The distortion on............................... is .... %	. . . DIS . . .
17	Vos signaux sont illisibles Your signals are unreadable	ZSU
18	Portez-vous sur circuit nº .... Meet me on circuit No.	MEET . . .
19	Veuillez vérifier l'abonné nº .... Please check subscriber No.	VERX . . .
20	Veuillez vérifier la vitesse .... Please check the speed...............................	VERS
21	Veuillez vérifier la distorsion à l'émission Please check the transmitter distortion	VERED
22	Veuillez vérifier la marge Please check the margin	VERM
23	Ecart de vitesse est de .... % Speed deviation is .... %	DEVS . . .
24	La marge est de .... % The margin is .... %	MAR . . .
25	La distorsion à l'émission est de .... % The transmitter distortion is .... %	EDIS . . .
26	Aucun signal de connexion de .... No call-connected signal from	NCS . . .
27	Aucun signal de confirmation d'appel sur .... No call-confirmation signal on	NCFM . . .
28	Signal d'occupation en permanence de............................... Permanent busy signal from...............................	OCC OCC . . .
29	Signal de prise permanent sur .... Permanent call on	PERC . . .
30	Bloquez s'il vous plaît............................... Please hold...............................	BL . . . SVP
30 *bis*	Je bloque .... Holding	BL
31	Débloquez s'il vous plaît .... Please clear	NBL . . . SVP

No.	Français English	Abréviation Abbreviation
31 *bis*	Je débloque .... Clearing	NBL . . .
32	Je reçois correctement I am receiving correctly	ZOK
33	Dérangement de télégraphie harmonique sur....................... Fault on voice-frequency system	DER VF . . .
34	Les signaux reçus ont une distorsion biaise de........... % (polarité de départ prolongée) The received signals have .... % bias (start polarity prolonged)	ZKWA . . .
34 *bis*	Les signaux reçus ont-ils une distorsion biaise (polarité de départ prolongée) ? Have the received signals a bias distortion (start polarity prolonged) ?	Q DIS A . . .
35	Les signaux reçus ont une distorsion biaise de .... % (polarité d'arrêt prolongée) The received signals have .... % bias (stop polarity prolonged)	ZKWZ . . .
35 *bis*	Les signaux reçus ont-ils une distorsion biaise (polarité d'arrêt prolongée) ? Have the received signals a bias distortion (stop polarity prolonged) ?	Q DIS Z . . .
36	Réduisez la distorsion biaise Reduce the bias	ZYN
37	Recevez-vous mon signal d'appel ? Are you receiving my calling signal ?	QRCS
37 *bis*	Je reçois votre signal d'appel I am receiving your calling signal	CSR
38	Veuillez mettre hors service le circuit n° .... Please take out of service circuit No.	CCT . . . OUT SVP
38 *bis*	J'ai mis hors service le circuit n° .... I have taken out of service circuit No.	CCT . . . OUT
39	Veuillez rétablir le circuit n° .... Please restore circuit No.	CCT . . . IN SVP
39 *bis*	J'ai rétabli le circuit n° .... I have restored circuit No.	CCT . . . IN
40	Je ne reçois pas votre signal de polarité de départ permanent I am not receiving your permanent start polarity signal	N PER A

No.	Français English	Abréviation Abbreviation
41	Je ne reçois pas votre signal de polarité d'arrêt permanent I am not receiving your permanent stop polarity signal	N PER Z
42	Je ne reçois pas votre signal d'invitation à numéroter I am not receiving your proceed-to-select signal	NPS
43	La communication est libérée après la sélection sur le circuit n° .... The connection is released after dialling on circuit No.	CRD ...
44	Veuillez envoyer signaux 1/1 Please send 1:1 signals	SIG 1/1 SVP
45	Veuillez envoyer signaux 2/2 Please send 2:2 signals	SIG 2/2 SVP
46	Signal de départ permanent constaté sur .... Permanent start polarity signal on	PER A
47	Signal d'arrêt permanent constaté sur.............................. Permanent stop polarity signal on..................................	PER Z
48	Veuillez envoyer signal de départ sur .... Please send permanent start polarity signal on......................	PER A SVP
49	Veuillez envoyer signal d'arrêt sur .... Please send permanent stop polarity signal on......................	PER Z SVP
50	Nous ne recevons pas votre indicatif We are not receiving your answer-back code	N IND
51	L'enregistreur ne fonctionne pas Register does not operate	DER REG
52	Votre bande perforée contient des erreurs Your perforated tape is faulty	DER TAPE
53	Bouclez le circuit .... s'il vous plaît Please loop the circuit	LOOP . . . SVP
53 *bis*	J'ai bouclé le circuit .... I have looped circuit..........	LOOP . . .
	II. *Service multiplex — Multiplex service*	
54	A l'émission, votre cycle de répétition contient des erreurs dans le code à 7 moments — Veuillez vérifier la voie n° .... Your repetition cycle transmission contains faults in 7-unit code — Please check channel No.	RQFS
55	Je reçois des erreurs dans le code à 5 moments — Veuillez vérifier la voie n° .... I am receiving errors in 5-unit code — Please check channel No.	RFC

No.	Français English	Abréviation Abbreviation
56	Votre manipulation sur voie .... déréglée; veuillez vérifier Your keying on channel .... is affected; please check	ZYK
57	Passez de téléimprimeur simplex à multiplex Change from single printer to multiplex	ZYM
58	Passez de multiplex à téléimprimeur simplex Change from multiplex to single printer	ZYP
59	Réception mutée sur .... Reception switched over to	RS
60	Emission mutée sur .... Transmission switched over to...............	TRS
61	Enregistrement muté sur .... Storage switched over to	SS . . .
62	Distribution mutée sur.............................. Distribution switched over to	DS . . .
63	Veuillez mettre en phase le système .... Please phase system	PH . . .
64	Ecart de vitesse du distributeur à votre extrémité Deviation of distributor speed at your end	DEVD
65	Déphasage sur système .... Out of phase on tem	OPH . . .
66	Multiplex .... sans protection; veuillez rétablir signal de répétition automatique (ARQ) Multiplex .... unprotected; please re-establish automatic request for repetition (ARQ)	NARQ . . .
67	Veuillez envoyer signal alpha sur la voie multiplex .... Please send alpha signal on multiplex channel	TRAS . . .
68	Veuillez envoyer signal bêta sur la voie multiplex .... Please send beta signal on multiplex channel	TRBS . . .
69	Votre transmetteur envoie ARQ en permanence Your transmitter is sending permanent ARQ	ZYC
70	Je reçois signaux mutilés sur voie multiplex .... Veuillez vérifier votre émission en code à 7 unités I am receiving garbled signals on multiplex channel .... Please check your 7-unit code	RMUT . . .
71	Cessez trafic sur toutes les voies; transmettez des A sur la voie A pour repérage Cease traffic on all channels; send A's on A channel for line-up	ZYA

RECOMMENDATION R.91

LIST OF INTERNATIONAL VOICE-FREQUENCY TELEGRAPH SYSTEMS

(New Delhi, 1960, amended Mar del Plata, 1968)

The C.C.I.T.T. *unanimously declares the view*

1. that the administrations and recognized private operating agencies should inform the C.C.I.T.T. Secretariat, not later than 1 October every year, of the international v.f. telegraph systems with which the terminal installations in their respective countries are equipped. The information for each system should indicate the type of modulation (am or fm), the system capacity, the nominal modulation rate(s), the number of channels in service and the name of the system's control station;

2. that the administrations and recognized private operating agencies should inform the C.C.I.T.T. Secretariat, not later than 1 October every year, of the switching and testing centres (S.T.C.) taking part in the international service, with their telephone and telex call numbers (Recommendation R.90);

3. that the C.C.I.T.T. Secretariat should publish the information assembled in this way in a document entitled " List of international voice-frequency telegraph systems " and send it, upon request, to the administrations and recognized private operating agencies.

SERIES S RECOMMENDATIONS

Alphabetical Telegraph Apparatus

RECOMMENDATION S.1

DEFINITIONS OF THE APPARATUS MARGIN (OR OF THE LOCAL END WITH ITS TERMINATION)

(former C.C.I.T. Recommendations C.1 and C.2, amended at New Delhi, 1960, and at Mar del Plata, 1968)

The C.C.I.T.T. *unanimously declares the view*

that it is advisable to adopt the following definitions:

1. The *margin* of a telegraph apparatus (or the local end with its termination) represents the maximum degree of distortion compatible with a correct translation when the signals are presented to a receiver under the most unfavourable conditions so far as the composition of the signals and of the distortion are concerned.

The maximum degree of distortion which results in incorrect translation applies without special reference to the form of distortion affecting the signals. In other words it is the maximum tolerable value of the most unfavourable distortion causing incorrect translation which determines the value of the margin (Definition 34.03).

2. The *theoretical* margin is that which could be calculated from the construction data of the apparatus, assuming that it is operating under perfect conditions (Definition 34.06 in the List);

3. The *effective* margin of an apparatus considered individually is that which could be measured on the apparatus under actual operating conditions (Definition 34.04 in the List);

4. The *nominal* margin of a type of apparatus represents the minimum value set for the effective margin of these apparatus under standard operating and adjustment conditions for the type (Definition 34.05 in the List);

For start-stop apparatus (or for the local end with its termination):

5. The margin is the maximum degree of *start-stop distortion* of the modulation which it is possible to apply to the apparatus compatible with the correct translation of all

the signals which it should be able to receive, whether the signals composing the modulation are transmitted separately or whether they follow one another with the maximum rapidity corresponding to the modulation rate (Definition 34.07 in the *List*);

6. In particular, it is convenient to consider:
   a) The *net* margin, which is represented by the degree of distortion indicated in 1, when the rate of modulation applied to the apparatus is exactly equal to the standard theoretical rate (Definition 34.031).

   b) The *synchronous* margin, which is represented by the degree of distortion indicated in 5, when the mean unit interval of the modulation applied to the apparatus is equal to that which would result from a transmission from the apparatus under examination, assuming it to include a transmitter as well as a receiver (Definition 34.09 in the List).

7. The margin of a synchronous receiver is the margin, as defined in 1, when the degree of distortion taken into account is the degree of isochronous distortion (Definition 34.091).

RECOMMENDATION S.2

TRANSMITTER DISTORTION OF APPARATUS (OR OF THE LOCAL END WITH ITS TERMINATION)

(New Delhi, 1960)

The C.C.I.T.T. *unanimously declares the view*

that the following definitions be adopted:

1. *Transmitter distortion:* a signal transmitted by an apparatus (or a signal at the output of a local line with its termination) is affected by telegraph distortion when the significant intervals of this signal have not exactly their theoretical durations;

2. The definitions of degree of individual distortion (Definition 33.06 in the List), of degree of isochronous distortion (Definition 33.07), of degree of start-stop distortion (Definition 33.08 in the List), of degree of gross start-stop distortion (Definition 33.09 in the List), of degree of synchronous start-stop distortion (Definition 33.10 in the List), of degree of distortion in service (Definition 33.11 in the List), of conventional degree of distortion (Definition 33.14 in the List), of fortuitous distortion (Definition 33.16 in the List), of bias distortion (Definition 33.17 in the List), of cyclic distortion (Definition 33.18 in the List) are applicable to transmitter distortion.

RECOMMENDATION S.3

CHARACTERISTICS, FROM THE TRANSMISSION POINT OF VIEW, OF THE LOCAL END WITH ITS TERMINATION WHEN A 50-BAUD START-STOP APPARATUS IN ACCORDANCE WITH THE INTERNATIONAL ALPHABET No. 2 IS USED

(former C.C.I.T. Recommendation C.4, amended at New Delhi, 1960, and at Geneva, 1964)

This Recommendation applies—except where otherwise specified (for example, the case of regenerative repeaters which is covered by Recommendations R.60 and R.61)—to start-stop apparatus, in the wide sense of the term as defined in 34.14 of the *List of definitions*, Part I, and that it covers also reperforators, service signals sent by the switching equipments, the signals of answer-back units, automatic transmitters, etc.

Some apparatus (apparatus for single current working, for instance) cannot be separated during operation from their supply and repeater devices; hence the measurements under operating conditions must apply to the *local end with its termination* (in French: *ensemble terminal*) defined as follows:

The whole of the apparatus, lines, telegraph repeaters and any control units between the apparatus and the first (or last) point of the connection where the quality of transmission can be measured.

The characteristics laid down below are those which should be evident in service conditions on the local ends with their terminations which are likely to be connected to the international network. It should be noted, however, that they apply to such local ends with their terminations only if the influence of the line in the local end produces negligible distortion.

The C.C.I.T.T. *unanimously declares the view:*

Characteristics of apparatus

1. The nominal modulation rate should be 50 bauds;

2. The difference between the real mean modulation rate of the signals when in service and the nominal rate should not exceed $\pm$ 0.75%;

3. The nominal duration of the transmitting cycle should be at least 7.4 units (preferably 7.5), the stop element lasting for at least 1.4 unit (preferably 1.5);

4. The receiver must be able to translate correctly in service the signals coming from a transmitter with a nominal transmitting cycle of 7 units; this is to accommodate the shortest signal which may be emitted by, for example, a regenerative repeater (see Recommendation R.60);

Transmitter characteristics of a local end with its termination

5. The degree of gross start-stop distortion of transmitted signals, measured at the output of the local end with its termination, must not exceed 10%. This value applies to all working conditions of the apparatus under consideration encountered during normal service, whether the signals are transmitted separately or whether they succeed one another at the maximum rate compatible with the modulation speed, in service.

It is recommended that the measurement should be made with a start-stop distortion measuring set for two consecutive periods, each of them corresponding to the transmission of about 300 transitions (i.e. about 15 seconds), early distortion being observed during one period and late distortion during the other;

Receiver characteristics of a local end with its termination

6. The effective net margin measured from the input of the local end with its terminations should not be less than 35% for signals sent by a transmitter having a nominal cycle equal to or greater than 7 units.

It is recommended that the measurement should be made under the following conditions, in service:

- $7^1/_2$-unit cycle for the signals transmitted by the measuring apparatus;
- use of one of the signal trains specified in Recommendation R.52;
- first test with an identical distortion rate on all the transitions of the signal train, obtained by lengthening the start element;
- a second test with the same rate of identical distortion on all the transitions of the signal train, but obtained in this case by shortening the start element;
- reading the margin when less than one error per sentence of the Recommendation R.52 is obtained. (The margin is the lesser of the two values of the degree of distortion obtained from the two measurements.)

Note 1. — It will be up to administrations using some other measuring method to work out for their own use figures to give equivalent results to those which would have been obtained by the recommended method.

Note 2. — Administrations are recommended to withdraw from the international service apparatus not meeting this recommendation. If this cannot be done immediately, then, in view of the special difficulties which are encountered in the regeneration of automatically transmitted 7-unit start-stop signals, it is recommended that urgent attention should be given to the replacement of 7-unit automatic transmitters by 7.5 (or 7.4 minimum) unit automatic transmitters.

RECOMMENDATION S.3 *bis*

CHARACTERISTICS, FROM THE TRANSMISSION POINT OF VIEW, OF THE LOCAL END WITH ITS TERMINATION, WHEN 75-BAUD START-STOP APPARATUS IN ACCORDANCE WITH THE INTERNATIONAL ALPHABET No. 2 IS USED

(Geneva, 1964, amended at Mar del Plata, 1968)

This Recommendation applies—except where otherwise specified (for example, the case of regenerative repeaters which is covered by Recommendations R.60 and R.61)—to start-stop apparatus, in the wide sense of the term as defined in 34.14 of the *List of* *definitions*, Part I, and that it covers also reperforators, service signals sent by the switching equipments, the signals of answer-back units, automatic transmitters, etc.

Some apparatus (apparatus for single current working, for instance) cannot be separated during operation from their supply and repeater devices; hence the measurements under operating conditions must apply to the *local end with its termination* (in French: *ensemble terminal*) defined as follows:

The whole of the apparatus, lines, telegraph repeaters and any control units between the apparatus and the first (or last) point of the connection where the quality of transmission can be measured.

The characteristics laid down below are those which should be evident in service conditions on the local ends with their terminations which are likely to be connected to the international network. It should be noted, however, that they apply to such local ends with their terminations only if the influence of the line in the local end produces negligible distortion.

The C.C.I.T.T.

unanimously declares the view

Characteristics of apparatus:

1. The nominal modulation rate should be 75 bauds.

2. The difference between the mean modulation rate of the signals in service and the nominal modulation rate should not exceed $\pm$ 0.75%.

3. The nominal duration of the transmitting cycle should be at least 7.4 units (preferably 7.5), the stop element lasting for at least 1.4 unit (preferably 1.5). Administrations should not authorize the use of terminal machines with a cycle of less than that value.

4. The receiver must be able to translate correctly in service the signals coming from a transmitter with a nominal transmitting cycle of 7 units; this is to accommodate the shortest signal which may be emitted by, for example, a regenerative repeater (see Recommendation R.60).

Transmitter characteristics of a local end with its termination

5. The degree of gross start-stop distortion of transmitted signals, measured at the output of the local end with its termination, must not exceed 10%.

This value applies to all working conditions of the apparatus under consideration encountered during normal service, whether the signals are transmitted separately or whether they succeed one another at the maximum rate compatible with the modulation speed, in service. It is recommended that the measurement should be made with a start-stop distortion measuring set for two consecutive periods, each of them corresponding to the transmission of about 450 transitions (i.e. about 15 seconds), early distortion being observed during one period and late distortion during the other.

Receiver characteristics of a local end with its termination

6. The effective net margin measured from the input of the local end with its termination should not be less than 35% for signals sent by a transmitter having a nominal cycle equal to or greater than 7 units.

It is recommended that the measurement should be made under the following conditions, in service:

— $7^1/_2$-unit cycle for the signals transmitted by the measuring apparatus;
— use of one of the signal trains specified in Recommendation R.52;
— first test with an identical distortion rate on all the transitions of the signal train, obtained by lengthening the start element;
— a second test with the same rate of identical distortion on all the transitions of the signal train, but obtained in this case by shortening the start element;
— reading the margin when less than one error per sentence of the Recommendation R.52 is obtained. (The margin is the lesser of the two values of the degree of distortion obtained from the two measurements.)

Note. — It will be up to administrations using some other measuring method to work out for their own use figures to give equivalent results to those which would have been obtained by the recommended method.

RECOMMENDATION S.3 *ter*

CHARACTERISTICS, FROM THE TRANSMISSION POINT OF VIEW, OF THE LOCAL END WITH ITS TERMINATION WHEN 100-BAUD START-STOP APPARATUS IN ACCORDANCE WITH THE INTERNATIONAL ALPHABET No. 2 IS USED

(Mar del Plata, 1968)

This Recommendation applies—except where otherwise specified (for example, the case of regenerative repeaters which is covered by Recommendations R.60 and R.61)—to start-stop apparatus, in the wide sense of the term as defined in 34.14 of the *List of definitions*, Part I, and that it covers also reperforators, service signals sent by the switching equipments, the signals of answer-back units, automatic transmitters, etc.

Some apparatus (apparatus for single current working, for instance) cannot be separated during operation from their supply and repeater devices; hence the measurements under operating conditions must apply to the local end with its termination (in French: *ensemble terminal*) defined as follows:

The whole of the apparatus, lines, telegraph repeaters and any control units between the apparatus and the first (or last) point of the connection where the quality of transmission can be measured.

The characteristics laid down below are those which should be evident in service conditions on the local ends with their terminations which are likely to be connected to the international network. It should be noted, however, that they apply to such local ends with their terminations only if the influence of the line in the local end produces negligible distortion.

The C.C.I.T.T.

unanimously declares the view:

Characteristics of apparatus

1. The nominal modulation rate should be 100 bauds.

2. The difference between the mean modulation rate of the signals in service and the nominal modulation rate should not exceed $\pm$ 0.75%.

3. The nominal duration of the transmitting cycle should be at least 7.5 units, the stop element lasting for at least 1.5 unit.

4. The receiver must be able to translate correctly in service the signals coming from a transmitter with a nominal transmitting cycle of 7.2 units. (This is to accommodate the shortest signal which may be emitted by, for example, a regenerative repeater (see Recommendation R.60).)

Transmitter characteristics of a local end with its termination

5. The degree of gross start-stop distortion of transmitted signals, measured at the output of the local end with its termination, must not exceed 10%.

This value applies to all working conditions of the apparatus under consideration encountered during normal service, whether the signals are transmitted separately or whether they succeed one another at the maximum rate compatible with the modulation speed, in service.

It is recommended that the measurement should be made with a start-stop distortion measuring set for two consecutive periods, each of them corresponding to the transmission of about 600 transitions (i.e. about 15 seconds), early distortion being observed during one period and late distortion during the other.

Receiver characteristics of a local end with its termination

6. The effective net margin measured from the input of the local end with its termination should not be less than 30% for signals sent by a transmitter having a nominal cycle equal to or greater than 7.2 units.

It is recommended that the measurement should be made under the following conditions, in service:

- $7^1/_2$ units cycle for the signals transmitted by the measuring apparatus;
- use of one of the signal trains specified in Recommendation R.52;
- first test with an identical distortion rate on all the transitions of the signal train, obtained by lengthening the start element;
- a second test with the same rate of identical distortion on all the transitions of the signal train, but obtained in this case by shortening the start element;
- reading the margin when less than one error per sentence of the Recommendation R.52 is obtained. (The margin is the lesser of the two values of the degree of distortion obtained from the two measurements.)

Note. — It will be for administrations using some other measuring method to work out for their own use figures to give equivalent results to those which would have been obtained by the recommended method.

RECOMMENDATION S.4

USE OF INTERNATIONAL TELEGRAPH ALPHABET No. 2

(former C.C.I.T. Recommendations C.7, C.8 and C.12, modified at New Delhi, 1960, and at Geneva, 1964)

A. *Secondaries of letters F, G, H—combinations Nos. 6, 7 and 8*

Some administrations exercise, whereas others do not, the right granted by the Telegraph Regulations to assign the secondaries of letters F, G and H to internal use and it is desirable to avoid disadvantages which might result from exercising this right in international services.

For these reasons, the C.C.I.T.T.

unanimously declares the view,

1. that the use of secondaries of F, G and H should be prohibited in international services, except by direct agreement between administrations;

2. that, in all services, the secondaries of F, G and H should be shown in some special manner on the keyboard;

3. that services in which these secondaries are not used should place on the secondary position on the printing blocks of the letters F, G and H an arbitrary sign, such, for instance, as a square, the appearance of such sign on the paper to indicate an abnormal impression.

B. *Control symbols for operating the " who are you? "* (secondary of letter D, combination No. 4) *and " alarm "* (secondary of letter J, combination No. 10) *devices*

The C.C.I.T.T.

unanimously declares the view

that such administrations as are desirous of confirming the reception or the transmission of signals " secondary of D " (" who are you? " signal) or " secondary of J " shall effect this confirmation by printing:

the symbol  for the confirmation of the signal " secondary of D ";

the symbol  for the confirmation of the signal " secondary of J ".

C. *Sequences of combinations used for special purposes*

As quoted in Recommendations S.11, U.21, U.22, certain sequences of combinations from international alphabet No. 2 are devoted to special purposes and they should not be used for other purposes when the equipment on such networks introduces special facilities for which these sequences are reserved.

These are:

a) ZCZC start-of-message signal in retransmission systems using perforated tape or equivalent devices;

b) ++++ end-of-telegram signal in retransmission systems using perforated tape or equivalent devices;

c) NNNN end-of-message signal, a switching signal in switching systems using perforated tape or equivalent devices for retransmission; also used for restoring the waiting signal device in accordance with Recommendation U.22;

d) CCCC for switching into circuit, by remote control, a reperforator (or equivalent device);

e) SSSS for switching into circuit data transmission equipment, in accordance with Recommendation V.10;

f) FFFF for switching out of circuit, by remote control, a reperforator (or reperforator device).

Note. — The sequences of secondaries of these combinations—although they are not to be used for the purposes devoted to these sequences—are subject to the same restrictions in use, the equipment having to recognize only the sequence of combinations.

In international services these sequences are:

+:+:	= corresponding to ZCZC	(combinations Nos. 26, 3, 26, 3),
ZZZZ	= corresponding to ++++	(combinations Nos. 26, 26, 26, 26),
,,,,	= corresponding to NNNN	(combinations Nos. 14, 14, 14, 14),
::::	= corresponding to CCCC	(combinations Nos. 3, 3, 3, 3),
''''	= corresponding to SSSS	(combinations Nos. 19, 19, 19, 19).

g) the signal " line feed " (combination No. 28) followed by 4 signals " carriage return " (combination No. 27) for the signal of operator recall on a telex connection made over a radiotelegraph circuit (see Recommendation U.21);

h) HHHH to prevent transmission of the delay signals described in Recommendation U.22, made up from combination No. 32 as described in D below.

D. *Use of combination No. 32*

1. Combination No. 32, repeated at intervals of 1.2 second, can be used as a delay signal to indicate that the error-correcting system is controlling a repetition;

2. Combination No. 32, repeated at intervals of 5 seconds, can be used as a delay signal to indicate that the storage device is not yet empty;

3. The reception of combination No. 32 shall not cause any spacing of the paper on tape-printing or page-printing teleprinters.

Note. — Sections C.g, C.h, etc., D.1 and D.2 apply directly only to start-stop apparatus operating at 50 bauds since this is the modulation rate for telex. However, in the event of suitable synchronous error-correcting systems being used for the interconnection of start-stop circuits that operate at higher modulation rates, similar facilities might be desirable and could be provided by similar means.

ANNEX

(to Recommendations S.4)

Table illustrating the use of various sequences of combinations for special purposes

Purpose of sequence	Sequence recommended in Rec. S.4	Method of operation		
		Message switching (including storage)	Through switching (without message storage)	Point-to-point operation
Start of message	ZCZC	Required in most systems	Could be useful in special cases	Not ordinarily required
Suppression of delay signals	HHHH	Not required (delay signal not envisaged)	Required for some types of message (e.g. cypher) when routed over synchronous error-corrected radiotelegraph channels	Not required on public systems (delay signal not envisaged)
End of telegram	++++ ZZZZ	Could be useful in special cases	Could be useful in special cases	Not ordinarily required
End of message	NNNN	Essential in most systems to separate individual messages at relay centres and to control message switching	Required only when it is necessary positively to re-connect delay signal facility after use of suppression of delay signals facility	Not ordinarily required
Connection of reperforator (or equivalent device)	CCCC	Not normally used (as storage if incorporated in the system); could be used for connection and disconnection of a supplementary storage device	Could be useful for special purposes; requires special equipment at point of reception	Could be useful for special purposes; requires special equipment at point of reception
Disconnection at distance of reperforator (or equivalent device)	FFFF			
Connection of data equipment	SSSS	Not normally used	Used for switching into data transmission equipment in association with telex networks	Could be useful for special purposes

RECOMMENDATION S.5

STANDARDIZATION OF PAGE-PRINTING START-STOP APPARATUS AND CO-OPERATION BETWEEN PAGE-PRINTING AND TAPE-PRINTING START-STOP APPARATUS

(Brussels, 1968, amended at New Delhi, 1960, and at Geneva, 1964)

The C.C.I.T.T.

unanimously declares the view

1. that the number of characters which the line of text of the page-printing apparatus may contain should be fixed at 69;

2. that tape-printing apparatus required to work in co-operation with page-printing apparatus should be equipped with:

a) keys for the transmission of the " carriage return " and " line feed " signals;

b) means to draw the attention of the operator to the need to transmit " carriage return " and " line feed " signals in time to prevent overprinting on the 69th character;

that for controlling the alarm, several signals " figures J ", one signal " carriage return ", one signal " line feed " should be transmitted in the order indicated;

3. that such administrations as are desirous of confirming on a tape machine the reception or transmission of the signals " carriage return " and " line feed " shall effect this confirmation by printing:

a) the symbol $<$ for the signal " carriage return ";

b) the symbol $\equiv$ for the signal " line feed ";

4. that, if the printing of the symbols indicated in paragraph 3 is not desired, the reception of at least one of these signals shall nevertheless cause the paper to move forward. When one only of these signals causes the paper to move forward, the signal should preferably be the " line feed " signal.

RECOMMENDATION S.6

CHARACTERISTICS OF ANSWER-BACK UNITS FOR START-STOP APPARATUS OF THE TELEX SERVICE

(former C.C.I.T. Recommendation C.9, Warsaw, 1936, amended at Brussels, 1948, and at Geneva, 1964)

The C.C.I.T.T.,

considering

that the start-stop apparatus is capable of receiving communications without the help of an operator;

that this advantage may be useful to the subscribers to the international telegraph service operated by start-stop apparatus;

that it is therefore desirable that a calling subscriber should be able to check the identity of his correspondent if there is no reply;

that it may be necessary to check the correct working of the subscriber's line and of the called terminal equipment from an automatic switching unit or from an international telex position,

unanimously declares the view

that it is advisable

1. to supply a code transmitter to all the subscribers' sets taking part in the international telex service;

2. to effect the operation of the code transmitter by combination No. 4 (letter D) in the international telegraph alphabet No. 2, preceded by the signal " figures ";

3. to compose the code-emission by a series of 20 signals, as follows:

1 signal " letters " or " figures ",
1 carriage return,
1 line feed,
16 signals chosen by each administration for the code signal of the subscriber,
1 signal " letters ";

4. when the code signal does not comprise 16 characters, to distribute them by inserting as many " letters " signals as are necessary to make up the total of 16 signals; this would give the calling subscriber the chance of noting clearly the end of the requested code transmission;

5. that the answer-back signals should be 7.5 (minimum 7.4) unit signals sent at the maximum cadence with a modulation rate of 50 bauds and subject to the tolerances specified in Recommendation S.3;

6. that the delay between the beginning of reception of the start unit of combination No. 4, by the apparatus in the " figures " position, and the beginning of the start unit of the first signal of the answer-back sent by this apparatus should lie between 150 and 600 milliseconds.

Note 1. — Points 1, 2, 5 and 6 apply to apparatus of the gentex network.

Note 2. — The C.C.I.T.T. believes:

a) that the start-stop apparatus of the telex service should be designed in the future so that reperforators used for this service should not perforate the " WRU " signal;

b) that the manufacturers should be informed that the answer-back mechanism should preferably be constructed so that the 20 positions of the answer-back code could be freely used for any signal of international alphabet No. 2.

RECOMMENDATION S.6 *bis*

ANSWER-BACK UNITS FOR 75-BAUD START-STOP APPARATUS IN ACCORDANCE WITH INTERNATIONAL ALPHABET No. 2

(Geneva, 1964)

The C.C.I.T.T.,

considering

that start-stop apparatus is capable of receiving communications without the aid of an operator;

that it may be necessary to verify the correct functioning of the line and of the distant terminal equipment,

unanimously declares the view

that if the use of an automatic answer-back unit is requested, it would be advisable:

1. to effect the operation of the code transmitter by the sequence of signals " figures ", D—combinations Nos. 30 and 4—in the international alphabet No. 2;

2. to compose the code-emission by a series of 20 signals, as follows:
   1 signal " letters " or " figures ",
   1 carriage return,
   1 line feed,
   16 signals chosen by each administration for the code signal of the subscriber,
   1 signal " letters ";

3. when the code signal does not comprise 16 characters, to distribute them by inserting as many " letters " signals as are necessary to make up the total of 16 signals; this would give the calling subscriber the chance of noting clearly the end of the requested code transmission;

4. that the answer-back signals should be 7.5 (minimum 7.4) unit signals sent at the maximum cadence with a modulation rate of 75 bauds subject to the tolerances specified in Recommendation S.3 *bis*;

5. that the delay between the reception of the beginning of the start unit of combination No. 4, when the apparatus is in the " figures " condition, and the beginning of the unit of the first signal of the answer back sent by the apparatus should lie between 100 and 600 milliseconds.

Note. — The C.C.I.T.T. believes:

a) that the start-stop apparatus should be so designed in the future that reperforators should not perforate the " WRU "signal;

b) that the manufacturers should be informed that the answer-back mechanism should preferably be so constructed that the 20 positions of the answer-back code could be freely used for any signal of international alphabet No. 2.

RECOMMENDATION S.6 *ter*

ANSWER-BACK UNITS FOR 100-BAUD START-STOP APPARATUS IN ACCORDANCE WITH INTERNATIONAL ALPHABET No. 2

The C.C.I.T.T.,

considering

that start-stop apparatus is capable of receiving communications without the aid of an operator;

that it may be necessary to verify the correct functioning of the line and of the distant, terminal equipment;

unanimously declares the view

that if the use of an automatic answer-back unit is requested, it would be advisable:

1. to effect the operation of the code transmitter by the sequence of signals " figures " D — combinations Nos. 30 and 4 — in the international alphabet No. 2;

2. to compose the code emission by a series of 20 signals, as follows:

   1 CR

   1 LF

   1 " letters " or " figures "

   16 signals chosen for the subscriber

   1 " letters ";

3. when the code signal does not comprise 16 characters, to distribute them by inserting as many " letters " signals as are necessary to make up the total of 16 signals; this would give the calling subscriber the chance of noting clearly the end of the requested code transmission;

4. that the answer-back signals should be 7.5 unit signals sent at the maximum speed with a modulation rate of 100 bauds subject to the tolerances specified in Recommendation S.3 *ter*;

5. that the delay between the reception of the beginning of the start unit of combination 4, when the apparatus is in the " figures " condition, and the beginning of the unit of the first signal of the answer-back sent by the apparatus should lie between 75 and 600 milliseconds.

Note. — The C.C.I.T.T. believes:

a) that the start-stop apparatus should be designed in the future so that reperforators should not perforate the " WRU " signal;

b) that the manufacturers should be informed that the answer-back mechanism should preferably be constructed so that the 20 positions of the answer-back code could be freely used for any signal of international alphabet No. 2.

RECOMMENDATION S.7

CONTROL OF THE MOTORS IN START-STOP TELEPRINTER APPARATUS FOR PUBLIC OR PRIVATE POINT-TO-POINT CIRCUITS

(former C.C.I.T. Recommendation C.13, amended at Arnhem, 1953)

The C.C.I.T.T.,

considering

that, in the case of public and private point-to-point circuits, it is desirable that the teleprinter motors shall be started with the commencement of traffic signalling, and stopped with the cessation of such signalling;

that the general practice on such circuits is to utilize a time-delay device associated with the teleprinter which allows of such operation,

unanimously declares the view

a) that, in the case of public and private point-to-point circuits, the terminal apparatus shall be so equipped as to allow of the starting and stopping of the teleprinter motors with the commencement and completion respectively of the traffic;

b) that these facilities shall normally be provided by means of a time-delay device incorporated in the teleprinter, whereby the teleprinter motor is started immediately upon commencement of the signalling of traffic, and is stopped within a time not less than 45 seconds after the last signal of traffic;

considering

that more strict unification of the delay-time of these automatic devices might give rise to serious technical complications;

that precautions should thus be taken lest an operator, the motor of whose apparatus is still rotating, should transmit signals to an apparatus of which the motor has just stopped,

unanimously declares the view

c) that, in the case of a pause in transmission for a period equal to or longer than 30 seconds, operators or subscribers are recommended to send the signal 29 of alphabet No. 2 (" letter-shift ") and to wait at least 2 seconds after the emission of this signal before recommencing transmission;

considering

that, for reasons associated with the unification of terminal apparatus and for others, certain administrations have expressed a preference for the utilization of a method whereby calling and clearing signals are used, as in the telex service, to effect the starting and stopping of the teleprinter motors,

unanimously declares the view

d) that, notwithstanding b) above, administrations can, if they find it convenient, arrange between themselves to use an alternative method whereby the teleprinter motor is started by the use of a call signal, and stopped by the use of a clearing signal. In such cases the calling and clearing signals employed should conform to those standardized for the telex service, namely Recommendation U.1.

RECOMMENDATION S.8

INTERCONTINENTAL STANDARDIZATION OF THE MODULATION RATE OF START-STOP APPARATUS AND OF THE USE OF THE COMBINATION " SECONDARY OF D "

(former C.C.I.T. Recommendations C.5 and C.11, Arnhem, 1953)

The C.C.I.T.T.,

considering

1. that the standardized modulation rate recommended for start-stop apparatus employed in international (including intercontinental) service is 50 bauds, in accordance with Recommendation S.3;

2. that there are nevertheless certain areas (notably in the U.S.A.) in which a different modulation rate for start-stop apparatus is employed;

3. that, even though it is recognized that universal adoption of a standardized modulation rate would be advantageous in the intercontinental service, it is not possible, at present, to secure universal adoption of a standard;

4. that it is essential to do everything possible to facilitate the establishment of intercontinental services, notwithstanding differences in modulation rates which may exist between the start-stop apparatus employed;

5. that there are in existence methods, employing automatic storage equipment in the circuit, which enable start-stop apparatus having different modulation rates to interwork;

6. that, furthermore, on certain intercontinental circuits, e.g. radio circuits, the employment of special forms of synchronous equipment in association with storage equipment is sometimes essential and is already in use in the intercontinental sections of start-stop circuits,

unanimously declares the view

1. that, when it is necessary in the intercontinental service to operate between start-stop apparatus having a modulation rate of 50 bauds and start-stop apparatus having

non-standard modulation rate, then conversion equipment, for example automatic storage and retransmission equipment, must be inserted in the international circuits concerned in a manner to be agreed bilaterally between the administrations and/or private recognized operating agencies concerned;

considering

that the use of different signs or functions for combination No. 4 in the figure case of the international alphabet No. 2 on start-stop apparatus having to work together in the same system leads to operational difficulties which ultimately amount to rendering the use of this combination impossible;

that the use of this combination to operate the answer-back unit, by allowing the caller to check the connection and the satisfactory working of his correspondent's apparatus, results in a considerable reduction in the time of establishing the communication, thereby facilitating operation of the service,

unanimously declares the view

2. that combination No. 4 (figure case) of the international telegraph alphabet No. 2 should be reserved exclusively, both in international service and in intercontinental service, for operating the answer-back unit;

3. that, in intercontinental service, when apparatus not permitting the use of the answer-back unit is being operated, the methods of using combination No. 4 (figure case), should be the subject of bilateral agreement between the administrations and/or private recognized operating agencies concerned.

RECOMMENDATION S.9

SWITCHING EQUIPMENT OF START-STOP APPARATUS

(former C.C.I.T. Recommendation F.60, modified at New Delhi, 1960)

In view of Recommendation U.1 relative to signalling conditions to be applied in the international telex service;

in view of Recommendation F.60 relative to Regulations for the telex service (*Red Book*, Volume II *bis*),

the C.C.I.T.T.

unanimously declares the view

1. that start-stop apparatus used in the telex service should be so equipped, or provided with the necessary devices, to permit of operation in accordance with Recommendations U.1 and F.60;

2. that, if a subscriber's apparatus is such that he can use his teleprinter outside communication periods in order to prepare perforated tapes, for local checking of those tapes, for staff training, etc., the possibility of taking the answer-back may be delayed for a period not exceeding 3 seconds after connection is established with the called subscriber.

RECOMMENDATION S.11

USE OF START-STOP REPERFORATING APPARATUS FOR PERFORATED TAPE RETRANSMISSION

(former C.C.I.T. Recommendation C.19, Arnhem, 1953, amended at New Delhi, 1960)

When a station is equipped with receiving reperforating apparatus, it is often necessary to clear the perforated tape of the reperforator to ensure transmission of the last characters of a message received during the perforation of the first characters of the next message;

This operation of clearing the tape may lead to mutilation of the beginning of the message which is being perforated (particularly if insufficient message separation signals have been transmitted);

For these reasons, the C.C.I.T.T.

unanimously declares the view:

1. it is recommended that arrangements be made to avoid the mutilation of signals transmitted at the head of a message and received on start-stop reperforating apparatus.

If the reperforating apparatus is provided with local means for feeding the paper, not more than one multilated signal should be tolerated. The wording of the message must make allowances for this fact.

It is recommended that the " message separation " signals should be sent at the end of a batch of telegrams following a given route at centres equipped with receiving reperforators. The choice of the type and number of signals to be sent for this purpose is left for agreement between the administrations concerned. Use of a series of " letter shift " signals appears particularly desirable for this purpose;

2. if the reperforator is to be switched into circuit and out of circuit under control of the transmitting station, the following sequences of signals should be used:

Combination No. 3 repeated 4 times (CCCC) for switching the reperforator into circuit by remote control;

Combination No. 6 repeated 4 times (FFFF) for switching the reperforator out of circuit by remote control.

These operations may equally well be controlled by the secondaries of CCCC and FFFF, but, for convenience in operating the primary signals, CCCC or FFFF only should be used by operating staff.

If the sequence four times combination No. 6 has not been received before the arrival of the clearing signal (or the end-of-message signal), receipt of the clearing signal (or end-of-message signal) should cause disconnection of the reperforator.

RECOMMENDATION S.12

CONDITIONS WHICH MUST BE SATISFIED BY SYNCHRONOUS SYSTEMS OPERATING IN CONNECTION WITH START-STOP TELEPRINTER SYSTEMS

(former C.C.I.T. Recommendation C.23, Geneva, 1956, amended at New Delhi, 1960)

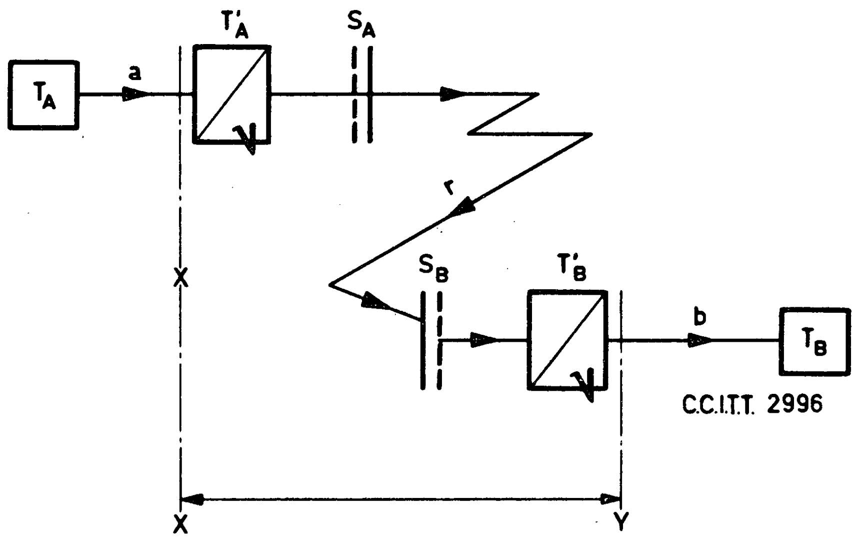
The C.C.I.T.T.,

considering, on the one hand,

that the receiving portion of the sending end of the synchronous system can be linked to a teleprinter receiver,

unanimously declares the view

that the receiving portion of the sending end termination shall satisfy the conditions laid down in Recommendation S.3, paragraphs 1, 2, 3 and 4;



In this diagram:

T_A and T_B are start-stop teleprinters.

T'_A and T'_B are repeaters with or without storage.

a and b represent the networks connecting teleprinters T_A and T_B to the repeaters T'_A and T'_B.

These networks may comprise any number of channels in tandem, relays or regenerative repeaters.

S_A and S_B are the distributors of the synchronous system, the complexity of which it is not necessary to state.

r denotes a synchronous radiotelegraph channel.

It is agreed that, for the study of this question, the synchronous system includes all the equipment shown between lines X and Y on the diagram.

The input and output of the synchronous system are thus directly connected to the start-stop networks.

FIGURE 1 — **Synchronous system**

considering, on the other hand,

that the retransmitting portion of the receiving end of the synchronous system can be linked to a start-stop transmitter having special characteristics, because of the high speed stability of synchronous systems,

unanimously declares the view

that the start-stop signals provided by the retransmitting portion of the receiving termination of the synchronous system shall have the following characteristics:

1. Nominal modulation rate, 50 bauds;

2. Gross start-stop distortion of the signals, less than 5%;

3. Interval between the beginnings of successive start elements, 145 $^5/_6$ milliseconds with a tolerance of $\pm 1/10^6$.

Note. — For a better understanding of the recommendation, the general arrangement of a communication system involving transmission over a synchronous channel is shown in Figure 1.

RECOMMENDATION S.13

USE ON RADIO CIRCUITS OF 7-UNIT SYNCHRONOUS SYSTEMS GIVING ERROR CORRECTION BY AUTOMATIC REPETITION

(former C.C.I.T. Recommendation C.24, Geneva, 1956, amended at New Delhi, 1960, at Geneva, 1964, and at Mar del Plata, 1968)

(This Recommendation corresponds to the C.C.I.R. Recommendation 342-1, Oslo, 1966)

The C.C.I.T.T.,

considering

a) that it is essential to be able to interconnect terminal start-stop apparatus employing the international telegraph alphabet No. 2 by means of radiotelegraph circuits;

b) that radiotelegraph circuits are required to operate under varying conditions of radio propagation, atmospheric noise and interference which introduce varying degrees of distortion which may at times exceed the margin of the receiving apparatus;

c) that, in consequence, the transmission of 5-unit code signals over radio circuits is liable to errors and that such errors are not automatically detectable by the receiving apparatus;

d) that an effective means of reducing the number of wrongly printed characters is the use of codes permitting the correction of errors by detecting the errors and automatically causing repetition;

e) that the method using synchronous transmission and automatic repetition (ARQ) is now well proven;

f) that it is desirable to permit correct phase to be established automatically on setting up a circuit;

g) that certain circumstances can occur which may result in a loss of the correct phase relationship between a received signal and the receiving apparatus;

h) that it is desirable to permit the correct phase relationship to be re-established automatically after such a loss, without causing errors;

i) that to avoid mis-routing of traffic it is essential to prevent phasing to a signal which has been unintentionally inverted;

j) that in certain cases there is a need to subdivide one or more channels in order to provide a number of services at a proportionately reduced character rate;

TABLE I

No. of alphabet No. 2 signal	Letter and figure case	5-unit international code No. 2	7-unit international code No. 3
1	A —	Z Z A A A	A A Z Z A Z A
2	B ?	Z A A Z Z	A A Z Z A A Z
3	C :	A Z Z Z A	Z A A Z Z A A
4	D [1]	Z A A Z A	A A Z Z Z A A
5	E 3	Z A A A A	A Z Z Z A A A
6	F [1]	Z A Z Z A	A A Z A A Z Z
7	G [1]	A Z A Z Z	Z Z A A A A Z
8	H [1]	A A Z A Z	Z A Z A A Z A
9	I 8	A Z Z A A	Z Z Z A A A A
10	J [1]	Z Z A Z A	A Z A A A Z Z
11	K (	Z Z Z Z A	A A A Z A Z Z
12	L)	A Z A A Z	Z Z A A A Z A
13	M .	A A Z Z Z	Z A Z A A A Z
14	N ,	A A Z Z A	Z A Z A Z A A
15	O 9	A A A Z Z	Z A A A Z Z A
16	P 0	A Z Z A Z	Z A A Z A Z A
17	Q 1	Z Z Z A Z	A A A Z Z A Z
18	R 4	A Z A Z A	Z Z A A Z A A
19	S '	Z A Z A A	A Z A Z A Z A
20	T 5	A A A A Z	Z A A A Z A Z
21	U 7	Z Z Z A A	A Z Z A A Z A
22	V =	A Z Z Z Z	Z A A Z A A Z
23	W 2	Z Z A A Z	A Z A A Z A Z
24	X /	Z A Z Z Z	A A Z A Z Z A
25	Y 6	Z A Z A Z	A A Z A Z A Z
26	Z +	Z A A A Z	A Z Z A A A Z
27	carriage return	A A A Z A	Z A A A A Z Z
28	line feed	A Z A A A	Z A Z Z A A A
29	letters	Z Z Z Z Z	A A A Z Z Z A
30	figures	Z Z A Z Z	A Z A A Z Z A
31	space	A A Z A A	Z Z A Z A A A
32	(not used)	A A A A A	A A A A Z Z Z
	signal repetition	—	A Z Z A Z A A
	signal α	(permanent A polarity)	A Z A Z A A Z
	signal β	(permanent Z polarity)	A Z A Z Z A A
	[1] See Recommendation S.4		

Note. — Symbols A and Z have the meanings defined in the *List of definitions*, Part I, definition 31.38.

k) that the method of automatically achieving the correct phase relationship between the received signal and the sub-channelling apparatus should be an integral part of the phasing process;

l) that compatibility with existing equipment designed in accordance with the former Recommendation S.13 is a requirement,

unanimously declares the view

A.1. that, when the direct use of a 5-unit code on a radio circuit gives an intolerable error rate and there is a return circuit, a 7-unit ARQ system be employed;

A.2. when automatic phasing of such a system is required, the system described below should be adopted as a preferred system;

A.3. that equipment, designed in accordance with paragraph 2, should be provided with switching, to permit operation with equipment designed in accordance with Recommendation S.13, New Delhi, 1960.

I. *Table of code conversion* (see Table I, preceding page)

II. *Repetition cycles*

1. Four characters for normal circuits which are not subject to excessive propagation time. The cycle should comprise one " signal repetition " and three stored characters.

2. Eight characters on circuits for which the four-character repetition cycle is inadequate. The cycle should comprise one " signal repetition ", three signals β and four stored characters, or one " signal repetition " and seven stored characters.

III. *Channel arrangement*

1. *Channel A*

1.1 For equipments employing a 4-character repetition cycle: one character inverted followed by three characters erect (see Figure 1*a*).

1.2 For equipments employing an 8-character repetition cycle: one character inverted followed by seven characters erect (see Figure 2*a*).

2. *Channel B*

2.1 For equipments employing a 4-character repetition cycle: one character erect followed by three characters inverted (see Figure 1*b*).

2.2 For equipments employing an 8-character repetition cycle: one character erect followed by seven characters inverted (see Figure 2*b*).

3. *Channel C*

As for Channel B (see Figures 1*c* and 2*c*).

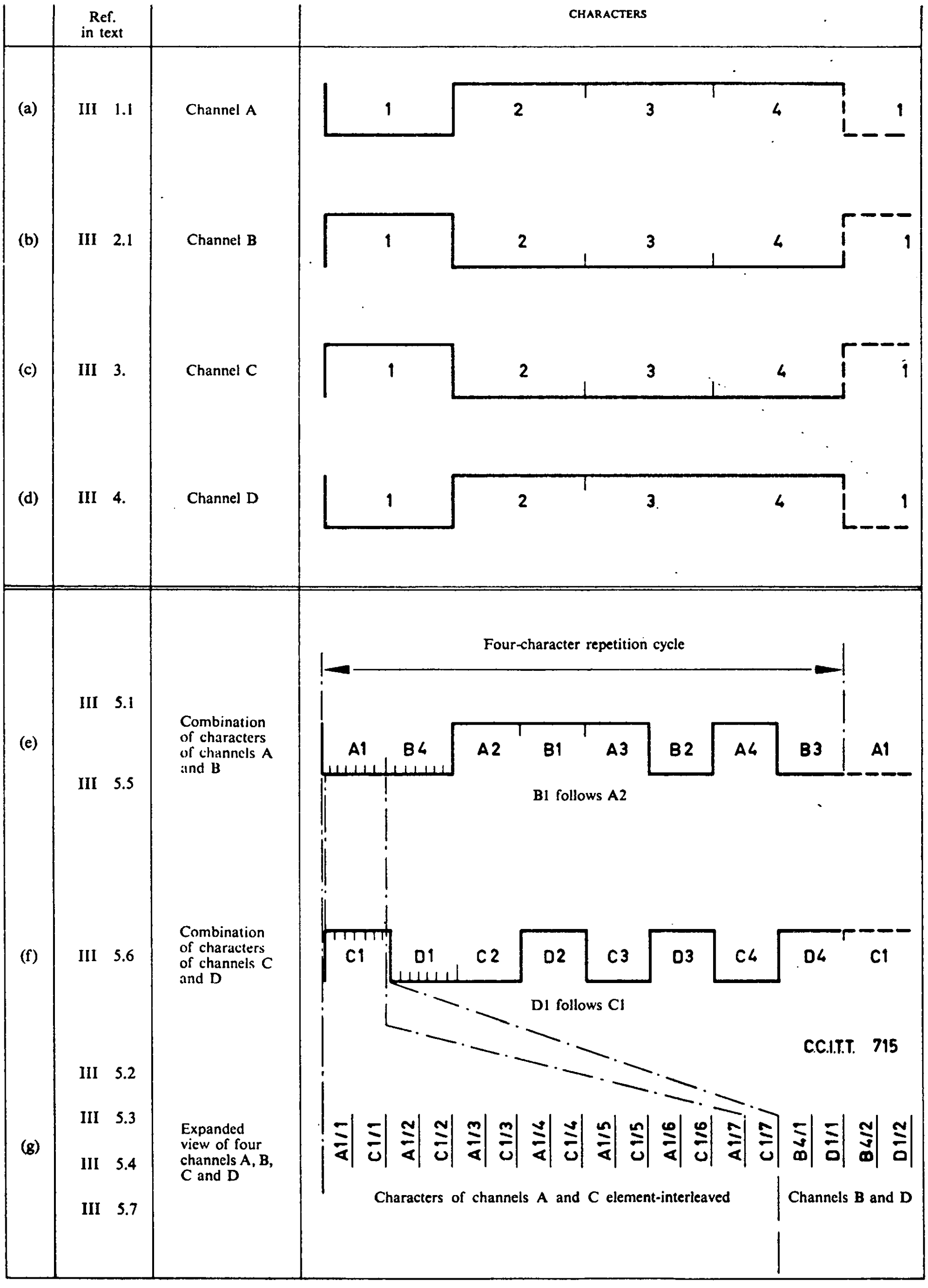


FIGURE 1. — **Channel arrangement for a four-character repetition cycle**

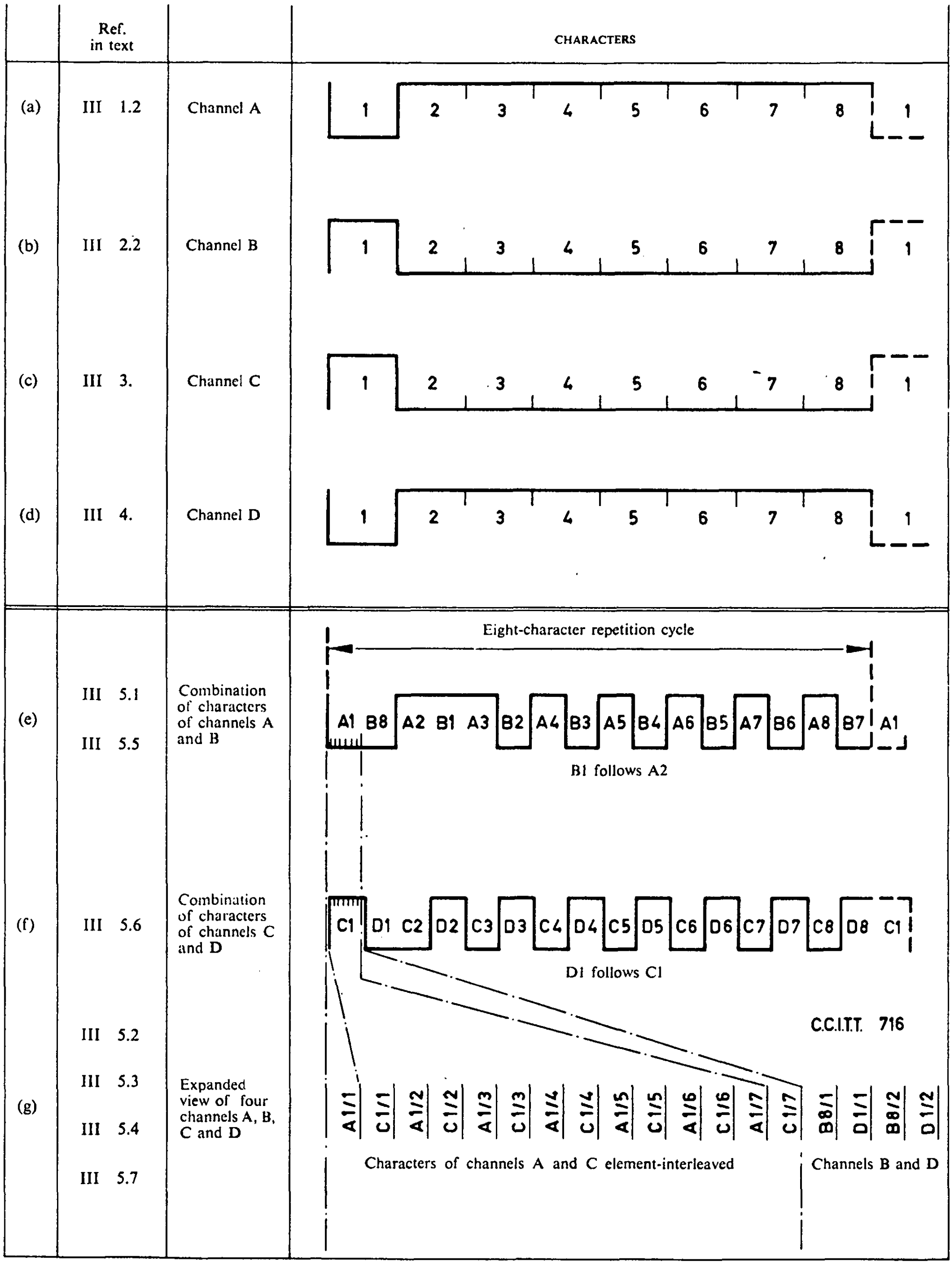


FIGURE 2. — **Channel arrangement for an eight-character repetition cycle**

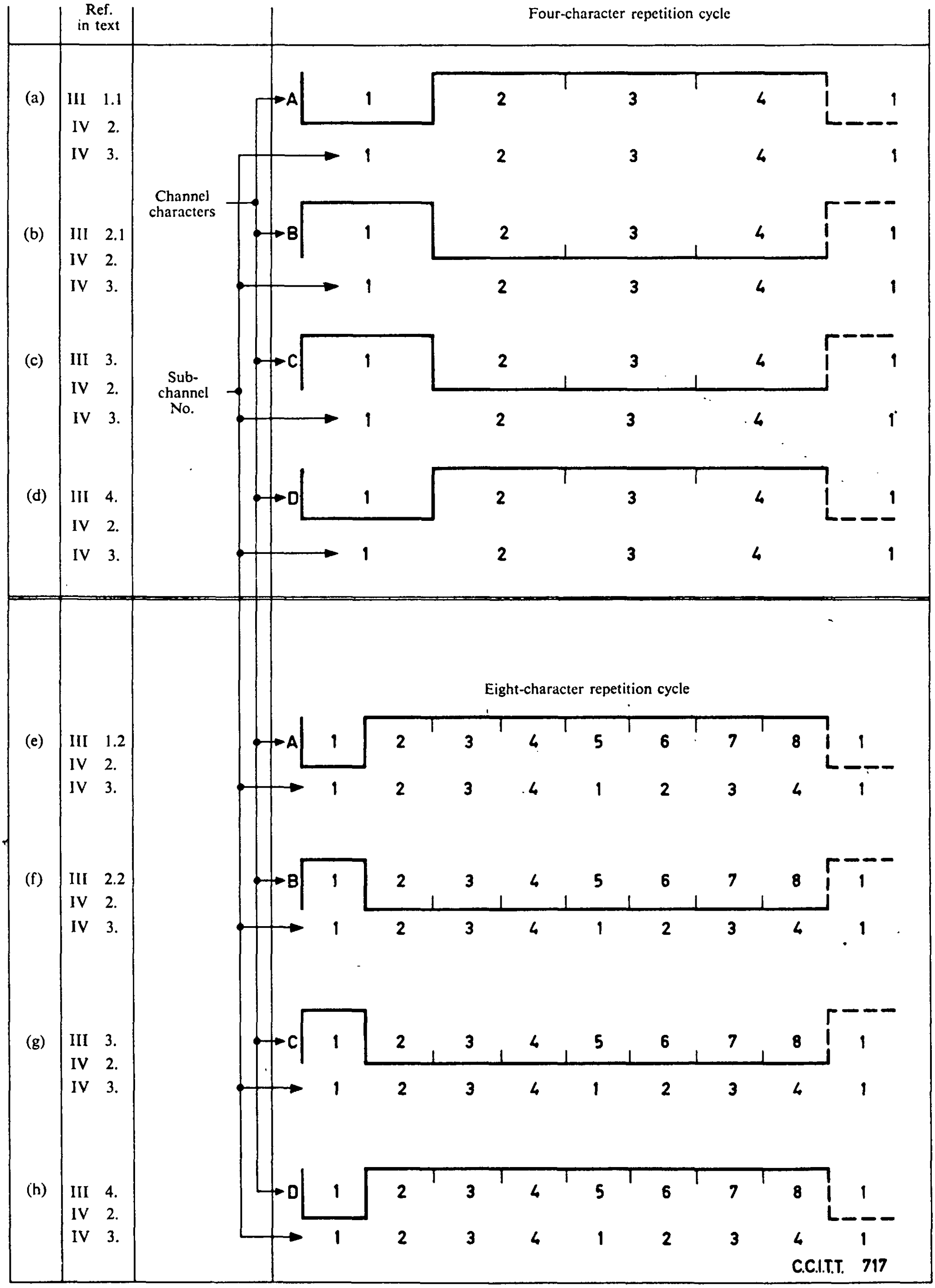


FIGURE 3. — **Sub-channelling arrangements for a four- and eight-character repetition cycle**

4. *Channel D*

As for Channel A (see Figures 1*d* and 2*d*).

5. *Order of transmission*

5.1 Characters of Channels A and B are transmitted consecutively (see Figures 1*e* and 2*e*)

5.2 Elements of Channel C are interleaved with those of Channel A (see Figures 1*g* and 2*g*).

5.3 Elements of Channel D are interleaved with those of Channel B (see Figures 1*g* and 2*g*).

5.4 In the aggregate signal, A elements precede those of C, and B elements precede those of D (see Figures 1*g* and 2*g*).

5.5 The first erect character on A transmitted after the inverted character on A is followed by the erect character on B (see Figures 1*e* and 2*e*).

5.6 The erect character on C is followed by the inverted character on D (see Figures 1*f* and 2*f*).

5.7 The inverted character on A is element-interleaved with the erect character on C (see Figures 1*g* and 2*g*).

IV. *Sub-channel arrangement*

1. The character transmission rate of the fundamental sub-channel should be a quarter of the standard character rate.

2. Sub-channels should be numbered 1, 2, 3 and 4 consecutively.

3. Where a 4-character repetition cycle is used, sub-channel 1 should be that sub-channel which has opposite keying polarity to the other three sub-channels of the same main channel (see Figure 3*a-d*).

Where an 8-character repetition cycle is used, sub-channel 1 should be that sub-channel which has alternately erect and inverted keying polarity (see Figure 3*e-h*).

4. In the case when sub-channels of half-character-rate, or three-quarter-character-rate are required, combinations of the fundamental sub-channels should be arranged as shown in Table II.

TABLE II

Proportion of full-channel character-rate	Combination of fundamental sub-channels
(1) quarter	No. 1
(2) quarter	No. 3
(3) half	Nos. 2 and 4
(1) half	Nos. 1 and 3
(2) half	Nos. 2 and 4
(1) quarter	No. 1
(2) three-quarters	Nos. 2, 3 and 4

V. *Diagrams*

As a result of the characteristics specified in II, III and IV above, the transmission of characters will be as shown in Figures 1, 2 and 3.

VI. *Automatic phasing*

i) Automatic phasing should normally be used. It should be initiated either:

a) after a waiting period during which cycling due to the receipt of errors has occurred continuously on both channels of a 2-channel system, or on at least two main channels of a 4-channel system;

b) after equal counts of A and Z elements have been made over at least two consecutive system cycles whilst continuous cycling due to the receipt of errors is occurring on all main channels.

ii) When the slave station is phasing, it should transmit in each channel, in place of the " signal repetition ", a 7-element signal in which all seven elements are of the same polarity, all other characters in the repetition cycle being transmitted unchanged.

B. that the start-stop sections of the receiving and transmitting portions of the radiotelegraph circuit should satisfy the conditions of Recommendations S.3 and S.12.

In conformity with Recommendation S.12, the aggregate modulation rate for a 2-channel time-division multiplex system will be 96 bauds and for a 4-channel system will be 192 bauds;

C. that if such systems are used in establishing telex connections, the signalling position should conform to the arrangements shown in Recommendations U.11, U.20, U.21, U.22.

1. For circuits on switched telegraph networks, the conditions of Recommendation U.20 should apply.

In this usage the polarity retransmitted by the terminal of the radio channel towards the start-stop section of the circuit during a repetition cycle shall be " start " polarity when the circuit is in the " free line " condition and " stop " polarity when the circuit is in the " busy circuit " condition.

2. For point-to-point circuits, administrations may adopt, at the terminal equipment under their jurisdiction, their own method of stopping and starting the motors of the receiving machines, based on C.C.I.T.T. Recommendation S.7.

Signal β should normally be transmitted to indicate the idle circuit condition. However, for signalling purposes, the signals α and β may be employed.

RECOMMENDATION S.14

SUPPRESSION OF UNWANTED RECEPTION IN RADIOTELEGRAPH MULTI-DESTINATION TELEPRINTER SYSTEMS

(former C.C.I.T. Recommendation C.22, Geneva, 1956, amended at New Delhi, 1960)

The C.C.I.T.T.,

considering

1. that in a radiotelegraph system in which a radio teleprinter transmitter broadcasts messages simultaneously to a number of receiving stations, this broadcast is sometimes required only by a restricted number of these stations;

2. that it is desirable in such cases to prevent the reception of the message at the other offices to avoid wastage of paper;

3. that such wastage can be avoided by the use of selective calling systems whereby only those stations required to receive the transmission are connected whilst it is in progress;

4. that various technical methods are available for achieving this, using either:
   a) pulse signalling (e.g. by dial), or
   b) signalling with 5-unit signals;

5. that a wide variety of systems may be devised based upon the methods in 4 above;

6. that such systems are normally used only for special services in which agreement can be reached on the particular type of system to be adopted,

unanimously declares the view

1. that, when it is desired to avoid wastage of paper at receiving stations in radiotelegraph multi-destination teleprinter systems, a selective calling system should be used;

2. that it is neither necessary nor desirable to recommend the use of any particular type of system for international use.

SERIES T RECOMMENDATIONS

Apparatus and Transmission for Facsimile Telegraphy

RECOMMENDATION T.1

STANDARDIZATION OF PHOTOTELEGRAPH APPARATUS

(former C.C.I.T. Recommendation D.1, amended at New Delhi, 1960, at Geneva, 1964, and at Mar del Plata, 1968)

The C.C.I.T.T.,

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 co-operation*

The normal index is 352 (corresponds to a factor of co-operation 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 co-operation of 829). The admissible tolerances on the above-mentioned values are $\pm 1\,\%$.

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

$$\frac{\text{length of document to be transmitted}^{1}}{\text{total length of a scanning line}} \times \pi$$

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

3.3 The following table gives corresponding values of index of co-operation M, factor of co-operation C, drum diameter D, total length of scanning line L, scanning pitch P and scanning density F for apparatus in most common use:

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 of the above table.

4. *Reproduction ratio*

In the case where apparatus working with different lengths of scanning line (but with the same index of co-operation) 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 The table below gives the normal and approved alternative combinations of drum rotation speeds or of scanning line frequencies and indices of co-operation:

[1] Measured in the direction perpendicular to the scanning line.

	Drum rotation speed in r.p.m. or scanning line frequency	Index of co-operation	
		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 of the table above 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: $\pm 0.5\%$ 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: $\Delta_E = \pm 1\%$ 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: $\Delta_R = \pm 2\%$ 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 a.m./f.m. 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.

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.

RECOMMENDATION T.2

STANDARDIZATION OF BLACK-AND-WHITE FACSIMILE APPARATUS

(Mar del Plata, 1968)

Note. — This recommendation does not apply to facsimile apparatus used for meteorological purposes, for which the W.M.O. has drawn up its own recommendations.

The C.C.I.T.T.,

considering

1. that the use of facsimile equipment for message transmission and the reproduction

of business and other papers will soon become fairly extensive in the international service on telephone-type circuits;

2. that such a service may be requested either alternatively with telephone conversation, or when the called station is not attended;

3. that, for this reason, the operations involved in setting up and breaking off facsimile connections should be capable of remote-control;

considering further

that even if there is no very definite call for such a service at present, the equipment which will one day be necessary and the manual or automatic operations to be performed ought to be standardized now,

unanimously declares the view

that the facsimile apparatus should be designed and operated according to the following standards [1]:

1. *Scanning track*

The message area should be scanned, in the transmitter and receiver, in a positive direction. (The orientation of the document in relation to the scanning plane will depend upon its dimensions and is of no consequence.)

2. *Index of co-operation*

The nominal index is 264, which corresponds to a " factor of co-operation " of 829. These values should be observed with $\pm 1\%$ tolerance.

3. *Dimensions of apparatus*

The facsimile apparatus should be capable of transmitting the documents of up to 21 cm × 29.7 cm.

— In drum apparatus, the normal diameter of the drum is 68.5 mm. The "drum factor " of the transmitter must not be more than 4.5 and that of the receiver not less than 4.5.

— Assuming a margin of 15 mm for the " dead sector " on the transmitter and a tolerance on phasing between the receiver and the transmitter (which could cause a relative drift of 6.5 mm at the maximum forward or backward) the " usable scanning line length " will be 193 mm (minimum).

— In flat-bed scanning apparatus, the " total scanning line length " must be 215 mm, on which 15 mm are not used for the actual transmission.
For continuous recorders, the width of the paper must be 210 mm.

[1] See Recommendation T.4 as regards the remote control and associated equipment.

4. *Scanning density*

" Scanning density " is normally 3.85 lines per mm.

5. *Variant admitted*

Apparatus designed with other characteristics than those indicated under points 3 and 4 can be used on condition that the index of co-operation (264) and the limits for the drum factor are respected.

Nevertheless, the total length of a scanning line must range between 210 mm and 234 mm; in the case of drum apparatus this corresponds to drum diameters between 67 and 74.5 mm.

6. *Reproduction ratio*

In the case where apparatus working with different lengths of scanning line (but with the same index of co-operation of 264) 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.

7. *Definition*

The " definition " must be the same in the longitudinal and transversal directions.

— Transmission definition:

The thickness of the smallest admissible detail on the original should be 0.2 mm (corresponding to a typewritten character). To allow for an inevitable tolerance, the apparatus should also recognize a thickness of 0.1 mm in both directions; but in that case, to avoid having a modulating frequency that is too high, shorter pulses than those corresponding to the length of the " scanning spot " should be artificially prolonged at the sending end so that the modulating frequency f_m does not exceed the limits:

$$f_m = \pi \times M \times \frac{n}{120} \text{ Hz}$$

in which M = index of co-operation
n = scanning line frequency (number of lines per minute).

— Reception definition:

The apparatus must be capable of producing on the recording paper and in the scanning direction a black line at least as long as the width of the scanning line.

8. *Scanning line frequency*

The equipment should be designed for two line frequencies: 120 and 180 per minute.

In the leased circuits service, the best line frequency will be chosen according to the circuit characteristics.

Note. — Higher line frequencies could be authorized on leased circuits that have been specially matched (e.g. by the insertion of phase distortion correctors).

In the subscriber-to-subscriber service via the general switched telephone network,

— with manual control at the two ends, either of the two line frequencies mentioned above may be chosen by telephonic agreement between the two operators;

— with remote control of the receiving equipment, the single standard line frequency is 120 per minute. Should it appear in due course that the line frequency 180 per minute can be used on the world telephone network, this line frequency could then be standardized instead of 120 per minute.

The scanning line frequency must be kept within ± 10 parts in 10^6 of the nominal figure. With this stability, an adequate synchronization between transmitter and receiver will be achieved [1].

Note. — This tolerance makes allowance for an oblique distortion of roughly 1 : 50 when transmitter and receiver are working with the maximum drift in reverse direction.

9. *Phasing*

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 tolerances: $\pm 0.5\%$ 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: $\Delta_E = \pm 1\%$ 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: $\Delta_R = \pm 2\%$ 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.

10. *Contrast*

The transmitter must transmit the original document with " accentuated contrast " (this means that the transmitter sends as black all the luminance darker than a certain

[1] In cases where apparatus is used on leased circuits or specialized networks, and where the mains of the terminal points are synchronized, the relative stability given by the direct feeding of the motors from the mains is sufficient for the operation on these leased circuits or networks.

medium value, and as white all the luminance lighter than this value). It should be so designed that it functions correctly when the difference in density between the inscription and the background is not less than 0.4.

11. *Modulation and demodulation equipments*

The type of modulation to be used is described in Recommendation T.10 *bis* on facsimile stations connected to the telephone network and in Recommendation T.10 on communications over leased circuits.

a) *Amplitude modulation* (for leased circuits only)

The facsimile signal level is higher for black and lower for white.

The carrier frequency should range between 1300 and 1900 Hz and will depend upon the characteristics of the circuits used.

b) *Frequency modulation* (for leased circuits and for switched connections)

The frequency corresponding to black will be $f_0 - 400$ Hz and the frequency corresponding to white $f_0 + 400$ Hz.

For switched connections $f_0 = 1700$ Hz (provisional). For leased circuits f_0 should range between 1300 and 1900 Hz; the choice of the centre frequency f_0 will depend upon the circuit characteristics. However, if the renter, in some cases, wishes to use the apparatus on switched connections, $f_0 = 1700$ Hz.

The stability of the transmitter must be such that the significant frequencies do not vary by more than 32 Hz from their nominal value in a period of 15 minutes.

c) *Power at the transmitter output*

When amplitude modulation is used, the power of black at the transmitter output must be able to be adjusted between —7 dBm (—0.8 Npm) and 0 dBm (1 mW). The white level must be approximately 15 dB below the black level.

In frequency-modulated systems, the level at the output of the facsimile apparatus must be able to be adjusted between −10 dBm (−1.15 Npm) and 0 dBm (1 mW).

d) *Power at the receiver input*

The facsimile receiver must be so designed that it functions correctly when the input power ranges between 0 dBm (1 mW) and −40 dBm (−4.6 Npm), the latter value being considered provisional. In the case of amplitude modulation, this concerns the power of the black signal.

Note. — No possibility of adjustment for send level or receive sensitivity should be under the control of the operator.

RECOMMENDATION T.4

REMOTE CONTROL OF BLACK-AND-WHITE FACSIMILE APPARATUS

(Mar del Plata, 1968)

Note. — This recommendation does not apply to facsimile apparatus used for meteorological purposes, for which the W.M.O. has drawn up its own recommendations.

An international service for the transmission by users of black-and-white facsimile messages, business papers, and similar documents should be considered from the point of view of two different cases:

1. if the receiving station is unattended;
2. if operators are present at the sending and the receiving stations;

on the understanding that the facsimile apparatus used is in conformity with Recommendation T.2.

The called subscriber is selected, if necessary, by means of the general switched telephone network. The facsimile apparatus should be connected to the telephone line by remote control.

International standards should be determined for supplementary equipment to be attached to the apparatus described in Recommendation T.2, for remote control, point-to-point operation and the signals for remote control.

For these reasons, the C.C.I.T.T. *unanimously declares the following view* which sets out the conditions to be observed in remote-control operation of facsimile receiving stations:

A. General provisions

1. All operations to be carried out by remote control should be replaceable by manual operations, in case of breakdown in automatic operation, or if desired for other reasons.

2. The equipment at both ends should allow the line to be returned to telephony by hand, if necessary.

3. In the rest position the apparatus must remain at the standardized transmission speed (see Recommendation T.2). However, it will be possible, if agreed, to switch them manually to another speed, in the case where such a speed can be provided at both stations. In this case the apparatus must automatically come back to the position for the standardized speed after the end of the facsimile communication.

4. The facsimile equipment should take over the call after the line has been switched to facsimile.

B. Operational and signalling conditions

The following tables describe the operational and signalling conditions:

— if the receiving station is unattended (Table 1);

— if operators are present at both stations (Table 2).

Notes concerning Tables 1 and 2

1. Tables 1 and 2 describe the transmission in succession of two messages in the course of one call. It is a simple matter to apply each table to the case where only one message is transmitted during a call, and also to the case where more than two messages are transmitted in succession.

2. Alternate black and white signals at a modulation rate of 100 bauds for signal No. 1 and 200 bauds for signal No. 3 have been selected because they can be readily obtained from a 50-Hz mains supply, frequently encountered.

If the main supply operates at a frequency other than 50 Hz, these signals must be generated by other means; in this case the tolerance from the nominal value would be $\pm 5\%$.

3. There is no need for a signal to show that the receiver is no longer available. Should the confirmation signal not be received (signal No. 1 returned), the transmitting operator may repeat by hand the dispatch of the remote control signal (signal No. 1) to request confirmation once more.

4. Ten seconds or more without reception of a guard signal (signal No. 1, signal No. 3 or " white " signal) would cause the remote control equipment to revert to the rest position, and automatic reversion of the line to telephony. (The " white " signal is the most frequent of the facsimile signals; it also forms a part of the phasing signal.)

5. In the case of Table 2, the station calling or called can operate as facsimile transmitter following the switch-over to facsimile.

6. The admissible tolerances on the duration of 1 or 2 seconds of signals No. 1 and No. 3 and on the estimated interval of 1 second before the transmission of a signal would be ± 250 milliseconds.

C. Description of signals

Signal No. 1: Alternate " white " and " black " signals at 100 bauds.

Signal No. 2: Alternate " white " and " black " signals (5% white and 95% black) during the time required to scan one line.

Signal No. 3: As for signal No. 1, but at 200 bauds.

D. Power levels

The levels at emission and sensitivity thresholds at reception of remote control signals are the same as those of message transmission signals.

1. *Power at the transmitter output*

When amplitude modulation is used, the power of black at the transmitter output must be able to be adjusted between -7 dBm (-0.8 Npm) and 0 dBm (1 mW). The white level must be approximately 15 dB below the black level.

In frequency-modulated systems, the level at the output of the facsimile apparatus must be able to be adjusted between -10 dBm (-1.15 Npm) and 0 dBm (1 mW).

2. *Power at the receiver input*

The facsimile receiver must be so designed that it functions correctly when the input power ranges between 0 dBm (1 mW) and -40 dBm (-4.6 Npm).

3. No possibility of adjustment for send level or receive sensitivity should be under the control of the operator.

TABLE 1

Fully automatic service on the telephone network [1]

Transmitter	Signalling →	Function or position	Signalling ←	Reception
Operator present. Facsimile equipment in the receive condition, power switched on. Line connected to the telephone.		1. Rest condition.		Station not attended. Facsimile equipment in the receive condition, power switched on. Line connected to the telephone. Telephone station provided with an automatic answering device.
Telephone receiver taken off the hook Selection Ringing tone.		2. Call.		Receipt of ringing signals. The automatic answering device a) counts a number of trains of ringing signal, b) simulates the unhooking of the telephone.
Checks the identity of the station obtained. (Guard delay: 10 seconds after end of spoken text.)		3. Identification.	Recorded announcement.	Emission of recorded announcement: recorded spoken text giving name of station and the possibility of *delivering a message* by facsimile. (The equipment simulates the act of hanging up the telephone, if ten seconds after the end of the recorded announcement signal No. 1 has not been received.)

[1] In the case of *leased circuits* position 1 is the same as in the above table but the called station has no automatic answering device. In the case of no reply the transmitting operator switches over manually a) facsimile to transmitting position, b) telephony to facsimile. The operations then take place as in the above table as from position 4.

Transmitter	Signalling →	Function or position	Signalling ←	Reception
The operator switches *manually*: a) facsimile to sending position, b) from telephony to facsimile (The facsimile takes over the call.) *Automatic* dispatch of signal No. 1 for at least 5 seconds until *manually* cut off. (While this signal is being sent, the operator may put the document to be transmitted on his machine, and may check transmission level.)	Signal No. 1 for at least 5 s.	4. Switch over to facsimile.		(Luminous signal lights up.) The telephone line is *automatically* connected to the facsimile station by detection of signal No. 1. ((The facsimile takes over the call.)
Luminous signal lights up for 2 s. a) *Automatic* start of transmitter motor on detection of signal No. 1 received. (Sent signal No. 1 (see point 4) has been prevented from being detected at the transmitting side.) b) *Manual* start of transmitter motor.		5. Availability confirmed. Start of transmitter.	Signal No. 1 for 2 s.	*Automatic* dispatch of return signal 1 s after end of signal received if receiver is available (proper power supply, adequate reserves of paper).
Automatic dispatch of phasing signals, 1 second after end of signal received during position No. 5.	Signal No. 2 (10 s).	6. Start of receiver. Phasing.		*Automatic* start of receiver motor. Phasing, 2 s after start of receiver at earliest. *Automatic* scanning when phasing occurs.

Transmitter	Signalling →	Function or position	Signalling ←	Reception
Automatic transmission immediately following the end of signal No. 2.		7. Transmission of message No. 1.		Reception properly so-called (after end of signal No. 2).
At end of message: — *Automatic* stop of the transmitter (at the end of its run, or by a movable device according to the length of the message). — *Automatic* sending of signal No. 1 until *manual* cut-off (During transmission of signal No. 1: Return to starting point of scanning system. Change of message.)	Signal No. 1 for at least 5 s.	8. Intermediate stop. — — — — — Followed by 9 or 9*bis* [1] as appropriate.		Luminous signal lights up. *Automatic* stop of the receiver, a) return to starting point of scanning system and automatic reloading of new form on drums, or b) positioning for further reception, if required, on continuous rolls.
As in 5.		9. Acknowledgement of receipt of message No. 1. = Availability of message No. 2 confirmed. Start of transmitter.	Signal No. 1 (2 s).	As in 5.

[1] 9 *bis*, see the end of Table 1.

Transmitter	Signalling →	Function or position	Signalling ←	Reception
As in 6.	Signal No. 2 (10 s).	10. Start of receiver. Phasing.		As in 6.
As in 7, but during the transmission of the last message operator proceeding according to 5 a) presses the " end " button.		11. Transmission of message, No. 2 (last message).		As in 7.
At end of last message: — *Automatic* stop of transmitter. — *Automatic* dispatch of signal No. 1.	Signal No. 1 (5 s).	12. Final stop. - - - - - - - 13 or 13 *bis* [1] follows as appropriate.		As in 8.
Luminous signal lights up (2 s). (" End " button pressed (see 11) to prevent start of transmitter motor.)		13. Last message acknowledged - - - - - - - 14 or 14 *bis* follows as appropriate.	Signal No. 1 (2 s).	As in 5.
Manual switch to telephony (Transmitter reverts to position 1.) Hooking of telephone (release of call).		14. End of communication.		The receiver reverts to position 1 having received no guard signal for 10 seconds (*automatic* switch-over to telephony).

[1] 13 *bis*, see the end of Table 1.

Transmitter	Signalling →	Function or position	Signalling ←	Reception
Operator presses call button on facsimile (call should follow not later than 10 seconds after end of signal acknowledging receipt).		14 *bis*. Call by operator to *receiving station.*		
Automatic dispatch of call signal repeated every 6 seconds.	Signal No. 3 (2 s).			Start of *acoustic* signal (2 s) repeated every 6 seconds.
Intermittent luminous signal lights up (2 s).			Signal No. 1 (2 s).	Return call, 1 second after end of each sequence train.
a) *Reply*				a) *Reply*
Acoustic signal sent instead of luminous signal (2 s). Call signals stop.		Confirmation of this call.	Signal No. 3 (2 s).	Operator presses call button on facsimile thus replacing signal No. 1 (return call) by signal No. 3.
Automatic transmission of return signal, 1 second after end of signal No. 3 received. *Manual* switch to telephony (facsimile transmitter reverts to position 1).	Signal No. 1 (2 s).			Luminous signal lights up. Telephone receiver taken off the hook. *Manual* switch to telephony (facsimile receiver reverts to position 1).
		Telephony.		
b) *No reply*				b) *No reply*
Manual switch to telephony (call signals stop, facsimile transmitter reverts to position 1). Hook-up of telephone (release of call).				Facsimile receiver reverts to position 1 having received no guard signal for 10 seconds (*automatic* switch to telephony).

Transmitter	Signalling →	Function or position	Signalling ←	Reception
Acoustic signal (2 s) repeated every 6 seconds sent instead of luminous signal (see 9 or 13) after end of transmission.		9 *bis*/13 *bis* Call by operator to *receiving station.*	Signal No. 3 (2 s).	Receiver may press call button during each transmission thus replacing signal No. 1 (acknowledgement) by signal No. 3 (call signal) repeated every 6 seconds.
Return call, 1 second after end of each train of call.	Signal No. 1. (2 s).			Intermittent *luminous* signal lights up (2 s).
Operator presses call button on facsimile thus replacing signal No. 1 (return call) by signal No. 3.	Signal No. 3 (2 s).	Confirmation of this call.		*Acoustic* signal sent (2 s) instead of luminous signal Stop of call signal.
Luminous signal lights up.			Signal No. 1 (2 s).	Send *automatically* a return signal, 1 second after end of reception of signal No. 3. Telephone receiver taken off the hook.
Manual switch to telephony (facsimile transmitter reverts to position 1).		Telephony.		*Manual* switch to telephony, if necessary (facsimile receiver reverts to position 1).

TABLE 2

Alternate transmission of facsimile and telephony

(This table can also be applied to calls on the telephone network and on leased circuits)

Transmitter	Signalling →	Function or position	Signalling ←	Reception
Facsimile equipment in reception position power switch on. Decision to switch over to facsimile (operator puts document for transmission into machine).		1. Telephony.		(Operator checks if receiver is available.)
Operator switches *manually*: a) facsimile to transmitting position, b) from telephony to facsimile (telephone remains unhooked, facsimile takes over call). *Automatic* dispatch of signal No. 1 for at least 5 seconds and until *manual* cut-off of transmissions (During transmission of signal No. 1 the operator may check transmission level.)	Signal No. 1 for at least 5 seconds.	2. Switch over to facsimile.		Luminous signal lights up (confirmation that transmitter has switched over to facsimile). The telephone line is *manually* connected to facsimile by detection of signal No. 1 (the facsimile takes over the call). Telephone hooked in cases where it has been decided not to telephone after the end of the facsimile transmission.
Luminous signal lights up (2 s) (confirmation that the receiver has switched over to facsimile.)		3. Start of transmitter.	Signal No. 1 (2 s).	*Automatic* dispatch of return signal one second after cut-off of signal No. 1 received.

Transmitter	Signalling →	Function or position	Signalling ←	Reception
a) *Automatic* start of transmitter motor by detection of signal received, or b) *Manual* start of transmitter motor.				
Automatic dispatch of phasing signals 1 second after end of reception of signal No. 1.	Signal No. 2 (10 s).	4. Start of receiver. Phasing.		*Automatic* start of receiver motor. Phasing occurs 2 s after start of receiver at earliest. *Automatic* scanning when phasing occurs.
Automatic transmission immediately following transmission of signal No. 2.		5. Transmission of message No. 1.		Reception proper (after end of signal No. 2).
At end of message — *Automatic* stop of transmitter. — *Automatic* dispatch of signal No. 1 until *manual* cut-off of transmission. (During transmission of signal No. 1: return to beginning of scanning system. Change of message.)	Signal No. 1 for 5 seconds at least.	6. Intermediate stop [1] - - - - - - - 7 or 7 *bis* [1] follows as appropriate		Luminous signal lights up. *Automatic* stop of receiver: a) Return to beginning of scanning system and reloading of new form on drums, or b) Positioning for further reception, if necessary, on continuous rolls.

[1] 7 *bis*. see the end of Table 2

Transmitter	Signalling →	Function or position	Signalling ←	Reception
As in 3.		7. Acknowledgement of receipt of message No. 1. Start of transmitter.	Signal No. 1 (2 s).	As in 3.
As in 4.	Signal No. 2 (10 s).	8. Start of receiver phasing.		As in 4.
As in 5, but operator proceeding as in 3 a presses " end " button during the last transmission.		9. Transmission of message No. 2 (last message).		As in 5.
At end of message: — *Automatic* stop of tıansmitter. — Automatic transmission of signal No. 1.	Signal No. 1 (5 s).	10. Final stop. - - - - - - - - 11 or 11 *bis* [1] follows as appropriate.		As in 6.
Luminous signal lights up (2 s). (The " end " button is pressed (see 9) to prevent new start of transmitter motor.)		11. Acknowledgement of receipt of last message. - - - - - - - - 12 or 12 *bis* follows as appropriate.	Signal No. 1 (2 s).	As in 3.

[1] 11 *bis*, see the end of Table 2.

Transmitter	Signalling →	Function or position	Signalling ←	Reception
Manual switch to telephony (transmitter reverts to position 1). Telephone is hung up (release of call).		12. End of call (case of facsimile transmission without return to telephony).		The receiver reverts to position 1, having received no guard signal for 10 seconds (*automatic* switch over to telephony).
Operator presses call button on facsimile (call to follow end of signal of acknowledgement of receipt within a maximum of 10 seconds). *Automatic* dispatch of call signal repeated every 6 s. Intermittent light-up of luminous signal (2 s) Acoustic signal sent (2 s) instead of luminous signal. Call signals stop. Automatic transmission of return signal 1 second after receipt of signal No. 3. *Manual* switch over to telephony. Call signals stop (transmitter reverts to position 1.)	Signal No. 3 (2 s). Signal No. 1 (2 s).	12 *bis*. Call by operator to *receiving station.* Confirmation of this call. Telephony.	Signal No. 1 (2 s). Signal No. 3 (2 s).	Acoustic signal sent (2 s) repeated every 6 seconds. Return call 1 s after end of each sequence train. Operator presses call button on facsimile thus replacing signal No. 1 (return call) by signal No. 3. Luminous signal lights up. *Manual* switch over to telephony (receiver reverts to position 1).
As in 9 *bis*/13 *bis* of Table 1.	As in 9 *bis*/ 13 *bis* of Table 1.	7 *bis*/11 *bis* Call by operator *to transmitting station.*	As in 9 *bis*/ 13 *bis* of Table 1.	As in 9 *bis*/13 *bis* of Table 1.

Note. During a facsimile call it is possible to change the direction of the transmission between successive messages even in the absence of intermediate return on the telephone. If this is envisaged, the transmitter switches its facsimile over manually, during the intermediate stop (position 6) to the receiving position. This operation cuts off signal No. 1 and the correspondent automatically replies by a return of signal No. 1 (acknowledgement of receipt of message No. 1). With the switch over of facsimile on the receiving side at the transmitting position, position No. 6 is re-established but the two stations have changed their role.

RECOMMENDATION T.10

BLACK-AND-WHITE TRANSMISSIONS ON TELEPHONE-TYPE CIRCUITS PERMANENTLY USED FOR FACSIMILE SERVICE (LEASED CIRCUITS)

(Geneva, 1964, amended at Mar del Plata, 1968)

When circuits are permanently allocated for a facsimile service, the characteristics of the facsimile equipment can be adapted to the circuit characteristics (or vice versa, to a certain extent).

Moreover, choice of the modulation method may be left to the user.

a) *Type of circuits to be used*

The trunk sections of the leased circuits should be generally four-wire lines. The voice-frequency telephone channels and carrier current telephone channels may also be used for their construction.

The junction lines of facsimile stations shall be two-wire lines (for systems transmitting one-way only or for systems transmitting alternately in both directions) or four-wire lines (for systems transmitting in both directions simultaneously).

Note. — If the leased circuit is used alternately for telephone conversation and facsimile transmission and if the latter is unidirectional, it is not necessary to provide for disabling echo suppressors located on the long-distance leased circuit. However, when such circuit is used for the simultaneous operation in both directions appropriate measures should be taken to disable echo suppressors before the actual facsimile transmission takes place.

b) *Modulation*

Amplitude modulation or frequency modulation may be used.

If the amplitude modulation is used, the carrier frequency shall be approximately 1300 Hz for audio-frequency circuits and 1900 Hz for carrier circuits. When a circuit is made up of different types of sections, the carrier frequency shall be between 1300 and 1900 Hz, depending on the characteristics of the total circuit used.

The higher level is for the black signal; the white signal shall be approximately 15 dB below the black signal.

If frequency modulation is used, the frequency corresponding to black shall be f_0-400 Hz and the frequency corresponding to white f_0+400 Hz. The centre frequency f_0 shall be chosen according to the characteristics of the circuit (1900 Hz for carrier circuits).

c) *Power*

The maximum power output of the transmitting apparatus into the line shall not exceed 1 mW whatever the frequency.

For frequency modulation systems, the level at the transmitter output shall be so adjusted that the level of the facsimile signals on the trunk circuit does not exceed -10 dBm0. For duplex systems, -13 dBm0 are permissible in each direction of transmission simultaneously.

In amplitude-modulated systems, higher black levels may be used provided the mean power in any hour, in both directions of transmission considered together, does not exceed 64 microwatts at zero relative level point of the trunk circuit. The black level on the trunk circuit may then be as much as -6 dBm0 in simplex and half-duplex systems or -9 dBm0 in duplex systems (the former corresponding to a mean level of -12 dBm0 in the transmission direction, and the latter to a mean level of -15 dBm0 in each direction of transmission simultaneously). Further, the level of any tones above 2400 Hz should not be so high as to cause interference on adjacent channels in carrier-type systems.

d) *Relative levels*

If facsimile transmissions take place simultaneously from a transmitting station to several receiving stations, arrangements shall be made at the junction points so that, on the circuits following the junction points, the same power levels are maintained as those prescribed for individual transmissions.

e) *Attenuation distortion*

When amplitude modulation is used, the attenuation distortion between terminal stations should not exceed 8.7 dB. Since, in the band of frequencies to be transmitted for the facsimile transmission, the distortion admitted for the telephone trunk circuit itself should not exceed 6.6 dB, it will not in general be necessary to compensate for the distortion of the lines joining the terminal stations to the amplifier stations.

In the case of frequency modulation, it suffices to use telephone circuits conforming to C.C.I.T.T. recommendations regarding attenuation distortion (see Recommendation G.132—*White Book*, Volume III).

f) *Variation of equivalent with time*

The overall loss should remain as constant as possible during the facsimile transmission. In the case of amplitude modulation, abrupt variations of even 0.9 dB may have an effect. It is, moreover, necessary to avoid any interruption of the circuit, however brief. For this reason, the greatest attention should be paid to the measurements made on the amplifiers and lines and to the changing of batteries.

Special precautions should be taken to make sure that no modulation of the carrier is caused by the line or the amplifiers, even if the modulation is inaudible. Such modulation may be due, in particular, to variations in the voltage of the supply batteries or to sub-audio telegraphy equipment.

In the case of frequency modulation, sudden changes of even 10 dB can be tolerated and telephone circuits, even when set up without special precautions, have sufficient stability.

This observation does not mean that sudden variations of level should not be avoided just as much as in the case of circuits carrying frequency-modulated facsimile telegraphy.

g) *Phase distortion*

Phase distortion influences the quality of facsimile transmissions. But in the case of black-and-white facsimile, this influence seems to be not so severe as in the case of phototelegraph transmission, for which the range of satisfactory transmissions is given in Recommendation T.12.

RECOMMENDATION T.10 *bis*

BLACK-AND-WHITE FACSIMILE TRANSMISSIONS IN THE GENERAL SWITCHED TELEPHONE NETWORK

(Mar del Plata, 1968)

a) *Type of circuits to be used*

Since circuits of the general telephone network and the station lines of telephone subscribers should be capable of being used for black-and-white facsimile transmissions on the general network, the circuits to be used are those of the switched general network which have two-wire terminals at both ends of the facsimile station.

Note. — There is no need to cater for the " disabling " of echo suppressors since facsimile transmission is one-way. Compandors do not seem detrimental to black-and-white facsimile.

b) *Overall loss*

The conditions for overall transmission loss are the same as those for circuits of the general telephone network.

c) *Modulation*

Black-and-white facsimile equipment for the subscriber service in the telephone network shall employ a frequency modulation system. The following characteristics shall be used:

— mean frequency (corresponding to assigned frequency) . . . . 1700 Hz (provisional)
— frequency corresponding to black . . . . 1700 − 400 Hz
— frequency corresponding to white . . . . 1700 + 400 Hz

d) *Sent signal power*

In order to avoid the risk that facsimile signals be disturbed, e.g. by dial pulses transmitted over adjacent channels or by noise, it is important that the sending level should be as high as possible, provided, however, that it shall not exceed −10 dBm0 on the multichannel system and also that the power at the output of the sending apparatus shall not exceed 1 mW.

Note. — The value of −10 dBm0 is in accordance with Recommendation V.2 (*White Book*, Volume VIII), since the facsimile transmissions are operated in all cases in simplex. This value may have to be revised if the percentage of circuits used for applications other than telephony should go beyond the assumption indicated in the considering of Recommendation V.2.

e) *Signal reception power*

Correct operation of the receiving apparatus will be ensured, if the input level is not less than −40 dBm (see Recommendation T.2 on this subject). However, for reasons of security, a margin of 3 dB should be allowed giving an effective minimum reception level of −37 dBm.

f) *Precaution concerning signalling*

It should be noted that when a call is being established on the general switched telephone network it is not possible to disconnect the telephone signalling devices and facsimile transmission may cause difficulties.

As regards the present two international signalling systems of the C.C.I.T.T. operating on the frequencies of 2280 Hz and 2040/2400 Hz and the intercontinental systems which use the line signalling frequencies of 2400 Hz and 2600 Hz, nothing is to be feared. However, the possibility of extending facsimile transmissions on to the domestic network may involve unwanted operation in the domestic system if the latter uses a telephone signalling of the frequency of 2100 Hz.

Since the telephone signalling frequency of 2100 Hz is not generally used and this frequency is even recommended for disablement of echo suppressors which may be located on long-distance international circuits, the C.C.I.T.T. considers that it is not necessary in the first place to transmit at the same time as the facsimile signal a continuous blocking frequency intended to prevent unwanted operation of the telephone signalling receiver.

g) *Attenuation distortion*

With the diagram in Recommendation G.132 (*White Book*, Volume III), the attenuation distortion in the 400-3000-Hz band is less than 0.75 Np (6.5 dB) on the circuits which are part of the connection and of the total connection established by means of channel equipments which conform to Recommendation G.232 shall not exceed about 1 Np (8.7 dB) in the bandwidth quoted above.

This is not harmful to facsimile transmission using apparatus specified in Recommendation T.2. Hence, the addition of attenuation distortion compensators to the facsimile apparatus need not be envisaged.

h) *Variation of equivalent with time*

It seems that connections established over the telephone network present a sufficient stability, on condition that the abrupt variations do not reach such a value that the reception level should fall below the limit specified in Recommendation T.2 for the level at the reception.

i) *Phase distortion*

It appears that the characteristics specified by the C.C.I.T.T. for modern-type telephone circuits are sufficient to permit of facsimile transmissions on a circuit taken at random from the circuit systems normally used for telephony.

However, it should be noted that the connection may include extreme channels of groups on which the effect of phase distortion is more evident; but it is not very likely that several of these channels will be taken in series at the same time, in which case the quality of the facsimile transmission might be impaired by a group delay distortion which might be too high.

Note. — It should be noted that as long as sections in loaded cables might be included in the established connection, with a scanning line frequency of 120 per minute (see Recommendation T.2) the quality of the restitution could be impaired, depending on the length of the loaded cable sections.

RECOMMENDATION T.11

PHOTOTELEGRAPH TRANSMISSIONS ON TELEPHONE-TYPE CIRCUITS

(former C.C.I.T. Recommendation D.3, amended at New Delhi, 1960, and at Geneva, 1964)

Note. — In the case of carrier circuits, this recommendation applies only to systems established on the basis of 12-channel group links. Systems using 16-channel group links will be the subject of subsequent study.

Both audio-frequency telephone circuits and carrier circuits can be used for phototelegraphy.

When normal audio-frequency circuits or carrier circuits are used, amplitude modulation offers some advantages over frequency modulation [1] and is therefore to be preferred for phototelegraph transmissions on circuits set up from end to end on cable or line-of-sight radio-relay links [2].

However, in the case of circuits subject to sudden level variations or to noise, frequency modulation may be preferable to amplitude modulation; administrations (or recognized private operating agencies) could in this case come to an agreement to use frequency modulation for phototelegraph calls over such circuits; the provisions of Recommendation T.1 relative to the frequency modulation characteristics should then be applied.

For these reasons, the C.C.I.T.T. *unanimously declares the view*

that phototelegraph transmissions over telephone circuits require that the following conditions be observed, according to the way in which the circuits are used for phototelegraphy:

A. Circuits permanently used for phototelegraphy

It seems that these circuits are few. In any case, they should even more easily meet the characteristics given in section B below.

B. Circuits used normally (and preferentially) for phototelegraphy

a) *Types of circuit to be used*

Two-wire circuits have no practical value for phototelegraphy because of feedback phenomena.

For the same reason, four-wire circuits should be extended to the phototelegraph stations on a four-wire basis at the appropriate amplifier stations, the terminating units and echo suppressors always being disconnected.

[1] In particular, with the same index of co-operation and speed, frequency-modulation necessitates wider frequency range than that of amplitude-modulation to obtain a picture of same quality.

[2] See Recommendation T.15 for phototelegraph transmissions over combined radio and metallic circuits.

b) *Overall loss*

The same conditions apply to the overall transmission loss of four-wire circuits used for phototelegraphy as apply, in general, for telephony.

c) *Sent signal power*

The emission voltage for the phototelegraph signal corresponding to maximum amplitude should be so adjusted that the absolute power level of the signal, at the zero relative level point deduced from the hypsogram of the telephone circuit, is 0 neper (0 decibel) for amplitude-modulation facsimile transmission and -1.15 neper (-10 decibels) for frequency-modulation facsimile transmissions. In the case of amplitude-modulation the level of the signal corresponding to black is usually about 30 decibels lower than that of the signal corresponding to white.

d) *Relative levels*

If phototelegraph transmissions take place simultaneously from a transmitting station to several receiving stations, arrangements shall be made at the junction point so that, on the circuits following the junction point, the same power levels are maintained as those prescribed for individual transmissions.

e) *Attenuation distortion*

When amplitude modulation is used, the attenuation distortion between phototelegraph stations should not exceed 1.0 neper (8.7 decibels). Since in the band of frequencies to be transmitted for the phototelegraph transmission, the distortion admitted for the telephone trunk circuit itself should not exceed 0.75 neper (6.6 decibels), it will not in general be necessary to compensate for the distortion of the lines joining the phototelegraph stations to the amplifier stations.

In the case of frequency modulation, it suffices to use telephone circuits conforming to C.C.I.T.T. recommendations regarding attenuation distortion (see Recommendation G.132—Volume III of the *White Book*).

f) *Variation of equivalent with time*

The overall loss should remain as constant as possible during the picture transmission. In the case of amplitude modulation, abrupt variations of even 2 centinepers (0.2 decibel) have an effect. It is, moreover, necessary to avoid any interruption of the circuit, however rapid. For this reason, the greatest attention should be paid to the measurements made on the amplifiers and lines and to the changing of batteries. To reduce the likelihood of disturbance, it is desirable that the terminal trunk exchanges should be excluded from the circuit when it is extended to the facsimile stations.

Special precautions should be taken to make sure that no modulation of the carrier is caused by the line or the amplifiers, even if the modulation is inaudible. Such modulation may be due, in particular, to variations in the voltage of the supply batteries, or to sub-audio telegraphy equipment.

In the case of frequency modulation, sudden changes of even 1.15 neper (10 decibels) can be tolerated and telephone circuits, even when set up without special precautions, have sufficient stability.

This observation does not mean that sudden variations of level should not be avoided just as much in the case of circuits carrying frequency-modulated phototelegraphy.

g) *Phase distortion*

Phase distortion limits the range of satisfactory phototelegraph transmissions. Differences between the group delays of a telephone circuit, in the interval of the phototelegraph transmission, should not exceed

$$\Delta t \leqslant \frac{1}{2f_p}$$

f_p = Maximum modulating frequency corresponding to the definition and scanning speed.

(See Recommendation T.12.)

h) *Interference*

Interfering currents, whatever their nature, should not exceed the C.C.I.T.T. recommended limits for telephone circuits.

C. Telephone circuits rarely used for phototelegraphy

a) *Transmission characteristics*

It seems that the majority of the characteristics specified by the C.C.I.T.T. for modern telephone circuits are sufficient to permit phototelegraph transmissions on a circuit chosen at random in a group of circuits normally used for telephone working. However, it is not certain that such a circuit would have a sufficiently low phase distortion for such use, particularly channels 1 and 12 of a 12-circuit group, use of which is not advised. The influence of phase distortion is more noticeable in frequency modulation.

With amplitude modulation there is a further risk that phototelegraph transmissions will be subject to faulty modulation because the special precautions applied to circuits regularly used for phototelegraphy (see B, f above) cannot be applied to circuits taken at random.

b) *Precautions concerning signalling*

So long as automatic switching for phototelegraph circuits is not envisaged, the signal receiver can be disconnected so that no signalling disturbances can occur even when frequency modulation is used. However, if frequency modulation is used for phototelegraph transmission and if it is impracticable to disconnect the signal receiver, then it would be desirable, in the case of the one-frequency system, that a blocking signal be transmitted along with the picture signal to operate the guard circuit and render the receiver inoperative.

It is also apparent that the frequency of such a blocking signal should lie well outside the range of frequencies involved in the picture transmission.

The frequency and the level of the blocking signal must depend on the characteristics of the v.f. receiver (or receivers in the case of a tandem international connection), as designed by different administrations to meet the specification to be prescribed for international signalling.

In the case of the two-frequency international signalling system, the C.C.I.T.T. has indicated its view that no interference will take place.

RECOMMENDATION T.12

RANGE OF PHOTOTELEGRAPH TRANSMISSIONS ON A TELEPHONE-TYPE CIRCUIT

(former C.C.I.T. Recommendation D.3, amended at New Delhi, 1960, and at Geneva, 1964)

Note. — In case of carrier circuits, this recommendation applies only to systems established on the basis of 12-channel group links. Systems using 16-channel group links will be the subject of subsequent study.

1. The differences between the delays of the various frequencies and the width of the transmission band actually usable on a circuit for telephony give rise, when phototelegraph signals are started or stopped, to transient phenomena which limit the phototelegraph transmission speed;

2. The range of phototelegraph calls of satisfactory quality, for a given transmission speed, depends especially on the constitution of the circuit, i.e. on:

- the loading and length, in the case of audio-frequency circuits;
- the number of 12-channel group links used in tandem in the case of carrier circuits, and on the choice of the carrier frequency for amplitude-modulated phototelegraph transmission, or on the mean frequency in the case of frequency modulation;

3. Phototelegraph transmission of satisfactory quality requires that the limits of difference between the group delays in the transmitted frequency band, as shown in the graph below (Figure 1), are not to be exceeded;

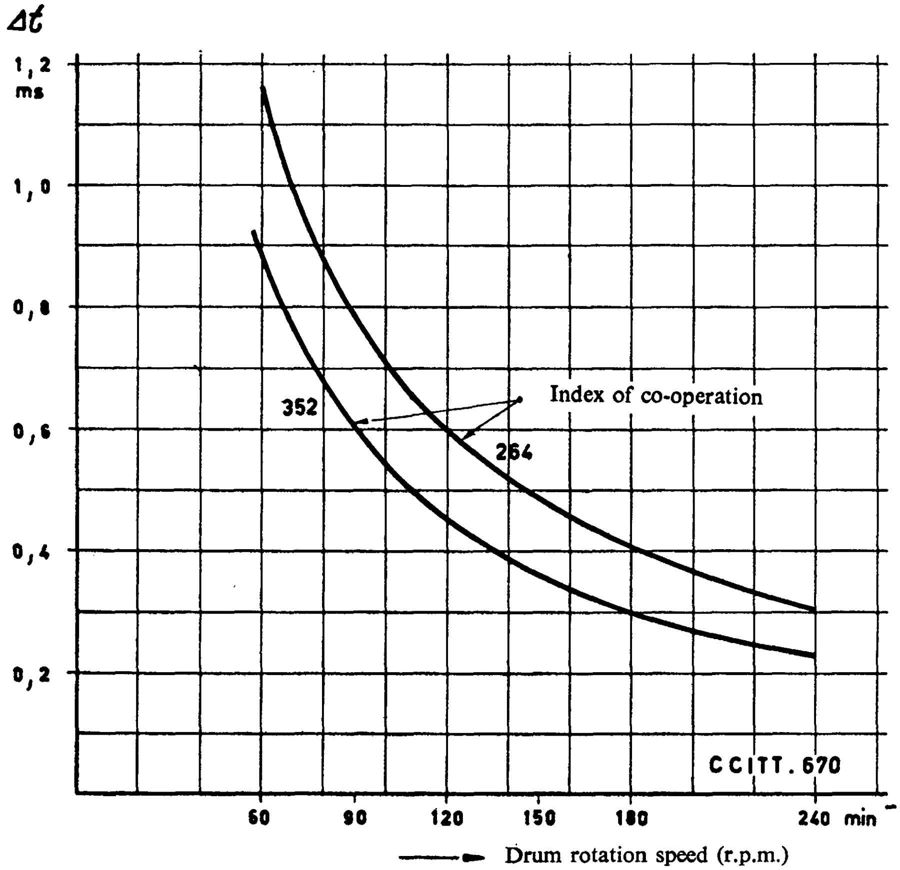


FIGURE 1. — **Permissible delay distortion in the transmitted frequency band as a function of the phototelegraph transmission speed**

Note. — The spot is assumed to have the same dimensions in both directions (square or circular).

4. The C.C.I.T.T. has recommended the following for international telephone circuits:

The permissible difference for a world-wide chain of twelve circuits, each set up on a single group link between the minimum group delay throughout the frequency band transmitted and the group delay at the upper and lower limits of this band are given in the table below:

	Lower limit of the frequency band	Upper limit of the frequency band
International chain	30 ms	15 ms
Each of the national four-wire extensions	15 ms	7.5 ms
On the whole four-wire chain	60 ms	30 ms

For these reasons, the C.C.I.T.T. *unanimously declares the following view:*

As regards the effect of phase distortion on phototelegraph transmission quality, the carrier frequency (where amplitude modulation is used) or the mean frequency (when frequency modulation is used) must be chosen in such a way that it is as near as possible to the frequency which has the minimum group delay on the telephone circuit.

A. Circuits permanently used for phototelegraphy

1. It will generally be possible, by agreement between administrations, to choose a circuit satisfying stricter limits than those specified above from the point of view of phase distortion

2. Moreover, it will be possible to compensate phase distortions by inserting phase equalizers and to effect phototelegraph transmissions occupying the whole nominal band of the circuit.

B. Circuits used normally (or preferentially) for phototelegraphy

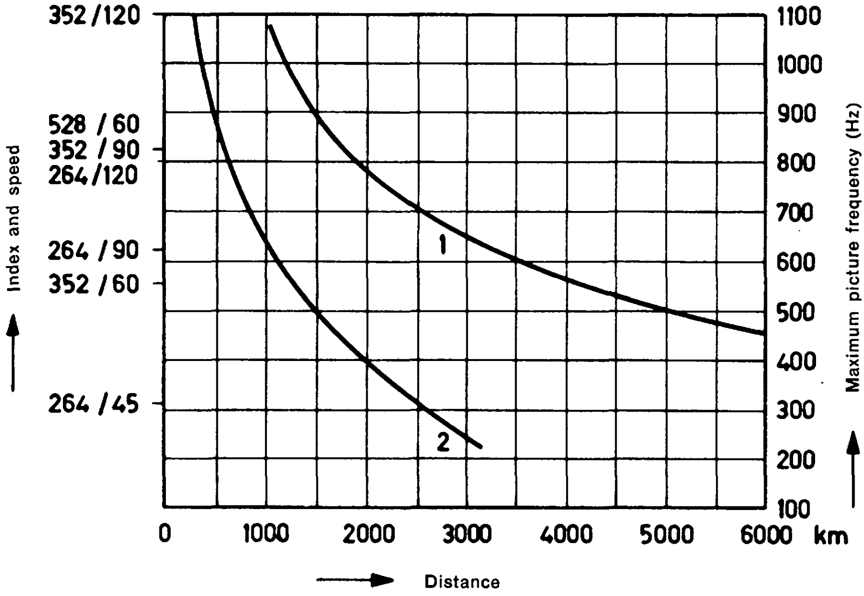
1. The greater the differences between the delays in the transmission intervals, the narrower should be the bandwidth chosen (leading to a lower phototelegraph definition or transmission speed).

2. Hence, audio-frequency circuits should in any case be lightly loaded circuits.

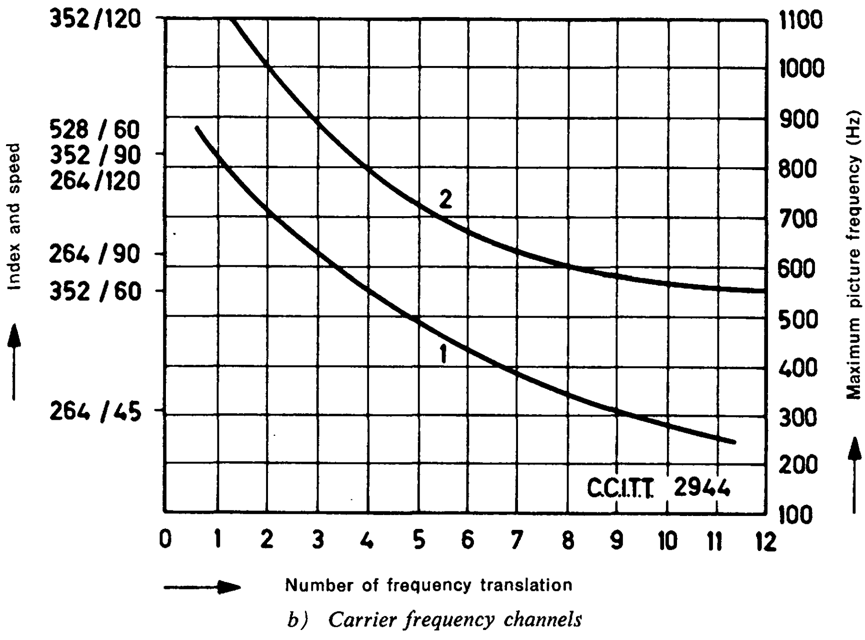
3. Phase distortion is well within the limits indicated above, in the case of carrier circuits, if a single modern-type carrier system is considered (and considering especially the telephone channels in the middle of a 12-channel group of such a system).

4. Nevertheless, it would be unjustifiable from the financial point of view to make the aforementioned recommendation concerning phase distortion stricter simply with a view to the occasional use of only a few circuits for high-speed phototelegraph transmissions.

5. The following curves give information on the relative performances of amplitude and frequency-modulated phototelegraph transmissions on audio-frequency and carrier telephone circuits.



a) Audio-frequency circuits



b) Carrier frequency channels

Curve 1: AM carrier = 1300 Hz Curve 2: FM = 1900 ± 400 Hz AM Carrier = 1900 Hz

FIGURE — **Range of phototelegraph transmission**

C. TELEPHONE CIRCUITS RARELY USED FOR PHOTOTELEGRAPHY

If phototelegraph connections are set up on circuits selected at random from modern-type groups of telephone circuits (for example, by automatic switching), a circuit may be taken which has too high a degree of phase distortion, particularly if it has been set up on channels 1 or 12 of a 12-channel group, use of which is deprecated. It is impossible, in this case, to draw up general information on the range of phototelegraph transmissions; however, it will be possible to meet the conditions for a transmission of adequate quality if the phototelegraph connection comprises only one 12-channel group link and if transmission is effected in normal conditions as outlined in Recommendation T.1.

RECOMMENDATION T.15

PHOTOTELEGRAPH TRANSMISSION OVER COMBINED RADIO AND METALLIC CIRCUITS [1]

(former C.C.I.T. Recommendation D.4, modified at New Delhi, 1960, at Geneva, 1964, and at Mar del Plata, 1968)

A. Characteristics of circuits and apparatus used

The C.C.I.T.T.,

considering

a) that, to facilitate interworking, it is desirable to standardize the characteristics of systems employed for phototelegraph transmission over long-distance h.f. (decametric) circuits [2];

b) that it is desirable to standardize certain characteristics of the systems in such a way as to make them equally suitable for transmission over metallic circuits;

c) that the transmission system using direct amplitude-modulation is generally unsatisfactory over h.f. (decametric) radio circuits, because of the intolerable fading ratio usually encountered;

d) that the system of sub-carrier frequency-modulation has proved satisfactory, but requires standardization in respect of the centre frequency and shift frequencies, taking into account the values of the picture-modulation frequencies to be transmitted;

e) that, when a direct frequency-modulation system is employed, the terminal equipment normally used for a sub-carrier modulation system should be usable without serious modifications;

f) that, taking into account the quality necessary for reproduction of the picture received, the effect of multipath echoes on long-distance h.f. (decametric) radio circuits normally limits the maximum admissible picture-modulation frequency to approximately 600 Hz,

unanimously declares the following view:

that phototelegraph transmissions over combined radio and metallic circuits should conform to the following provisions:

[1] This Recommendation corresponds to C.C.I.R. Recommendation 344-1.
[2] The transmission over communication-satellite systems will be the subject of later study.

Characteristics of radio circuits

1. Over the radio circuit,

1.1 when sub-carrier frequency-modulation system is used, the following characteristics should be observed:

centre frequency . . . . 1900 Hz
frequency corresponding to white . . . . 1500 Hz
frequency corresponding to black . . . . 2300 Hz
(the 1500-Hz frequency is also used for the phasing signal);

1.2 when a direct frequency-modulation system is employed, the following characteristics should be observed:

centre frequency (corresponding to assigned frequency) . . . . f_0
frequency corresponding to white . . . . f_0-400 Hz
frequency corresponding to black . . . . f_0+400 Hz
(the frequency f_0 -400 Hz is also used for the phasing signal);

2. in both systems the stability of frequencies should be such that the variations are less than:

8 Hz during a period of 1 second,
16 Hz during a period of 15 minutes.

Characteristics of equipment and metallic circuits

3. The standards for phototelegraph apparatus and the specifications for transmission on metallic circuits are given in Recommendations T.1 and T.11.

Typical circuit

4. In principle, a world-wide hypothetical connection consisting of combined radio and wire channels may involve a maximum of two radio circuits with two metallic circuits at either end. Another metallic circuit may be required in the radio channel link if, in a country, the receiving and transmitting radio stations are at a distance from each other or

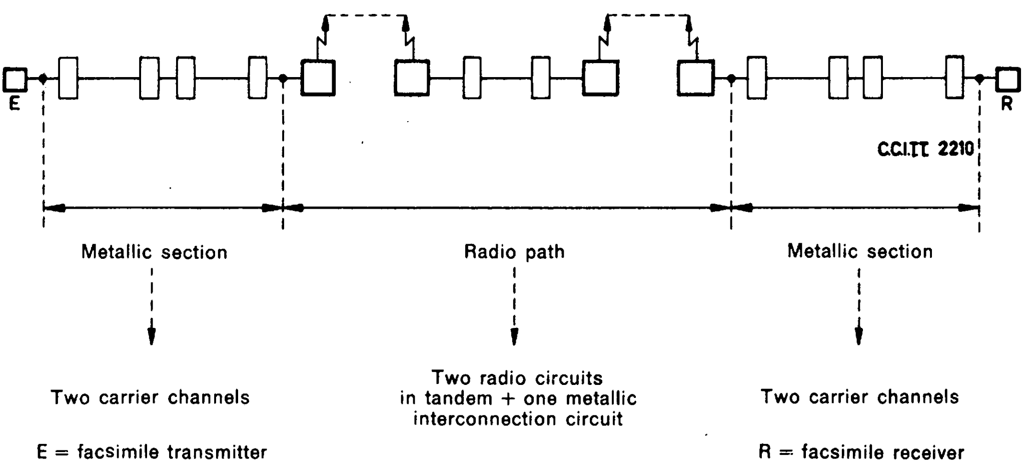


FIGURE 1. — **Typical circuit in a world-wide phototelegraph connection**

if the two radio circuits terminate in neighbouring countries. The typical circuit for this connection is shown in Figure 1.

B. Overall frequency stability

The C.C.I.T.T.,

considering, further,

a) that in such a world-wide connection, the stability of black and white frequencies at the input of the receiving apparatus should be such that they do not exceed their nominal value by more than ± 32 Hz during any period of 15 minutes (see Recommendation T.1);

b) that sudden frequency variations due to instability of the a.m./f.m. converter or the radio circuits which are limited to ± 8 Hz for each element, could occur four times with the maximum value and in the same direction, before causing an intolerable frequency drift at the receiving end;

c) that such an occurrence as well as an unfavourable addition of errors will be unlikely to occur, as it seems unlikely that such variations will occur simultaneously;

d) that it also seems unlikely that gradual frequency variation limited to ± 16 Hz for each element constituting the transmission system will occur simultaneously in the same direction to the limit of tolerance admitted and that it would be added to frequency drifts over terrestrial circuits (carrier channels) for which Recommendation G.225 admits ± 2 Hz at the maximum;

e) that it may be assumed that the above-mentioned frequency variations would be distributed at random and the frequency drifts at the receiving end of the world-wide connection do not exceed the standard mean value:

$$\Delta F = \sqrt{3 \times 16^2 + 5 \times 2^2} = 28 \text{ Hz}$$

f) that, in practice, the actual deviations will be much less than this value owing to the fact that in general a frequency stability much higher than the admissible tolerance could be realised,

unanimously declares the following view:

1. on the metallic sections connected to both ends of the radio path, frequency modulation can be used whatever type of modulation be used over the radio circuits;

2. however, amplitude modulation should preferably be used (see Recommendation T.11 on this subject).

C. Modulation conversion

The C.C.I.T.T.,

considering, on the other hand,

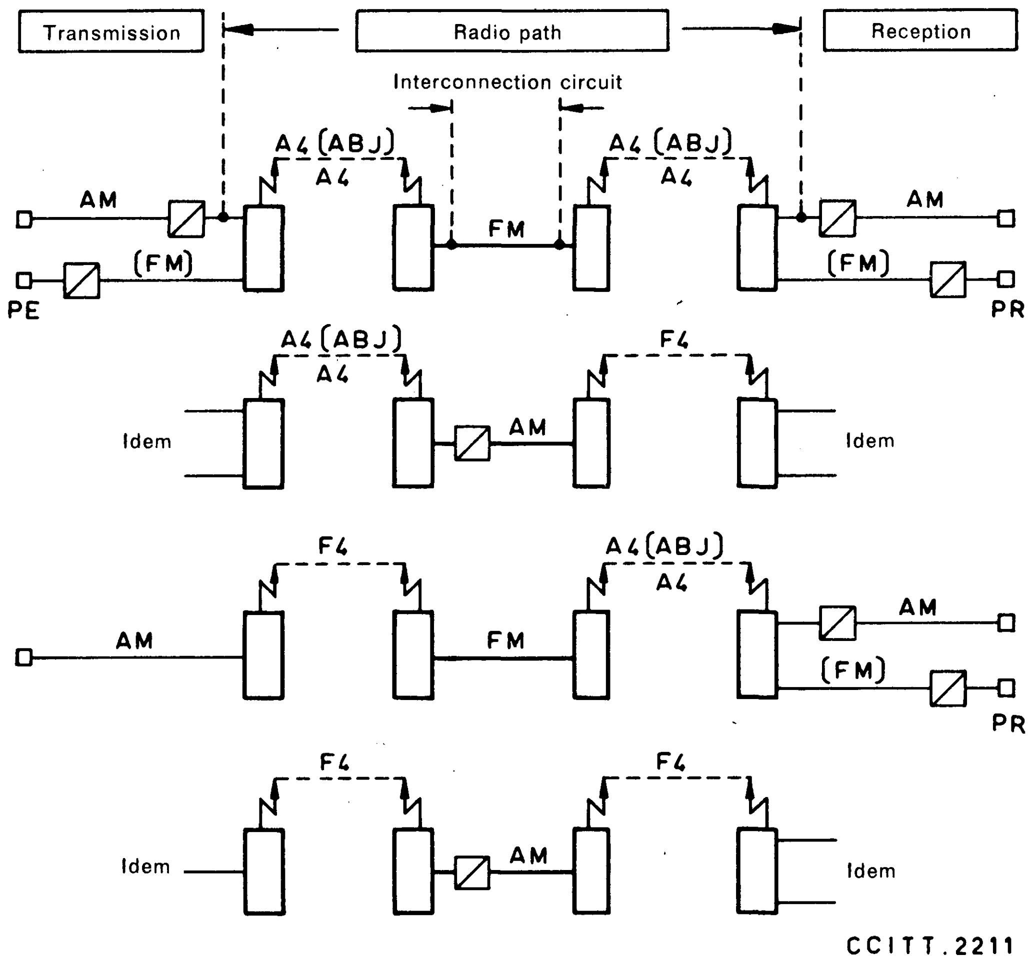
a) that existing two modulation variants are permissible over the terrestrial circuits and that it will be necessary to convert in certain cases from one type of modulation to the other;

b) that it will also be necessary to decide the location of the modulation converters;

unanimously declares the following view:

1. when conversion from amplitude modulation to frequency modulation (or vice versa) is required, the conversion should be such that the deviation of the frequency-modulated carrier varies linearly with the level of the amplitude-modulated carrier;

2. the converters will be placed either at the terminal phototelegraph station or at the control station serving the radio circuit in order to permit speech on the circuit used for phototelegraphy, if the radio channel will carry speech;



PE = Transmitting station.
PR = Receiving station.
A4A = Single-sideband system, with reduced carrier.
A4J = Single-sideband system with suppressed carrier.
A4B = Independent-sideband system with suppressed carrier, two channels.
A4 = Double-sideband system with full carrier. (These systems use a sub-carrier f.m. system.)
F4 = System with direct frequency modulation of the main carrier.

FIGURE 2. — **Position of modulation converters** (⧄)

3. according to Recommendation T.11, amplitude-modulation transmission normally is used on metallic circuits. When the circuit is of the combined type and includes two radio circuits, however, frequency modulation may be kept on the interconnection circuit, should this type of modulation be required at the input of the second radio section.

But if conversion from frequency modulation to amplitude modulation is necessary between the output of the first radio circuit and the input of the second, the f.m./a.m. converter should preferably be placed at the control station at the output of the first radio circuit (see Figure 2).

RECOMMENDATION T.16

FACSIMILE TRANSMISSION OF METEOROLOGICAL CHARTS OVER RADIO CIRCUITS [1]

(former C.C.I.T. Recommendation D.7, Geneva, 1956, amended by C.C.I.R., Los Angeles, 1959, Geneva, 1963, and Oslo, 1966)

The C.C.I.R. and the C.C.I.T.T,

considering

a) that increasing use is being made of facsimile telegraphy for the transmission of meteorological charts for reception on direct-recording apparatus;

b) that it is desirable to standardize certain characteristics of the radio circuits for this purpose,

unanimously declare the view

1. that when frequency-modulation of the sub-carrier is employed for the facsimile transmission of meteorological charts over radio circuits, the following characteristics should be used:

centre frequency	1900 Hz
frequency corresponding to black	1500 Hz
frequency corresponding to white	2300 Hz

2. that when direct frequency modulation is employed on radio circuits the following characteristics should be used:

2.1. *h.f. (decametric) circuits*

centre frequency (corresponding to the assigned frequncy)	f_0
frequency corresponding to black	f_0 −400 Hz
frequency corresponding to white	f_0 +400 Hz

[1] This Recommendation corresponds to C.C.I.R. Recommendation 343-1.

2.2. *l.f. (kilometric) circuits*

centre frequency (corresponding to the assigned frequency)	f_0
frequency corresponding to black	$f_0 - 150$ Hz
frequency corresponding to white	$f_0 + 150$ Hz

RECOMMENDATION T.20

STANDARDIZED TEST CHART FOR FACSIMILE TRANSMISSIONS

(black-and-white and picture facsimile)

(New Delhi, 1960, amended at Geneva, 1964, and at Mar del Plata, 1968)

It will be a great advantage to use a standardized test chart to check the quality of facsimile transmissions. Such a chart would provide the receiving office with a reliable and rapid means of checking the quality of test transmissions according to uniform principles and of making comparisons between different transmission results in a precise way. The chart has been designed for measuring the quality of both picture and black-and-white transmissions and it enables the apparatus used and the communication channels to be judged by means of objective measurements, the results of which may be expressed in code.

For the above reasons, the C.C.I.T.T. *unanimously declares the following view:*

1. Tests of facsimile transmission quality (including phototelegraph transmissions) will be carried out in the international service with the aid of the " C.C.I.T.T. standardized test chart ".

2. This test chart is made by the I.T.U. under the supervision of the C.C.I.T.T. and should be offered for sale by the I.T.U. There are two editions:

— test charts sold before the IVth Plenary Assembly of the C.C.I.T.T. (October 1968) are of the first edition;

— test charts sold since the IVth Plenary Assembly of the C.C.I.T.T. are of the second edition.

These test charts are described in the Annex to this Recommendation; the specimens printed in the annex cannot be used for measurements.

3. These two test charts are compatible and a test chart of either the first edition or the second can be used in the international service.

ANNEX

The C.C.I.T.T. standardized test charts

1. The test chart has the following dimensions:

length: 250 mm
width: 110 mm

The lateral margin is some 10 mm wide on either side. The margin at top and bottom is 20 mm wide, approximately. The chart is divided into sections marked on the transparent paper delivered with every chart.

2. Sections 1 and 2 contain two tone scales, each having 15 density steps, varying from black to white and vice versa. Nos. 1, 4, 8, 11, and 15 bear their numbers on them, the number 1 always betokens white and the number 15 black.

3. Section 3 is occupied by a group of black lines on a white background, in the form of hyperbolae. The thickness of the lines and the distances between them diminish regularly from left to right, from 1 mm to 1/6 mm.

If a vertical line be drawn through the hyperbolae, the lines therein will subtend distances on the vertical line equal to the inverse of the figures on the scale graduated from 1 to 6 at the bottom of Section 3.

4. Section 4 contains two groups of hyperbolae similar to those of Section 3 but limited to the scanning densities lying between 3 and 6. One group is made up of grey lines on a white ground, the other by grey lines on a black ground.

5. Section 5 contains three patterns.

a) First edition:

The first pattern is made up of five black lines on a white background, the lines being 0.25 mm thick, arranged in one group of two lines and another of three lines. These lines are 0.25 mm apart, and the two groups are separated by 1.5 mm.

The second pattern is the same as the first, but the lines are white on a black background.

The third pattern consists of two similar groups of black lines on a white background, as follows:

— line, thickness	1 mm
— separation	0.25 mm
— line, thickness	0.25 mm
— separation	1 mm
— line, thickness	0.25 mm
— separation	0.25 mm
— line, thickness	1 mm

The two groups are separated by 1 mm.

b) Second edition:

The first pattern is made up of eight black lines on a white background, separating into three groups:

— one group of two black lines being 0.25 mm thick and 0.25 mm apart;

— one group of three black lines being 0.25 mm thick and 0.25 mm apart;

— one group of three black lines being 0.1 mm thick and 0.25 mm apart.

These groups are separated by 1.5 mm.

The second and third patterns are respectively the same as those of section 5 of the first edition.

6. Section 6 contains a tapering black line on a white background, and a tapering white line on a black background. The maximum width of the tapering lines is 0.7 mm.

At the top of the section is a scale in millimetres, showing the width of the tapering lines.

7. Section 7 contains a strip of tone equivalent to that in Section 1, step 11, on a background of Section 1, step 5.

8. In the first edition, Section 8 accommodates a photograph of UNESCO House in Paris. In the second edition, Section 8 accommodates a portrait of an Argentine boy.

9. Section 9 contains two concentric circles, the radii of which differ by 1 mm. A square, with its diagonals, is inscribed in the inner circle.

In the second edition the radii of the two circles are bigger than those of the first edition and the exterior circle is osculating with the limits of Section 9.

10. There are two Sections numbered 10 which contain adjustment lines.

In the first edition, these lines are numbered from 1 to 6 and these figures are placed in the central part of the left half of Section 10.

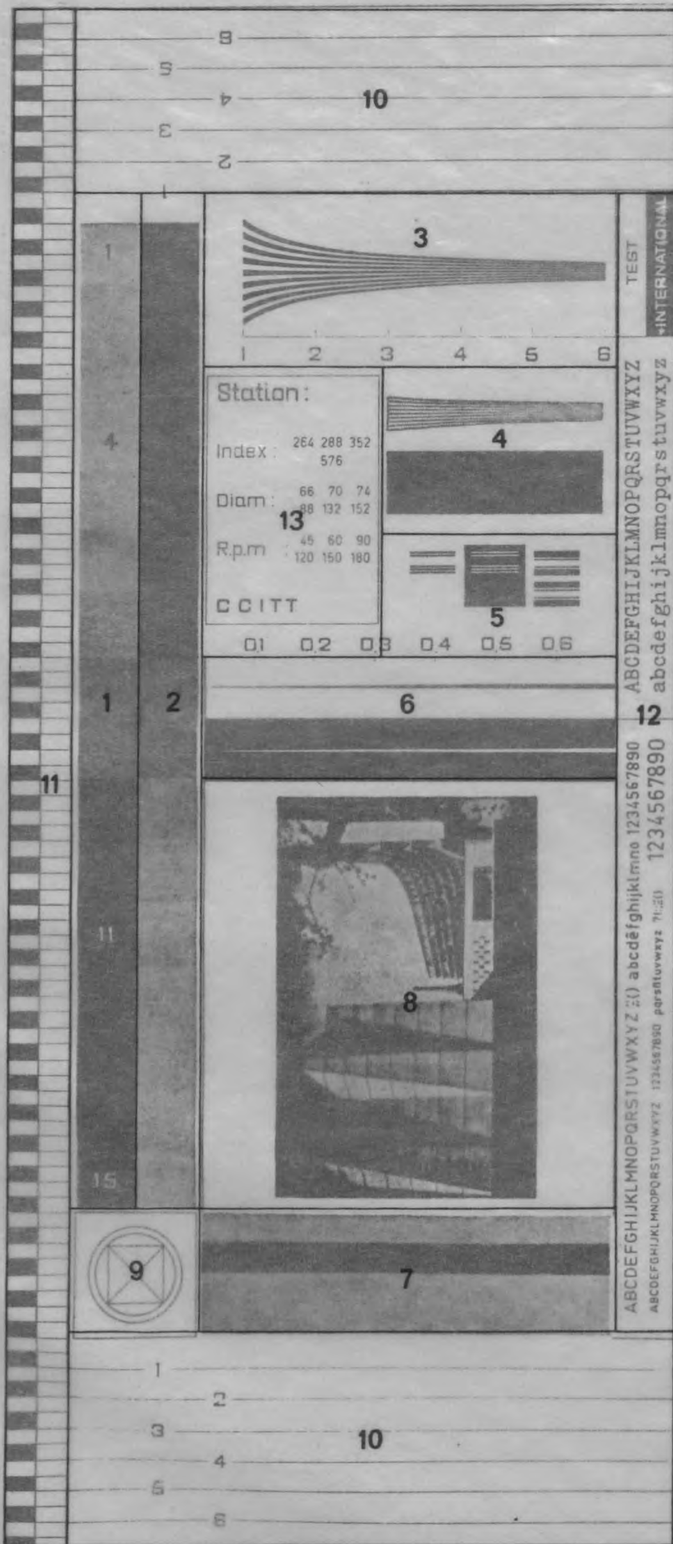
In the second edition, only the even adjustment lines are numbered and these figures are placed at the left of the prolongation of the line separating sections 3 and 12, 7 and 12 respectively.

11. Section 11 contains a pattern of lines, with a spacing of 2.5 mm. It is divided into two equal parts by a vertical line. The column on the right contains white rectangles, while that on the left contains alternate white and black rectangles.

In the second edition Section 11 is so cut that the parts adjacent to Sections 10 are kept in white. These parts are used for extension of the adjustment lines of Sections 10.

To indicate the centre of the test charts of the second edition, a line in the right column of section 11 which is the prolongation of the line separating the density steps 8 and 9 of Section 1 is 0.5 mm thick.

12. Section 12 contains letters, digits, and punctuation marks printed in various styles, and arranged so that they can be read sideways.



Test chart (first edition)

Test chart (second edition)

Section 12 is divided into three parts:

The bottom part contains typographical signs (letters, figures, and a few punctuation marks), printed in various styles.

The middle part contains signs in typewritten characters 2.3 mm high.

The top part contains two words: "TEST" and "INTERNATIONAL" one above the other. "TEST" is black on a white background, while "INTERNATIONAL" is white on a black background.

13. Section 13 contains

— space for the name of the transmitting station;

— the co-operation indices most often used;

— the diameters in millimetres of the drums most often used;

— the r.p.m. of the drums;

— « Mod.: AM FM » to indicate either amplitude-modulation or frequency-modulation (the second edition only);

— the indication " C.C.I.T.T." in the test charts of the first edition is replaced by " C.C.I.T.T. 2 " for the test charts of the second edition.

SERIES U RECOMMENDATIONS

Telegraph Switching

RECOMMENDATION U.1

SIGNALLING CONDITIONS TO BE APPLIED IN THE INTERNATIONAL TELEX SERVICE

(former C.C.I.T. Recommendation E.1, Arnhem, 1953, amended at Geneva, 1956, at New Delhi, 1960, at Geneva, 1964. and at Mar del Plata, 1968)

Signalling conditions in the international telex service require accurate definition of the signals to be used on international telex circuits in putting through, supervising, clearing, and charging for international telex calls.

These signals must be such as to take into account that there are some fairly important differences in make-up between the telex networks of different countries. In some countries, selection is done by dialling, in others by means of start-stop signals; some networks use direct selection while others use register translators; between some networks, subscriber automatic selection is used whilst, in relations with other networks, semi-automatic or manual selection is still being used.

Hence it has not been possible to lay down uniform signals for all international telex relations. While, for certain signals, it has been possible to lay down rules valid for all relations, for others the choice has been left between two types of signals known as type A and type B. Within each type, it has sometimes been necessary to provide alternative forms for certain signals. The signals with regard to which there is a choice are described in Tables I a, I b and II of the recommendation.

It is intended that the signalling with which this recommendation deals should apply as far as possible when telex circuits make use of transmission devices having multiplex and signal regeneration facilities. In the case of operation over error-corrected radio circuits, Recommendation U.20 lays down the conditions for adapting the signalling defined in Recommendation U.1. In the case of operation over channels using synchronous multiplex equipment in accordance with Recommendation R.44, Recommendation U.24 lays down the conditions for adapting the signalling defined in Recommendation U.1. When the signals defined in Recommendation U.1 are transmitted via regenerative repeaters the signals received from these transmission devices may lie outside the tolerances stated in this recommendation, and the permitted variations are shown in Recommendation U.5.

It has also been necessary to define an additional signalling standard (type C signalling) for use on the intercontinental telex transit network. Details of this method of signalling are laid down in Recommendation U.11.

For these reasons, the C.C.I.T.T. *unanimously declares the view:*

A. That in general, so far as signalling over international telex circuits is concerned, the outgoing country should conform to the signalling requirements of the incoming country. Nevertheless, when in the case of fully automatic service this requirement would entail considerable difficulty, alternative arrangements may be adopted by agreement between the two administrations concerned.

B. That the following signals shall be employed, under the conditions indicated:

1. *Free line condition*

The " free line " is characterized by a permanent signal corresponding to the start impulse in accordance with international telegraph alphabet No. 2 on the forward and backward signalling paths.

2. *Call*

The " call " is characterized by the inversion of the condition specified in paragraph 1 on the forward signalling path.

3. *Call-confirmation signal*

A " call-confirmation " signal shall be returned over the backward signalling path following the initiation of a call to prove the continuity of the line and the response of the distant terminal equipment.

The call-confirmation signal shall be returned by the receiving end as quickly as possible and in any event with a delay not exceeding 150 milliseconds after the arrival of the calling signal at the receiving end.

4. a) *Proceed-to-select signal*

In the case of international telex circuits terminated on distant automatic switching equipment which cannot accept the selection information immediately (either after the reception of the calling signal or after the sending of the call-confirmation signal), a distinct " proceed-to-select " signal shall be returned over the backward signalling path after the call-confirmation signal, to indicate that the selection information may be transmitted.

For type A signalling, the sending duration of the " stop " polarity, from the beginning of the call confirmation signal until the moment when the proceed-to-select signal begins to be sent, should be at least 100 milliseconds.

For type B signalling, the time interval between the end-of-the-call confirmation signal pulse and the moment when the proceed-to-select signal begins to be sent, during which the " start " polarity is sent, should be at least 100 milliseconds.

During the busy hour, for 99 calls in 100, the delay in the return by the receiving system of the proceed-to-select signal must not exceed 3 [1] seconds after the reception of the calling signal.

If the automatic switching equipment at the receiving end can receive the selection information immediately after the sending of the call-confirmation signal, the call-confirmation signal shall constitute the proceed-to-select signal.

If the automatic switching equipment at the receiving end can receive the selection information at the time of receiving the call signal, there shall be no proceed-to-select signal.

b) *Proceed-to-transmit signal*

In the case of international telex circuits terminated on a distant manual switchboard, a " proceed-to-transmit " signal shall be returned over the backward signalling path following the initiation of a call, to indicate that the teleprinter of the distant operator has been connected to the international circuit.

5. *Selection signals*

a) The selection signals should be in conformity with international alphabet No. 2 or dial signals in conformity with Recommendation U.2.

b) In the case of dial selection into a system employing letters in the national numbering scheme, figures only will be used on international circuits, because of the difficulty in transmitting signals other than figures from dials.

c) In the case of selection into a keyboard selection system, the " prepare for digits " signal will be combination No. 30 (figures shift).

d) In those cases where an " end-of-selection " signal is required, this signal shall be combination No. 26, possibly followed by another combination characterizing the class of traffic in the incoming country.

e) In systems which use keyboard selection and which require an " end-of-selection " signal, the subscribers' numbers shall consist of a uniform number of characters. A smaller uniform number of characters is, however, permitted for special services, provided the discrimination of these special services can be effected on the first character.

f) To avoid undue occupation of lines and equipment, administrations should take all reasonable steps to ensure that the transmission of selection signals over international circuits are completed without undue delay. In particular, where excessive delays are encountered the incoming country may cause the connection to be cleared. When dialling signals are sent by a subscriber, or by an operator, from country A towards a register in country B, country B may disconnect itself from the call if a time interval between two successive pulse trains exceeds 5 seconds.

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[1] In certain existing networks, this time may be 4 seconds.

6. *Call-connected signal*

a) A " call-connected " signal shall be returned over the backward signalling path to indicate that the call has been extended to a called subscriber. In the case of fully automatic switching between subscribers, this signal will start the equipment for determining the charge for the call. For administrative purposes (accounting between administrations), the conventional start of the chargeable duration is fixed at 6 ± 1 seconds after the start of the " call-connected " signal (see Recommendation F.67). For the same purposes, the end of the chargeable duration will be between 300 and 1000 milliseconds after the start of the clearing signal.

Switching systems not giving an automatic return of answer-back signals over the international telex circuits shall be arranged to be ready to respond to WRU signals (transmitted from the calling country) with a delay not exceeding two seconds from the beginning of the call-connected signal.

If the incoming country automatically returns the obtained subscriber's answer-back, the delay between the start of the call-connected signals and the start of the answer-back signals (if applicable, of date and time signals) should not exceed:

3 seconds for new networks;
6 seconds for existing networks.

To meet this requirement in the case of " in local " working, the return of the " call-connected " signal has to be delayed until the moment when the teleprinter of the obtained subscriber has in effect been connected to line (see section 2 of Recommendation S.9).

b) In the case of a call to a switchboard or service point the call-connected signal shall be returned as soon as the call reaches the terminal equipment even though it may be required to wait before being switched to the service position.

c) If the answer-back is preceded by date and/or time signals, this signal sequence should be limited to not more than 12 characters and it should be followed within 800 milliseconds by the answer-back code.

7. *Idle-circuit condition*

On an established connection, the " idle-circuit " is characterized by a permanent signal corresponding to the stop impulse, in accordance with international telegraph alphabet No. 2, on the forward and backward signalling paths.

8. *Clearing*

a) *Clearing signal*

The clearing signal is characterized by a reversion to the condition specified in paragraph 1 on either signalling path maintained until the complete release of the circuit.

The supervisory equipment of the international connection shall be arranged to interpret a signal of " start " polarity as a clearing signal within 300 and 1000 milliseconds.

b) *Clear-confirmation signal*

The clear-confirmation signal is reversion to the condition specified in paragraph 1 on the other signalling path in response to the clearing signal. When a clearing signal transmitted on an international circuit has reached the receiving end of that circuit the clear-confirmation signal must be sent back in the other direction within 350 to 1500 milliseconds after the initial " start " polarity begins.

The minimum period will be increased to 400 milliseconds for future systems.

c) *Guard delay*

Guard arrangements at the ends of an international telex circuit should be such that the circuit cannot be used for a new call until the distant equipment is free to accept another call.

The equipment at the incoming end of the international circuit shall be completely released and ready to receive a new call after a maximum period of 2 seconds.

This delay is measured from the moment when in the international switching centre " start " polarity has appeared on both signalling paths of the circuit.

During this guard period, " start " polarity shall be maintained on both signalling paths of the international circuit.

9. *Service signals*

a) *Signals for ineffective calls*

If a " busy ", " out of order ", " office closed ", " number changed ", or " number unobtainable " (i.e. not connected, service ceased or barred access) condition is encountered in the distant network, this shall be indicated by the return of a signal to the calling end. This signal shall cause the connection to be cleared.

In printed service signal sequences the code expressions mentioned in Article 17 of Recommendation F.60 should be used. In this case, the code expression should be preceded by the carriage return, line feed and letter shift signals and followed by line feed (preferably together with carriage return) and then immediately by the clearing signal in all cases.

Ineffective telex calls should not be charged for. With this in view printed service signal sequences returned on ineffective calls should never be preceded by the call-connected signal; however, under faulty conditions which can be detected only after the call has been put through, it may be impossible to prevent the return of the call-connected signal, and, subsequently, charging of the call.

b) *Waiting signals*

b.1) Should a call be routed to a point in the system where it is required to wait before connection can be made to the requested service, a waiting signal (MOM) should be sent back automatically in accordance with the following table.

b.2) The *waiting signal sequence* should include the carriage return, line feed and letter shift signals followed by the characters MOM. It may be useful in some instances to include characters to indicate the date and/or time and also characters indicating the identity of the switchboard or service point returning the signals. In some existing systems, however, the waiting signal sequence consists only of a group of characters indicating the date and/or time.

The first character of the waiting signal sequence shall be transmitted within 8 seconds of the commencement of the call-connected signal.

The MOM signal sequence shall be followed by a stop polarity until the service-connected signal is returned.

In some systems, however, arrangements are provided so that the transmission by the caller of suitable teleprinter characters causes the return of a further sequence of the MOM signal. Where such a facility is provided attention is drawn to the need for the administrations returning the signal to make arrangements to ensure that the signal sequence can be correctly received without mutilation in the calling system. For this purpose it is acceptable to include one or two letter shift signals at the beginning of the MOM signal sequence.

It is desirable that when connection is established to the requested service the *service-connected* signal should be returned as quickly as possible.

The equipment must be arranged so that a caller in the waiting condition can be released.

b.3) *Service-connected signal*

A " service-connected " signal shall be returned over the backward signalling path to indicate that the call has been extended to the teleprinter, or equivalent, of the requested service point. This signal may comprise the answer-back code of the teleprinter or a group of teleprinter characters identifying the service point or switchboard position. The service-connected signal may also include characters indicating date and/or time.

Where waiting signals are not provided the first character of the service-connected signal shall be returned within 8 seconds of the commencement of the call-connected signal.

c) *Backward busying signal*

c.1) To facilitate routine tests of the switching equipment connected at the incoming end of an international telex circuit, a backward busying signal might be sent on the return signalling channel to show, at the other end, that the circuit is occupied.

c.2) With fully-automatic operation, on one-way circuits as well as on both-way circuits, the signal would take the form of a permanent stop polarity for not more than 5 minutes.

c.3) In semi-automatic working, the signal would be:

either a permanent start polarity, or
a permanent stop polarity, lasting not more than 5 minutes;

the particular polarity chosen would be that requested by the outgoing country.

If the outgoing equipment is designed to block the outgoing end of the circuit in the " busy " position, after receipt of the permanent stop polarity, the stop polarity would be used for preference. In some instances, use of the stop polarity could give rise to difficulties. It might, for example, cause a call signal to appear in the outgoing manual switching equipment. In such circumstances, recourse will have to be had to a permanent start polarity.

Access to switchboards and service points

Signal	Type A	Type B
Call confirmation (see 3 and 4 a)	Permanent " stop " polarity	25-ms pulse of " stop " polarity (between 17.5 and 35 ms)
Proceed-to-select (see 4 a)	40 ms pulse (± 8 ms) of "start" polarity	25-ms pulse of " stop " polarity (between 17.5 and 35 ms)
Selection (see 5)	Teleprinter signals	Dial pulses or teleprinter signals
Call-connected (see 6)	150 ms pulse (± 11 ms) " start " polarity followed by " stop " polarity for a period between 2 and 8 seconds	" Stop " polarity for a period between 2 and 8 seconds
Waiting signals (see 9 b)	Teleprinter signals which may interrupt the " stop " polarity period of the call-connected signal, in which case the initial period of " stop " polarity should not be less than 1500 ms	Teleprinter signals which may interrupt the call-connected signal, in which case the initial period of " stop " polarity should not be less than 1500 ms
Service-connected (see 9 b.3)	Teleprinter signals indicating the identification of the switchboard or service point	Teleprinter signals indicating the identification of the switchboard or service point
Busy (see 9 a)	Teleprinter signals followed by clearing signal	i) 165-260-ms pulse of " stop " polarity followed by " start " polarity for 1500 ms (tolerance ±30%) (Note 1) ii) 165-260-ms pulse of " stop " polarity followed by teleprinter signals and then by " start " polarity for 1500 ms (tolerance ±20%) (Note 1)

Note 1. — This sequence of signals may be repeated until a clearing signal is sent over the forward signalling path.

c.4) As to tests made at the outgoing end of one-way circuits, there will be no call for a forward busying signal. The blocking of these circuits is locally done, on the outgoing side.

d) *Retest signal*

When the call confirmation is not returned over the " backward " signalling path within the delay indicated in paragraph 3 of this recommendation, administrations may apply after a certain delay a retest signal which automatically provides for the test of the circuit in such a way that the international circuit may be restored to service if the fault disappears in the course of this test.

This signal, transmitted over the " forward " path, is composed of five successive cycles, each cycle incorporating:

— a " stop " polarity period of 2 seconds duration,

— a " start " polarity period of 58 seconds duration (tolerance on time intervals ±30%).

If, at the end of five cycles, the fault has not disappeared, permanent " start " polarity will be sent by the centre which has made the retest. The circuit must then be marked " unavailable " for the outgoing traffic. If this circuit is both-way, the receipt of a call must terminate the unavailability immediately and the call must be accepted.

If, during a cycle, the fault can be regarded as cleared, sending of the retest signal is terminated.

For the fault to be regarded as cleared, the return of " stop " polarity should occur during the " stop " period of a retest cycle.

A return of " stop " polarity during the " start " period of a cycle cannot be taken as an indication that the fault has been cleared. However, if the circuit under test is being operated both-way, the appearance of " stop " polarity (of the normal duration for the recognition of a call signal) during the " start " period of a cycle should be regarded as the arrival of a call coming from the other end which should be accepted and consequently should terminate the emission of the retest signal.

In order to avoid simultaneous seizure of too many registers at the distant centre, it is advisable that the retest signals, which might be sent simultaneously on various circuits subjected to this test, should be out of phase with one another.

C. *Setting-up time*

The setting-up time is defined as follows:

Period of time from the initiation of the call on the international circuit until the initiation of the return of either the call-connected signal or a service signal indicating that the call has been unsuccessful, provided the selection signals have been transmitted at the maximum speed.

For new networks, the objectives are as follows:

— an average of 8 seconds.

— a maximum of 15 seconds with a probability of 1% exceeding this value.

D. *Both-way working*

1. For both-way cable circuits used in the fully automatic telex service, the following action to minimize the incidence of head-on collision is recommended:

a) that inverse order testing, or a close approximation to it by testing the route in small groups of circuits in fixed order, always starting the search from the same initial position, should be adopted at opposite ends of a both-way group of trunk circuits;

b) that calls should be offered in such a way that each circuit is treated once only for the minimum period of time necessary to ascertain whether it is free or busy, and the outgoing selectors should not have facilities for delayed hunting.

2. The absence of the proceed-to-select signal in type A signalling or the substitution of call signal for the call-confirmation signal in type B signalling will serve respectively to detect a head-on collision when the group of circuits is totally occupied or very nearly totally occupied.

The two calls will then be cleared down unless there are still free circuits in the route.

E. *Characteristics of the signals defined in paragraphs 3, 4, 5, 6 and 9*

The characteristics of these signals can be divided into two basic groups: type A and type B, as given in Tables I a, I b and II.

I. International telex circuits terminated on distant automatic switching equipment

TABLE I a)

Semi-automatic working to subscribers

Signal	Type A	Type B
Call-confirmation (see 3 and 4 a) above)	Permanent " stop " polarity	25-ms pulse of " stop " polarity (between 17.5 and 35 ms)
Proceed-to-select (see 4 a) above)	Teleprinter signal (s)	25-ms pulse of " stop " polarity (between 17.5 and 35 ms)
Selection (see 5 above)	Teleprinter signals	Dial pulses, or teleprinter signals
Call-connected (see 6 above)	Teleprinter signals *Note:* The teleprinter signals may be preceded by a 150-ms (± 11 ms) pulse of " start " polarity.	" Stop " polarity for at least two seconds
Busy (see 9 above)	Teleprinter signals followed by clearing signal	i) 165-260-ms pulse of " stop " polarity followed by " start " polarity for 1500 ms (tolerance: ±30%) (Note 1) ii) 165-260-ms pulse of " stop " polarity followed by teleprinter signals and "start" polarity for 1500 ms (tolerance: ±20%) (Note 1)
Out-of-order, number changed and number unobtainable (see 9 above)	Clearing signals normally preceded by teleprinter signals	i) Permanent " start " polarity ii) 165-260-ms pulse of " stop " polarity followed by " start " polarity or 1500 ms (tolerance: ±30%) (Note 1) iii) 165-260-ms pulse of " stop " polarity followed by teleprinter signals and " start " polarity for 1500 ms (tolerance: ±20%) (Note 1)

Note 1. — This sequence of signals may be repeated until a clearing signal is sent over the forward signalling path.

TABLE I b)

Fully automatic working between subscribers

Signal	Type A	Type B
Call-confirmation (see 3 and 4 a) above)	Permanent " stop " polarity	25-ms pulse " stop " polarity (between 17.5 and 35 ms)
Proceed-to-select (see 4 a) above)	40-ms (±8 ms) pulse of " start " polarity	25-ms pulse of " stop " polarity (between 17.5 and 35 ms)
Selection (see 5 above)	Teleprinter signals	Dial pulses, or teleprinter signals
Call-connected (see 6 above)	150 ms (±11 ms) pulse of " start " polarity followed by " stop " polarity for at least 2 seconds and possibly of teleprinter signals	" Stop " polarity for at least 2 seconds
Busy (see 9 above)	Teleprinter signals followed by clearing signal	i) 165-260-ms pulse of « stop » polarity followed by " start " polarity for 1500 ms (tolerance: ±30%) (Note 1) ii) 165-260-ms pulse " stop " polarity followed by teleprinter signals and " start " polarity for 1500 ms (tolerance: ±20%) (Note 1)
Out-of-order, number changed and number unobtainable (see 9 above)	Clearing signal normally preceded by teleprinter signals	i) Permanent " start " polarity (Note 2) ii) 165-260-ms pulse of " stop " polarity followed by " start " polarity for 1500 m (tolerance: ±30%) (Note 1) iii) 165-260-ms pulse " stop " polarity followed by teleprinter signals and " start " polarity for 1500 ms (±20%) (Note 1)

Note 1. — This sequence of signals may be repeated until a clearing signal is sent over the forward signalling path.
Note 2. — The use of this signal should be avoided if possible.

II. International telex circuits terminated on distant manual switching equipment

TABLE II

Signal	Type A	Type B
Call-confirmation (see 3 above)	Permanent " stop " polarity	25-ms pulse " stop " polarity (between 17.5 and 35 ms)
Proceed-to-transmit (see 4 b above)	Teleprinter signals	" Stop " polarity followed by teleprinter signals
Call-connected (see 6 above)	Teleprinter signals	Teleprinter signals
Busy, out-of-order, number changed and number unobtainable (see 9 above)	Teleprinter signals	Teleprinter signals

RECOMMENDATION U.2

STANDARDIZATION OF DIALS AND DIAL PULSE GENERATORS FOR THE INTERNATIONAL TELEX SERVICE

(former C.C.I.T. Recommendation E.2, 1951, amended at Arnhem, 1953, and at Geneva, 1956)

The C.C.I.T.T.,

considering

1. that, when dials and dial pulse generators are used for the process of automatic selection of subscribers to the international telex network, it is advantageous to standardize as far as possible the characteristics of such dials and dial pulse generators;

2. that the standardization of the dialling speed and lost motion periods of dials presents no technical difficulty;

3. that, for the satisfactory working of certain automatic systems, the time between successive pulse trains should not be less than 500 milliseconds, but that experience has shown that the minimum time taken by an experienced operator to rotate the dial is of the order of 300 milliseconds;

4. that pulse ratios from 1.2 : 1 to 1.9 : 1 will ensure the satisfactory working of existing automatic switching systems;

5. that these pulse ratios can be usefully adopted with a view to simplifying direct dialling between subscribers,

unanimously declares the view

1. that in the international telex service, when dials or dial pulse generators are used for the automatic selection of subscribers:

   a) the dialling speed shall be standardized at 10 pulses per second with a tolerance of plus/minus 10%;

   b) the lost motion period of dials shall be not less than 200 milliseconds nominal value;

   c) the inter-digit pause of dial pulse trains generated by dial pulse generators shall not be less than 600 milliseconds;

2. a) that the pulse ratio must be between 1.2 : 1 and 1.9 : 1, the nominal ratio may be chosen as lying between 1.5 : 1 or 1.6 : 1;

   b) that, when the selection signals pass through a regenerative repeater it may be advantageous to use a nominal ratio of 1.5 : 1.

RECOMMENDATION U.3

ARRANGEMENTS IN SWITCHING EQUIPMENT TO MINIMIZE THE EFFECTS OF FALSE CALLING SIGNALS

(former C.C.I.T. Recommendation E.3, Geneva, 1956)

The C.C.I.T.T.,

considering

that transmission systems at present in use for international telex trunks are liable to generate false calling signals;

that such false calling signals can seize and engage switching equipment, thereby reducing the grade of service. This is of particular importance with systems in which common equipment normally used only to set up calls is seized by false calling signals;

that the ill effects of false calling signals can be minimized by delaying the operation of the calling relay at the termination of the international telex trunk circuit;

that, however, when direct dial selection is employed over an international trunk line, unless it is a manually selected circuit not preceded by a stage of automatic selection, there is normally insufficient time available between successive digits to permit the use of slow operating relays;

that, nevertheless, administrations may agree between one another to use digit storage at the outgoing end of the circuit so that the inter-train pause can be increased to permit the calling relays to be made slow to operate,

unanimously declares the view

1. that the design and maintenance of transmission systems should be such as to reduce to a minimum the number and duration of false calling signals. In this connection attention is drawn to the merits of f.m. v.f. systems, particularly with long overhead lines;

2. that, wherever possible, calling relays on international telex trunk circuits should have an operation lag of at least 100 milliseconds. Administrations using circuits on lines prone to long-duration false calling signals may agree to use calling relays with longer operation lags.

RECOMMENDATION U.4

EXCHANGE OF INFORMATION REGARDING SIGNALS DESTINED TO BE USED OVER INTERNATIONAL CIRCUITS CONCERNED WITH SWITCHED TELEPRINTER NETWORKS

(former C.C.I.T. Recommendation E.4, Geneva, 1956, modified at New Delhi, 1960)

The C.C.I.T.T.,

considering

that certain signals and certain characteristics of signals used in the international telex service have been standardized in Recommendation U.1:

that standardized signals for the European switched network for the public service (gentex network) are advocated in Recommendation U.30;

that in view of the foregoing an exchange of information regarding the precise nature of the signals proposed to be used in the above-mentioned services by interested administrations would be very useful;

that certain administrations have already supplied such details regarding their telex services in a useful form (see documents VII/28, 29, 30, 31 and 32 published in the " Supplements to the documents of the VIIIth Plenary Assembly of the C.C.I.T.", pages 184 to 213),

unanimously recommends

that administrations concerned in the international telex service and gentex network be invited to supply to the C.C.I.T.T. time-sequence diagrams showing in each case the signals at present transmitted or proposed to be transmitted over the international circuit for incoming calls. The diagrams should show not only the sequence and characteristics of the signals, but also the timing tolerances to be expected.

RECOMMENDATION U.5

REQUIREMENTS TO BE MET BY REGENERATIVE REPEATERS IN INTERNATIONAL CONNECTIONS

(former C.C.I.T. Recommendation E.5, Geneva, 1956, amended at Geneva, 1964, and at Mar del Plata, 1968)

The C.C.I.T.T.,

considering

that it may be desirable to include regenerative repeaters in teleprinter switching networks;

that the only signals other than teleprinter signals that must be transmitted by a regenerative repeater are the clearing signal and the call-connected signal (reference 3.1.3 below), since all other signals can be by-passed;

that other signals may be transmitted by regenerative repeaters,

unanimously declares the view

1. that, when regenerative repeaters are used in switching systems, the clearing signal should be retransmitted with a minimum of delay. This delay is of course the same as for the transmission of teleprinter signals;

2. that to ensure the correct retransmission of the call-connected signal (reference 3.1.3 below) the clearing signal and the regenerative repeater must not automatically insert the stop element in either of these signals;

3. that for other signals that may pass through regenerative repeaters, the tolerances at the origin and after retransmission through the regenerative repeaters are as stated below.

Note. — The characteristics and tolerances quoted are for the signals at the origin. The tolerances at the input to the regenerative repeater will depend on the degree of distortion in the transmission path from the origin to the input of the regenerative repeater. The tolerances at the output will depend on the normal tolerances for the regenerative repeater.

3.1 *Pulse signals*

3.1.1 *Call-confirmation (proceed-to-select) signal.* Type B signalling.

A pulse of " stop " polarity of duration from 17.5 to 35 milliseconds. The nominal duration of the pulse after retransmission through the regenerative repeater should not be less than 20 milliseconds or more than 40 milliseconds.

Note. — This signal will be transmitted over only one international trunk circuit and should thus normally pass through not more than one regenerative repeater.

3.1.2 *Dial selection signals.* Type B signalling.

These signals have been standardized (Recommendation U.2) at a dial speed of 10 pulses per second $\pm 10\%$, and a pulse ratio (start/stop) between the tolerance of 1.2 : 1 and 1.9 : 1 with a nominal ratio lying between 1.5 : 1 and 1.6 : 1. Such signals after retransmission through several regenerative repeaters should not fall outside the tolerances above stated.

3.1.3 *Call-connected signals.* Type A signalling.

A pulse of " start " polarity lasting 150 ± 11 milliseconds. The nominal duration of the pulse after retransmission through several regenerative repeaters should be within the limits of 140 to 160 milliseconds.

3.1.4 *Busy signal.* Type B signalling.

Pulses of " stop " polarity lasting 200 milliseconds $\pm 30\%$, separated by intervals of " start " polarity lasting 1.5 second $\pm 30\%$. After retransmission through several regenerative repeaters neither the pulses nor the intervals should be shortened by more than 10%.

3.2 *Sequence signals (involving a single change of polarity)*

3.2.1 *Calling signal.* Types A and B signalling.

3.2.2 *Call-connected signal.* Type B signalling.

These signals (inversion from " start " to " stop " polarity) have no timing tolerances as such. It is, however, essential that they should be retransmitted by a regenerative repeater with a minimum of delay, which in no case should exceed 20 milliseconds.

RECOMMENDATION U.6

PREVENTION OF FRAUDULENT TRANSIT TRAFFIC IN THE FULLY AUTOMATIC INTERNATIONAL TELEX SERVICE

(New Delhi, 1960, amended at Geneva, 1964)

With fully automatic working in the international telex service, the possibility of fraudulent routing by subscribers of international calls involving tandem connection of international telex trunks might arise whenever subscribers are given automatic access to international telex trunk circuits which have, at their incoming ends, automatically switched access to other international telex trunk circuits.

By the adoption of a systematic plan, such traffic can be barred without involving either expensive or elaborate equipment arrangements.

To be effective such a plan would need to be adopted by all administrations and recognized private operating agencies since failure to provide barring facilities on the traffic between two countries could open the way for irregular routings at the expense of a third country.

The C.C.I.T.T. therefore *unanimously declares the view*

1. That national telex systems shall be so arranged that the first digit of the selection signals transmitted over incoming international telex trunks will indicate whether an automatic transit call is concerned;

2. That where an international telex trunk carrying fully automatic traffic also carries traffic requiring access at the incoming end to outlets selected by means of the digit characterizing an automatic transit call, the country of origin will bar irregular routings, by discriminating on the digits transmitted by calling subscribers;

3. That where an international telex trunk carrying fully automatic traffic does not carry traffic requiring access at the incoming end by means of the digit characterizing an automatic transit call, the incoming equipment shall be so arranged that the corresponding outlets are not accessible and that when access is attempted, the " number unobtainable " signal is returned;

4. That it is not admitted that two administrations can agree to omit the provision of barring facilities on traffic between their respective countries. However, where the incoming country has an existing network in which considerable difficulty would be experienced in barring in accordance with paragraph 3, the responsibility for barring may, by agreement, be assumed by the country of origin in the manner specified in paragraph 2.

Note about paragraph 1. — The use of a common first digit to indicate access to both international telex trunk circuits and manual switchboards leads to complication in the barring arrangements and should therefore be avoided as far as possible.

RECOMMENDATION U.7

NUMBERING SCHEMES FOR AUTOMATIC SWITCHING NETWORKS

(former C.C.I.T. Recommendation E.7, Geneva, 1956)

The C.C.I.T.T.,

considering

that with fully automatic working between subscribers in the international telex service it is desirable to envisage the possibility:

a) to route traffic over the appropriate international trunk route where more than one such route exist between two countries;

b) to enable the appropriate tariff to be determined automatically (in the originating country), even if the objective country is divided into several tariff zones,

unanimously declares the view

1. that subscribers' national numbering plans should be systematically arranged;

2. that, where more than one international trunk route exist between two countries, the corresponding geographical division and hence the appropriate point of entry should be identifiable by examination of the initial digits of the called subscriber's national number;

3. that, where a multiple tariff scale exists, the different tariff zones should be identifiable in the originating country by the initial digits of the called subscriber's national number;

4. that the number of initial digits to be examined should be limited, preferably to one, but in any case should not exceed two. When a single digit provides the discrimination it will usually be the first digit, but, where the subscribers' national numbers have a uniform initial digit (usually " 0 ") to permit discrimination on internal calls, the following (second) digit should be used.

Note. — The attention of administrations (and recognized private operating agencies) is drawn to the considerable technical advantage which would result from the adoption of a single tariff between two countries.

RECOMMENDATION U.8

INTERNATIONAL NUMBERING PREFIXES

(New Delhi, 1960)

In an international call, the national number of the called subscriber has to be preceded by a prefix which enables access to be given to the called country from the calling one.

A uniform prefix scheme would be one in which the prefix for a called country would be the same, no matter what the calling country might be.

The chief advantage of the uniform prefix scheme is that it affords facilities for the automatic alternative routing of traffic with fully automatic operation, when such re-routing involves a transit country other than the normal one.

In the European system, there is no great point in such automatic re-routing, in view of the facilities afforded by voice-frequency telegraph systems.

Between continents the problem is different, because channels are fewer and are more heavily loaded, and automatic re-routing over a second choice route might conceivably be useful with fully automatic operation.

The uniform scheme would have an advantage in so far as it would prevent administrations from changing their prefixes too often, which might well cause inconvenience to those countries having to use transit connections.

But the drawbacks of a uniform prefix scheme are as follows:

— complication of national networks,

— lack of flexibility,

— present acceptance of future commitments,

— premature expenditure on equipment not required for a considerable time to come.

The absence of a standardized range of country codes or prefixes would not prevent the provision of facilities for automatic alternative routing and/or re-routing, although there would be some increase in the complexity of the register translators required.

For these reasons, the C.C.I.T.T. *realizes* that, for the moment, a uniform prefix scheme is not feasible for the European telex and gentex networks, and

unanimously declares the view

1. that the prefix should characterize the called country from the calling country;

2. that countries providing transit services must avoid frequent changes in the codes used for routing transit traffic.

Note. — See Question 8/X concerning intercontinental traffic.

RECOMMENDATION U.10

EQUIPMENT OF AN INTERNATIONAL TELEX POSITION

(former C.C.I.T. Recommendation F.60, modified at New Delhi, 1960)

An international telex position which is a manual position in an international telex exchange and is used to set up international telex calls should be so equipped as to permit of satisfactory operation in conformity with C.C.I.T.T. Recommendation F.60, Volume II of the *Blue Book.*

For the above reasons, the C.C.I.T.T. *unanimously declares the following view*

1. An international telex position must be equipped in such a way as to receive the clearing signal from both sides.

2. It should not be possible to recall the operator of that position by a signal to an established connection, except if Recommendation U.21 is applied.

3. Precaution must be taken that, in the event of the operator of the international telex position delaying to remove the plug on reception of the clearing signals, a new call from a subscriber on one network shall not pass to the other network.

4. When communication has been established, the answer-back signals of apparatus used as the intermediate telex positions must not be sent to line when figure-shift D is received.

5. The international telex position must be provided with equipment to determine the chargeable time of calls controlled by these positions, this timing equipment to be brought into operation in accordance with the provisions of Article 16 of Recommendation F.60, but to be stopped on receipt of the first clearing signal.

RECOMMENDATION U.11

TELEX AND GENTEX SIGNALLING ON INTERCONTINENTAL CIRCUITS USED FOR INTERCONTINENTAL AUTOMATIC TRANSIT TRAFFIC (TYPE C SIGNALLING)

(Geneva, 1964, amended at Mar del Plata, 1968)

It is necessary to standardize an intercontinental signalling system to be used between intercontinental transit centres, as the present standard systems A and B, in the limits of C.C.I.T.T. recommendations, do not comply with all the requirements of an intercontinental signalling system.

The intercontinental links that are used and could be used in the future for telex and gentex operation use various transmission systems, including not only the standard v.f.

telegraph channels—normally used in the continental field—but also 7-unit error-proof multiplex system over radio circuits, 6-unit or 5 unit-multiplex systems over v.f. channels. Other transmission systems will perhaps be used in the future. Therefore, it seems necessary that the intercontinental signalling system should be suitable for as wide a variety of transmission systems as possible.

This signalling system must enable the channels to be operated on a both-way basis. This type of operation can produce collisions; therefore it was noted that the intercontinental signalling system must provide for limiting collisions, or at least, for simple facilities to detect head-on collision, and for taking appropriate action after their detection.

Another important feature of the intercontinental signalling system should concern the automatic testing of the ability of the multiplex equipment to transmit teleprinter characters, before establishing a call to the distant subscriber, through an intercontinental transit centre.

The class of traffic signal, the class of traffic check signal, and the transmission confirmation signal in the form proposed, can provide an efficient and simple method of meeting this requirement. The signals provided also check the functioning of the FRXD when used.

The use of teleprinter characters, for selection information, and other signalling functions, appears to be most advantageous, as they can be transmitted over the error-proof radio circuits, which undoubtedly will be part of the intercontinental transit network.

It is emphasized that the signals, in the form proposed, simplify interconnection of the intercontinental transit network to the terminal networks, in the outgoing and in the incoming countries.

As regards the method of transmission of selection information, it has been decided that the selection by complete block will be adopted on intercontinental routes. Under this arrangement, the telex destination code and the national call number of the called subscriber are sent successively without interruption, it being clear that the retransmission of the selection signals from one switching centre to the next may start even before the block has been completely received.

For these reasons, the C.C.I.T.T. *unanimously declares the view:*

1. The signalling system between two intercontinental transit centres will be as described in Table I.

Note 1. — In this Recommendation:

X denotes the intercontinental transit centre which originates the call under consideration on the intercontinental circuit,

Y denotes the intercontinental transit centre which receives the call considered on the intercontinental circuit.

Both the forward and backward path signals are described at the moment of their emission on the intercontinental circuit. It should be noted that the signals in Tables I, II and III are those transmitted by the switching equipment irrespective of the type of transmission used for the intercontinental trunk circuit. It is possible that the teleprinter signals, although transmitted at automatic speed, may be delayed or separated by periods of stop polarity after transmission via multiplex systems and that the original periods of start and stop polarity may be either lengthened or shortened by the incidence of error-correction on radio circuits.

The circuits between X and Y may transmit calls in both directions.

Note 2. — For the description of the combinations of the international telegraph alphabet No. 2 used in this Recommendation, see Annex 1 at the end of the Recommendation.

2. For new exchanges introduced into the intercontinental transit network, intercontinental circuits should be searched in a fixed order, always starting the search from the same initial position. The order of search should be inverse to the order used at the distant end.

A head-on collision is detected by the fact that centre X receives combination No. 20 (100 ms pulse of polarity A) instead of combination No. 22 (40 ms pulse of polarity A); when this combination No. 20 has been detected, centre X checks receipt of the second combination No. 20 to confirm the head-on collision; during this time, centre X continues signalling towards centre Y, until both combinations No. 20 of the calling signal have been transmitted, and the trunk is then cleared.

When a head-on collision is detected, the switching equipment at each end of the circuit should make another attempt to select a free circuit either on the same group of circuits or on a group of overflow circuits, if they exist. In the event of a further head-on collision on the recall or on the call attempt via the overflow route, no further recall will be made and the call will be cleared down after returning the transit failure signal.

Should the second combination No. 20 not have arrived in the two seconds following the commencement of receipt of the first combination No. 20, centre X will put into operation the automatic retest procedure and recall.

3. There is no need to distinguish on a circuit XY whether a call is to terminate in centre Y or if it is to pass in transit via Y to a country other than the country (or network) of Y; the advantage of not having to transmit on circuit XY the digits of the destination code in the case of a call termination in Y is offset by the complication of the registers and the necessity for an additional discrimination in the " class-of-traffic " signal.

4. The registers will be provided with a code of which the uniform format is as follows:

space—letter shift—one or two letters designating the transit administration or recognized private operating agency—figure shift—two-digit number of the register in the network of the transit administration or recognized private operating agency.

The letter (or two letters) designating the transit administration or recognized private operating agency shall be the letter (or two letters) of the telex network identification code as far as possible.

The register code will be returned automatically in all cases and will continue as far as the calling country. If several registers are involved in setting up a call, the calling network will receive the codes of these registers one after the other.

This information is useful for retracing the route followed by a call (for traffic statistics, international accounts and the clearing of faults).

5. To simplify the solution of problems raised by overflow (increased congestion of systems, risk that the call may return back to the original exchange) overflow will be allowed at only one centre for each call.

Note. — The rigour of this rule could be eased by admitting alternative (2nd choice) routings in certain traffic relations. This question will be discussed when the routing plans are established.

6. A transit centre will have to be advised:

1) that an incoming call is:

a) a telex call (between telex subscribers);

b) a gentex call (between gentex stations);

c) a call originating from a switchboard operator or maintenance staff to a manual switchboard or service point. This class of traffic signal is to be used if signalling conditions for calls to manual switchboards or other service points in the destination network are different from those returned on calls to subscribers;

d) a special category call (see §§ 7.1 and 7.2 below).

2) that the call concerned has already been subjected to overflow.

Other possibilities must be reserved, such as routing via telegraph circuits for 100 or 200 bauds, and a reserve supply of class-of-traffic signals has been envisaged to this end.

7. *Class-of-traffic signal*

7.1 The class-of-traffic signals are divided into two categories:

Category A: Signals for transmission at 50 bauds, the utilization of which is allocated as shown in the following tables.

Category B: Signals reserved to meet future uses, not yet defined, such as use of circuits for more than 50 bauds.

7.1.1 The signals of category A are characterized by Z polarity of the first unit; the signals under category B are characterized by A polarity of the first unit.

7.1.2 For the signals of category A the second and third units are associated to discriminate the four following categories:

telex,
gentex,
transit between service positions,
special category (see Note under § 7.2).

7.1.3 For the signals of category A as well as for those of category B, the polarity of the fourth unit indicates whether or not the call has already been overflowed.

7.1.4 For the signals of category A as well as for those of category B, the fifth unit must always have an A polarity in order to avoid the use as a class-of-traffic signal of the special signals, combination No. 20 (calling signal) and combination No. 30 (special pre-signal).

	Unit 1	2	3	4	5	Condition signalled
	Z					Category A (50 bauds)
	A					Category B (reserved)
Cat. A		A	A			Special category (see Note under 7.2)
Cat. A		A	Z			Gentex
Cat. A		Z	A			Transit between service positions
Cat. A		Z	Z			Telex
Cat. A and B				A		Not previously overflowed
Cat. A and B				Z		Previously overflowed
Cat. A and B					A	Permanent polarity

7.2 The following table indicates the combinations used for class-of-traffic and class-of-traffic check signals.

Note. — For 50-baud transmissions during which an alphabet with a non-5-unit code could be used to avoid routing through time-division multiplex channels (see Recommendation V.10, Part II, *Blue Book*, Volume VIII).

Category	Combination	Class-of-traffic 1	2	3	4	5	Combination	Class-of-traffic check 1	2	3	4	5	Function: Gentex, telex, telex and gentex combined, or special category	Function: Previously alternatively routed (overflowed)
A	11	Z	Z	Z	Z	A	20	A	A	A	A	Z	Telex	yes
	21	Z	Z	Z	A	A	15	A	A	A	Z	Z		no
	10	Z	Z	A	Z	A	8	A	A	Z	A	Z	Transit between service positions	yes
	1	Z	Z	A	A	A	13	A	A	Z	Z	Z		no
	6	Z	A	Z	Z	A	12	A	Z	A	A	Z	Gentex	yes
	19	Z	A	Z	A	A	7	A	Z	A	Z	Z		no
	4	Z	A	A	Z	A	16	A	Z	Z	A	Z	Special category (see Note in paragraph 7.2)	yes
	5	Z	A	A	A	A	22	A	Z	Z	Z	Z		no
B	3	A	Z	Z	Z	A	26	Z	A	A	A	Z		yes
	9	A	Z	Z	A	A	2	Z	A	A	Z	Z		no
	18	A	Z	A	Z	A	25	Z	A	Z	A	Z		yes
	28	A	Z	A	A	A	24	Z	A	Z	Z	Z		no
	14	A	A	Z	Z	A	23	Z	Z	A	A	Z		yes
	31	A	A	Z	A	A	30	Z	Z	A	Z	Z		no
	27	A	A	A	Z	A	17	Z	Z	Z	A	Z		yes
	32	A	A	A	A	A	29	Z	Z	Z	Z	Z		no

7.3 The " class-of-traffic " combination for a previously alternatively routed call shall be inserted by the switching equipment in the centre at which overflow occurs.

8. The ability of the trunk to transmit 5-unit signals is checked by using complementary class-of-traffic and class-of-traffic check signals. The two combinations of the transmission confirmation signal are also complementary. Failure to receive the transmission confirmation signal correctly should initiate the automatic retest signal.

9. The registers of centre Y must begin the forward selection as soon as the first digit of the called number has been registered.

If D1, D2 and D3 are the destination code digits of the called country (or network), and if N1, N2, N3, etc. are the digits of the called number, the sequence of selection signals will be as follows on any intercontinental circuit XY, including for calls terminating in country Y:

Case of a called country having a 2-digit destination code

Class-of-traffic

Class-of-traffic check

D1

D2

N1

→ start of forward selection

N2

N3

.

.

N*n*

Combination No. 26

Case of a called country having a 3-digit destination code

Class-of-traffic

Class-of-traffic check

D1

D2

D3

N1

→ start of forward selection

N2

.

.

N*n*

Combination No. 26

The maximum number of digits to be expected in the sum of the destination code and national number is 12.

10. The automatic retest signal should be initiated on failure to receive the reception confirmation and transmission confirmation signals within 2.5 seconds from the start of the calling signal (this period excludes the propagation time of the medium used); a new attempt to select another circuit is made (only once) and if unsuccessful, NC signal returned to the preceding exchange. The circuit should be tested for a period of $2^1/_2$ or 3 minutes (i.e. five tests) and a check made to confirm the receipt of the transmission confirmation signal in response to each test. When a valid transmission confirmation signal is

received, the circuit should be returned to service; otherwise, after five test cycles, it should be permanently taken out of service and an alarm given.

In order to cater for the possibility that a faulty circuit may be seized at both ends, the automatic retest equipment should be arranged to allow an incoming call to be received during the interval between tests. The intervals between the tests at the two ends of the trunk route should be made different to be sure that successive retests do not overlap at both ends.

When a circuit is found to be still faulty after five tests it should be busied to outgoing traffic but incoming calls should be accepted.

11. The guard period on clearing should be from 1 to 1.5 second measured from the appearance of start polarity on both signalling paths. The equipment at the incoming end of the intercontinental circuit shall be completely released and ready to receive a new call after a maximum period of 1 second. The " start " polarity should be maintained throughout the guard period, on both signalling paths of the international circuit.

Note. — In the case of error-corrected radiotelegraph systems the guard period should be measured from the moment that the appropriate number of α signals has been transmitted and received in accordance with Recommendation U.20, paragraph H.5.

12. The register congestion signal should be returned on not more than 0.4% of calls in the busy hour and the equipment should ensure that this signal is returned only when the register congestion is positively identified, and not in the case of a fault in the register access equipment.

13. The incoming equipment should be arranged to maintain start polarity on the backward path if the first character of the selection signal is spurious as indicated either by a character other than a class-of-traffic signal or the pre-signal combination No. 30 (see notes to Table II).

The incoming register may release the connection if the combinations of the calling and selection signals are delayed for 5 seconds or more, the appropriate action depending on whether the class-of-traffic signal has been received or not. Up to the reception of the class-of-traffic signal, permanent start polarity should be maintained on the backward path; and following the reception of the class-of-traffic signal, the service signal NC should be returned after the reception confirmation, the transmission confirmation and register code signals and followed by the clearing signal.

An administration may release the connection or recall if the register code from the next transit centre has not been returned within three seconds after the receipt of the transmission confirmation signal.

14. The normal time (i.e. without taking account of the supplementary delay which could be introduced by operation of ARQ equipment) required to switch through a transit centre measured from the beginning of the receipt of the calling signal to the offering of the calling signal on the outgoing route varies from 1200 to 1500 milliseconds (according to the number of digits to be examined), plus the time required to position the selectors. (*Note.* — This time is independent of the transmission delay of the transmission system.) The time required to position the selectors should not exceed 800 milliseconds.

15. For signalling purposes on international circuits which will be used between the international exchange of the terminal country and an intercontinental transit centre, several solutions are available to the administrations concerned.

The choice between the solutions must be the subject of agreement between the terminal country and the country handling the intercontinental transit.

These solutions will result from the following considerations:

1) Whether the routing towards the intercontinental transit centre (or from the intercontinental transit centre) would be made through the continental centre adjacent to the intercontinental transit centre in the transit country (in this case the access prefix 00 should be used).

2) Alternatively, whether the routing would be made directly from the international terminal centre towards the intercontinental centre and vice versa.

3) Whether the international circuits between the terminal country and the transit country would be operated only as outgoing or incoming circuits or whether it would be possible to operate them in both directions for setting up calls.

4) Whether the signalling system on these circuits would be the one which is used for automatic traffic between the terminal country and the transit country, the transit country being responsible for making the conversion of this signalling system according to type C, Table I signals on the intercontinental circuits and vice versa.

5) Alternatively, whether this signalling would be established according to type C signalling.

To give some guidance to administrations Tables II and III below have been set up.

Table II corresponds to the case of access to the intercontinental transit centre through the adjacent continental centre with circuits able to transit calls in both directions.

Table III corresponds to the case of direct access to the intercontinental transit centre with unidirectional circuits. In the case of direct access to the intercontinental transit centre using both-way circuits, type C signalling indicated in Table I could be applied.

TABLE I

Signalling between the two intercontinental transit centres

Signal or function	Forward path (X towards Y)	Backward path (Y towards X)	Remarks
Free line	Start polarity (polarity A)	Start polarity (polarity A)	
Call	Stop polarity (polarity Z) for 150-300 ms followed by 2 combinations No. 20 (2 polarity A pulses of 100 ms duration) and then followed immediately by the selection signals		The Y incoming register must be connected and ready to receive selection signals within 425 ms of the commencement of the inversion to stop polarity; the combinations No. 20 do not need to be detected as part of the signal for calling purposes. The Y register must be able to absorb any combination No. 20 or portion of a combination No. 20 which may precede the selection signals. *Note 1:* It is necessary for the transmission system to be capable of transmitting the combinations No. 20 of the calling signal before reception of the reception confirmation signal. In the case of error-corrected radio circuits the radio equipment must ensure that the period of " stop " polarity preceding the first combination No. 20 is transmitted as four consecutive β signals, and that at the Y end the inversion to " stop " polarity is retransmitted when two consecutive beta signals have been received. The radio equipment at the Y end must also ensure that the first combination No. 20 is preceded by at least 140 ms " stop " polarity.
Reception confirmation		Stop polarity followed by combination No. 22 (40-ms pulse of A (polarity)	*Stop polarity:* returned 450 ms ($\pm 10\%$) after the end of receipt of the class-of-traffic signal. *Combination No. 22:* returned 450 ms ($\pm 10\%$) after the inversion to stop polarity on the backward path.

TABLE I *(continued)*

Signal or function	Forward path (X towards Y)	Backward path (Y towards X)	Remarks
Selection signals	" Class-of-traffic " signal " Class-of-traffic check " signal The 2 or 3 digits of the destination code of the called country The digits of the called station number Combination No. 26		These signals are transmitted immediately after the calling signal, without awaiting the reception at X of the reception confirmation signal. These signals are transmitted according to the code of alphabet No. 2 at the normal modulation rate of 50 bauds; the digits of the destination code and the first two digits of the called station are transmitted at automatic speed.
Transmission confirmation		Combination No. 29 (20-ms pulse of A polarity) Combination No. 32 (120-ms pulse of A polarity)	Transmitted after the reception of confirmation signal on condition that the class-of-traffic check signal has been correctly received. This signal and the reception confirmation signal will have to be absorbed by the switching equipment of X and should not be able to go through that equipment to arrive at the preceding centre.
Register code signals		Combination No. 31 (space) Combination No. 29 (letters) 2 identification letters of transit centre Y Combination No. 30 (figures) The 2 digits of the register number	Teleprinter signals following immediately the transmission confirmation signal at automatic speed. These signals must go through centre X and arrive at the originating country.
Call connected		Combination No. 32 (120-ms pulse of A polarity) followed by 8 combinations No. 29 (20-ms pulses of A polarity) transmitted at automatic speed	As soon as it is possible, at the last transit centre, to discriminate that the signal received is the call-connected signal from the destination network, it should be returned immediately to the calling network, in type C format, by the last transit centre.

TABLE I *(continued)*

Signal or function	Forward path (X towards Y)	Backward path (Y towards X)	Remarks
			In the event of non-receipt of a call-connected signal from the destination network, the last transit centre will return an appropriate service signal and release the connection. Non-receipt of the call-connected signal at the first transit centre within 60 seconds will cause this transit centre to return the NC service signal and release the connection.
Answer-back signals			Where the destination system returns the answer-back automatically, the answer-back and any associated signals (e.g., date and time) should be extended to the calling network as and when received. Where the destination system does not return the answer-back automatically, the last transit centre in the connection will make a request for the return of the answer-back code of the obtained teleprinter.
Teleprinter service signals from type A or B systems		Teleprinter signals as returned from the called system, followed by the clearing signal	
Non-printing service signals from type B systems a) Spare line of permanent start polarity		Combination No. 27 Combination No. 28 Combination No. 31 Combination No. 29 Combination No. 4 (D) Combination No. 5 (E) Combination No. 18(R) Combination No. 27 Combination No. 28 followed by the clearing signal	These signals a, b or c should be transmitted by the last transit centre in the connection. In order to reduce the ineffective time of trunk circuits to a minimum the service signal in a) should be returned not later than 15 s from the end of the last selection signal transmitted to the terminal system and in c) should be returned within 6 s from the inversion to stop polarity from the terminal system.
b) Busy or similar signals		Combination No. 27 Combination No. 28 Combination No. 31 Combination No. 29 Combination No. 15(O)	

TABLE I *(continued)*

Signal or function	Forward path (X towards Y)	Backward path (Y towards X)	Remarks
		Combination No. 3 (C) Combination No. 3 (C) Combination No. 27 Combination No. 28 followed by the clearing signal	
c) Station faulty permanent stop polarity		Combination No. 27 Combination No. 28 Combination No. 31 Combination No. 29 Combination No. 4 (D) Combination No. 5 (E) Combination No. 18(R) Combination No. 27 Combination No. 28 followed by the clearing signal	
Idle circuit	Stop polarity	Stop polarity	
Clearing	Inversion to start polarity in the direction of clearing for minimum of 300 ms		
Clear confirmation	Inversion to start polarity in the opposite direction, within 500±100 ms of the commencement of the clearing signal		
Automatic retest	Stop polarity for 300 ms Combination No. 20 Combination No. 20 Combination No. 21 Combination No. 15 Combination No. 16 Combination No. 16 Combination No. 16 Stop polarity for two seconds, start polarity for either 30 or 36 seconds, repeated		3 combinations No. 16 correspond to a spare destination code 000, allocated for retest purposes. 30 seconds for one centre. 36 seconds for the other centre.
Backward busy	Continuous stop polarity for a maximum of 5 minutes		

TABLE I *(continued)*

Signal or function	Forward path (X towards Y)	Backward path (X towards Y)	Remarks
Register congestion		Stop polarity for 450 ms followed by clearing signal	This signal is returned not more than 500 ms after the start of the calling signal when there is no register free to be connected to receive the selection signals within 425 ms of the start of the calling signal.
Transit failure		Combination No. 27 Combination No. 28 Combination No. 31 Combination No. 29 Combination No. 14(N) Combination No. 3 (C) Combination No. 27 Combination No. 28 followed by clearing signal	This signal is returned immediately following the register code signal: when there is no free trunk outgoing from the transit centre, or when the three digits following the class-of-traffic check signal do not correspond to an allocated code, or the incoming Y selection signals are delayed for more than 5 seconds, or when a call fails owing to head-on collision, or when the class-of-traffic signal received does not correspond to an authorized type of call.
Transmission failure		Combination No. 15 Combination No. 15 (Two 80-ms pulses of A polarity) followed by clearing signal	Returned after the reception confirmation signal as soon as the class-of-traffic check signal has been found to be incorrect.

TABLE II

Signalling between the calling international system and the intercontinental transit system (using code 00 for access via the international exchange of the transit administration)

Function	Forward path	Backward path	Remarks
Call			These are signalled in accordance with the type of signalling used on terminal calls into the national system of the transit administration.
Call confirmation			
Proceed-to-select			
Selection	Digits 00		
Transit proceed-to-select		Stop polarity for at least 450 ms followed by combination No. 22 (40-ms pulse of A polarity)	In the case where the transit administration uses type A signalling for terminal calls to its national network, the inversion to stop polarity takes place when the incoming trunk circuit is seized. Where the transit system uses type B signalling for this traffic the inversion to stop polarity occurs after the transit access code digits 00 have been selected. The transit access code is selected in accordance with the same signalling arrangements as those used for the terminal traffic into the national network.
Selection signals [1]	Combination No. 30 Class-of-traffic 2 or 3 digit destination code Digits of called number Combination No. 26		
Register code signals		As in Table I Returned within 150 ms of recognition of the class-of-traffic signal	
Call connected		As in Table I	
Service signals		As in Table I	
Clear			These are signalled in accordance with the type of signalling used on terminal calls into the national system of the transit administration.
Clear confirmation			

[1] The pre-signal combination No. 30 indicates a call without class-of-traffic check facilities, which are considered unnecessary for circuits of this type.

TABLE III

Signalling between the calling international system and the first transit exchange (when access to this is by direct connection to the transit switching equipment)

Function	Forward path	Backward path	Remarks
Free line	As Table I		
Call	Inversion to stop polarity for 450 ms		The incoming register must be connected and ready to receive selection signals within 425 ms of the commencement of the inversion to stop polarity.
Reception confirmation		As Table I	
Selection signals	As Tables I or II		As Table I
Transmission confirmation		Combination No. 29 (20-ms pulse of A polarity) Combination No. 32 (120-ms pulse of A polarity)	Transmitted only on receipt of selection signals in accordance with Table I and then as soon as the class-of-traffic check combination has been correctly received.
Register code signals		As Table I	
Call connected		As Table I	
Service signals		As Table I	
Idle circuit	As Table I		
Clearing	As Table I		
Clear confirmation	As Table I		
Automatic retest	As Table I		

TABLE III *(continued)*

Function	Forward path	Backward path	Remarks
Backward busy	As Table I		
Register congestion		As Table I	
Transit failure		As Table I	
Transmission failure		As Table I	

Notes:

1. Working over these circuits is on a unidirectional basis and there is therefore no requirement for the inclusion of combinations No. 20 in the calling signal.
2. In the case of both-way working, the use of the signalling system of Table I is recommended.

ANNEX 1
(to Recommendation U. 11)

Table of the combinations used in the type C signalling system

No. of signal	Combination	Indication according to international telegraph alphabet No. 2 — Letter case	Figure case
15	A A A A Z Z Z	O	9
16	A A Z Z A Z Z	P	0
20	A A A A A Z Z	T	5
21	A Z Z Z A A Z	U	7
22	A A Z Z Z Z Z	V	=
26	A Z A A A Z Z	Z	+
27	A A A A Z A Z	Carriage return	
28	A A Z A A A Z	Line feed	
29	A Z Z Z Z Z Z	Letter-shift	
30	A Z Z A Z Z Z	Figure-shift	
31	A A A Z A A Z	Space	
32	A A A A A A Z	Not used	

RECOMMENDATION U.20

TELEX AND GENTEX SIGNALLING ON RADIO CHANNELS (SYNCHRONOUS 7-UNIT SYSTEMS AFFORDING ERROR CORRECTION BY AUTOMATIC REPETITION)

(Geneva, 1956, amended at New Delhi, 1960, at Geneva, 1964, and at Mar del Plata, 1968)

Numerous radiotelegraph circuits working in association with 5-unit start-stop apparatus make use of error-correcting synchronous systems having a special error-detecting 7-unit code enabling errors to be corrected by a request for a repetition (ARQ system).

When they are usable for switched communications, on the radio section these synchronous systems use two combinations α and β which characterize the permanent conditions of start polarity and stop polarity respectively, in the start-stop part of the connection.

The special make-up of these systems is such that a change in the significant condition at the input to the system is not reproduced at the output with a constant delay.

The experience acquired with telex and gentex switching through these radiotelegraph systems seems sufficient to justify the laying down of general rules specifying signalling arrangements for manual, semi-automatic and automatic working in such international radio channels.

For these reasons, the C.C.I.T.T. *unanimously declares the view*

that the signals, enumerated in Recommendation U.1, to be used in setting up international telex and gentex calls over radio channels comprising synchronous systems with error correction by automatic repetition should be characterized as follows:

A. *Free line condition*

Successive α combinations on the forward and backward paths.

B. *Call*

Transition from combination α to combination β on the forward signalling path. Reception of two consecutive β signals over the forward signalling path shall be interpreted as a calling signal.

On circuits automatically operated in both directions, reception of a single β signal at the end of the circuit remote from the calling subscriber must cause the outgoing equipment on this circuit at that end to be marked busy immediately. This busy condition must be applied until two α signals are received.

If the motor of the FRXD (or equivalent motor-driven storage device) is not already running, it must be started without delay, in order to accept the subsequent selection signals. Furthermore, if the motor of the storage device at the called end is not already working, it must be started.

It is desirable that, in the busy hour at least, the starting of the motor of the storage device should not be dependent on the calling signal for each call. One simple method of meeting this requirement is to provide a device which delays the switching off of the motor until about 5 minutes after the call has been cleared.

C. *Call-confirmation signal*

Transition from combination α to combination β on the backward signalling path. The reception of two consecutive β signals over the backward signalling path shall be interpreted as a call-confirmation signal.

The return of this signal can be initiated either by the switching equipment or by the radio equipment. Not more than one second shall elapse at the incoming end between the moment when two β signals have been received and the return of the first β signal of the call-confirmation signal.

With manual switching the call-confirmation signal shall be returned independently of the operator's answer.

For retest purposes radio circuits may be considered faulty when the call-confirmation signal is not received within three seconds.

D. 1) *Proceed-to-select signal*

1 a) *Semi-automatic working*

If the automatic switching equipment at the receiving end can receive the selection information immediately after the sending of the call-confirmation signal, the call-confirmation signal shall constitute the proceed-to-select signal.

If the automatic switching equipment at the receiving end cannot receive the selection information immediately after the sending of the call-confirmation signal, a distinct " proceed-to-select " signal, combination No. 22, shall be returned over the backward signalling path after the call-confirmation signal. For 99% of calls in the busy hour, this signal must be returned not more than 3 [1] seconds after the transmission of the call-confirmation signal begins.

1 b) *Fully-automatic working*

The " proceed-to-select " signal, combination No. 22, returned over the backward signalling path shall always be distinct from the call-confirmation signal and should be returned within the limits specified under semi-automatic working.

2) *Proceed-to-transmit signal*

2 a) On the backward signalling path teleprinter signals indicating the called operator's position.

2 b) The sending of the proceed-to-select or the proceed-to-transmit signal should be delayed until two consecutive β signals have been correctly received over the backward signalling path. Two consecutive β signals can be presumed to have been or to be received

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[1] For some existing systems this delay will be 4 seconds.

when four β signals have been accepted by the storage of the error-correcting equipment at the sending end. (This allows for the loss of one β signal as an undetected error.)

The receiving equipment shall be arranged so that when two β signals are received and followed immediately by teleprinter signals [representing the call-confirmation and proceed-to-select (or proceed-to-transmit) signals in rapid succession] the recognition of the two β signals as the call-confirmation signal will allow the teleprinter signals to be preceded by 140 ms (minimum) of " stop " polarity.

Measures should be taken so that, if proceed-to-select or proceed-to-transmit signals are relayed by the FRXD (or equivalent storage device), the switching equipment does not return these signals until the motor has reached its full speed.

E. *Selection signals*

1) For manual working, teleprinter signals over the forward signalling path.

2) For semi-automatic working, teleprinter signals over the forward signalling path as follows: the " prepare-for-digits " shall be combination No. 30. Digits of the called subscriber's number in international alphabet No. 2. End-of-selection signal, combination No. 26. This may be followed by another combination characterizing the class of traffic in the incoming country.

3) For fully-automatic working, teleprinter signals over the forward signalling path, as follows:

the " prepare-for-digits " signal shall be combination No. 30 (figure shift);

digits of the called subscriber's number in international alphabet No. 2.

If an end-of-selection signal is required, this should be combination No. 26, This may be followed by another combination characterizing the class of traffic in the incoming country.

Where the incoming system uses a uniform numbering plan so that the number of digits in the number can be determined from the initial digit, the outgoing administration must transmit an end-of-selection signal if this is required by the incoming country.

Where the incoming system has a non-uniform numbering scheme the end-of-selection signal cannot be made obligatory. However, for such a system it may be advantageous to use this signal subject to the agreement of the outgoing administration, in those cases where the outgoing system can readily insert the signal.

F. *Call-connected signal*

1) Manual working: the code DF over the backward signalling path.

2) Semi-automatic working: either answer-back signals or the signals defined for fully-automatic working below.

3) Fully-automatic working:

Combination No. 32, followed by 11-13 combinations No. 29 (letter shift) followed by the obtained subscriber's answer-back code. The insertion of the combinations No. 29 must not cause mutilation of the subsequent signals in the sequence.

G. *Idle circuit condition*

Combinations β on the forward and backward signalling paths.

H. *Clearing signal*

1) The appearance of α combinations in the direction in which the clearing signal is sent. Reception of two consecutive α signals will have to be interpreted as a clearing signal.

2) On recognition of the clearing signal received over the radio circuit any text remaining in the store, at the point where the clearing signal is recognized, must be destroyed

On recognition of the clearing signal received over the land line, any text remaining in store, at the point where the clearing signal is recognized, must be transmitted before the α signals are sent over the radio path.

3) Clear confirmation signal.

The appearance of α combinations in the direction opposite to that from which the clearing signal was sent. Reception of two consecutive α signals will be interpreted as a clear confirmation signal when a clearing signal of [1] 7 α signals has been accepted by the storage of the radio equipment without a request for repetition. The transmission of [1] 7 α signals in this way ensures that, allowing for the loss of one α signal as an undetected error, the clearing signal can be presumed to have been received and recognized at the distant end.

4) It is desirable that the equipment shall be arranged so that the clearing and clear confirmation signals do not cause spurious characters (including combinations No. 32) to be transmitted over the radio path. Where electronic storage devices are used it is possible to arrange for these spurious characters to be suppressed in the storage device. Where electro-mechanical storage devices are used, the generation of spurious characters by the clear confirmation signal can be minimized by arranging that when the clearing signal is received over the radio circuit, the input to the storage device is blocked.

5) In order to ensure that, on transit calls, switching equipment and possibly the subscriber's teleprinter set are not unnecessarily held because of delay in transmitting the clearing and clear confirmation signals over the radio path, the radiotelegraph equipment should return the clear confirmation signal to the switching equipment without waiting for the exchange of clearing and clear confirmation signals over the radio path.

6) *Guard delay*

The circuit shall be guarded on release as specified in Recommendation U.1 except that the delay shall be measured from the moment when the equipment has both:

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[1] For radio circuits using an eight-character cycle with four characters stored, a sequence of 8 α signals shall be used.

For radio circuits using an eight-character cycle with seven characters stored, a sequence of 11 α signals shall be used.

a) transmitted 7 α signals over the radio path without request for repetition;

b) has received two consecutive α signals over the other signalling path.

During the guard period the free line condition shall be maintained on both signalling paths of the international circuit.

Because it is possible for the circuit to be opened for traffic at one end before the equipment at the other end has completed the transmission of the 7 α signals, it is possible that an incoming call may be received before the 7 α signals have been transmitted. Where this occurs, the call should be accepted but the call-confirmation signal should not be returned until the transmission of the 7 α signals has been completed.

I. *Register congestion*

Semi-automatic working: the return of a signal indicating congestion may be allowed: the NC sequence with the standard form of service signals should be used to indicate the situation.

Fully-automatic working: the return of a signal indicating congestion is prohibited.

J. *Service signals*

Teleprinter signals (OCC, NC, NCH, NA, NP, DER, ABS) preceded by the carriage return, line feed and letter-shift signals and followed by line feed (preferably together with carriage return) and then immediately by the clearing signal in all cases.

K. *Both-way working*

1. For both-way ARQ radio circuits used in the fully-automatic telex and gentex services, the following action to minimize the incidence of head-on collision is recommended:

a) that inverse order testing, or a close approximation to it by testing the route in small groups of circuits in fixed order, always starting the search from the same initial position, should be adopted at opposite ends of a both-way group of trunk circuits.

b) that calls should be offered in such a way that each circuit is tested once only for the minimum period of time necessary to ascertain whether it is free or busy, and the outgoing selectors should not have facilities for delayed hunting.

2. The absence of the proceed-to-select signal will serve to detect a head-on collision when the group of circuits is totally occupied or very nearly totally occupied.

The two calls will then be cleared down unless there are still free circuits in the route.

Note 1. — See Recommendation S.13 for signals α and β.

Note 2. — The recognition of the calling, call-confirmation, clearing and clear confirmation signals requires the detection of two consecutive signals β or α as specified. The detection device should, in new equipment, be arranged to recognize two consecutive signals even though these may be separated by a period of automatic correction, i.e. the discrimination involves counting. In some existing equipments the detection device requires that the two signals to be recognized shall occur in consecutive character periods, i.e. the discrimination involves timing. The transmission of the call-confirmation, clearing and clear confirmation signals requires that the appropriate number of β or α signals shall be offered to the storage of the radio equipment without a request for repetition, i.e. the control should be by a timing device which is reset when automatic correction occurs.

The following diagram clarifies this Recommendation U.20.

Notes to the diagram opposite

1. If the motor of the FRXD (or equivalent motor-driven storage device) in A is not already running, it must be started without delay in order to accept the subsequent selection signals.

2. On circuits automatically operated in both directions, reception of a single β signal at the end of the circuit remote from the calling subscriber must cause the outgoing equipment on this circuit at that end to be marked busy immediately. This busy condition must be applied until two α signals are received. If the motor of the storage device in B is not already running it must be started. It is desirable that, in the busy hour at least, the starting of the motor of the storage device should not be dependent on the calling signal for each call. One simple method of meeting this requirement is to provide a device which delays the switching off of the motor until about 5 minutes after the call has been cleared.

3. With manual switching, the call confirmation signal shall be returned independently of the operator's answer.

4. Semi-automatic working: if the automatic switching equipment at the receiving end can receive the selection information immediately after the sending of the call-confirmation signal, the call-confirmation signal shall constitute the proceed-to-select signal.
   If the automatic switching equipment at the receiving end cannot receive the selection information immediately after the sending of the call-confirmation signal, a distinct proceed-to-select signal shall be returned over the backward signalling path after the call-confirmation signal.
   Fully-automatic working: the proceed-to-select signal returned over the backward signalling path shall always be distinct from the call-confirmation signal.
   For 99% of calls in the busy hour, the proceed-to-select signal must be returned not more than 3 seconds after transmission of the call-confirmation signal begins. For some existing networks, this delay will be 4 seconds. Measures should be taken so that, if proceed-to-select or proceed-to-transmit signals are relayed by the FRXD (or equivalent storage device), the switching equipment does not return these signals until the motor has reached its full speed.

5. The letter v (combination No. 22 of alphabet No. 2) shall be used for the proceed-to-select signal.

6. For manual working: teleprinter signals over the forward signalling path.
   For semi-automatic working: teleprinter signals over the forward signalling path, as follows:
   - the prepare-for-digits signal shall be combination No. 30 (figure-shift).
   - digits of the called subscriber's number in alphabet No. 2.
   - end-of-selection signal, combination No. 26. This may be followed by another combination characterizing the class of traffic in the incoming country.

For fully-automatic working: teleprinter signals over the forward signalling path, as follows:
- the prepare-for-digits signal shall be combination No. 30 (figure-shift).
- digits of the called subscriber's number in alphabet No. 2.
- if an end-of-selection signal is required, this should be combination No. 26. This may be followed by another combination characterizing the class of traffic in the incoming country.

The transmission of the selection signals should be delayed if the motor of the FRXD has not yet gained speed.

Where the incoming system uses a uniform numbering plan so that the number of digits in the number can be determined from the initial digit, the outgoing administration must transmit an end-of-selection signal if this is required by the incoming country. Where the incoming system has a non-uniform numbering scheme the end-of-selection signal cannot be made obligatory. However, for such a system it may be advantageous to use this signal subject to the agreement of the outgoing administration, in those cases where the outgoing system can readily insert the signal. To avoid undue occupation of trunks and equipment, administrations should take all reasonable steps to ensure that selection signals are transmitted over radio circuits without undue delay.

(7) Manual working: the code DF over the backward signalling path. Semi-automatic working: either answer-back signals or combination No. 32, followed by 11-13 combinations No. 29 (letter-shift) followed by the obtained subscriber's answer-back code. The insertion of the combinations No. 29 must not cause mutilation of the subsequent signal in the sequence. Fully-automatic working: combination No. 32, followed by 11-13 combinations No. 29 (letter-shift) followed by the obtained subscriber's answer-back code. The insertion of the combinations No. 29 must not cause mutilation of the subsequent signal in the sequence.

(8) If there is still text stored, this text must be transmitted before the α-signals are sent over the radio path.

(9) In order to ensure that, on transit calls, switching equipment and possibly the subscriber's teleprinter set are unnecessarily held because of delay in transmitting the clearing and clear confirmation signals over the radio path, the radio equipment should return the clear confirmation signal to the switching equipment without waiting for the exchange of clearing and clear confirmation signals over the radio path. It is desirable that the equipment shall be arranged so that the clearing and clear confirmation signals do not cause spurious characters (including combinations No. 32) to be transmitted over the radio path. Where electronic storage devices are used it is possible to arrange for these spurious characters to be suppressed in the storage device. Where electro-mechanical storage devices are used, the generation of spurious characters by the clear confirmation signal can be minimized by arranging that when the clearing signal is received over the radio circuit, the input to the storage device is blocked.

(10) Should there still be text stored, this text must be destroyed. If an FRXD contains perforated tape which has not yet been transmitted, this tape should be fed out independently of possible requests for repetition. During the feeding out of the tape there shall be blocking with β-signals. The transmission of α-signals should be delayed until the perforated tape has been completely fed out.

(11) At the beginning of the guard period at leat 7* α signals should have been transmitted. Because it is possible for the circuit to be opened for traffic at one end before the equipment at the other end has completed the transmission of the 7* α signals, it is possible that an incoming call may be received before the 7* α signals have been transmitted. Where this occurs, the call should be accepted but the call-confirmation signal should not be returned until the transmission of the 7* α signals has been completed.

* For radio circuits using an 8-character cycle with 4 characters stored, a sequence of 8 α signals shall be used.

For radio circuits using an 8-character cycle with 7 characters stored, a sequence of 11 α signals shall be used.

Note 1. The recognition of the calling, call-confirmation, clearing and clear-confirmation signals requires the detection of two consecutive signals β or α as specified. The detection device should, in new equipment, be arranged to recognize two consecutive signals even though these may be separated by a period of automatic correction, i.e. the discrimination involves counting. In some existing equipment the detection device requires that the two signals to be recognized shall occur in consecutive character periods, i.e. the discrimination involves timing. The transmission of the call-confirmation, clearing and clear-confirmation signals requires that the appropriate number of β or α signals shall be offered to the storage of the radio equipment without a request for repetition, i.e. the control should be by a timing device which is reset when automatic correction occurs.

A = Start polarity.

Z = Stop polarity.

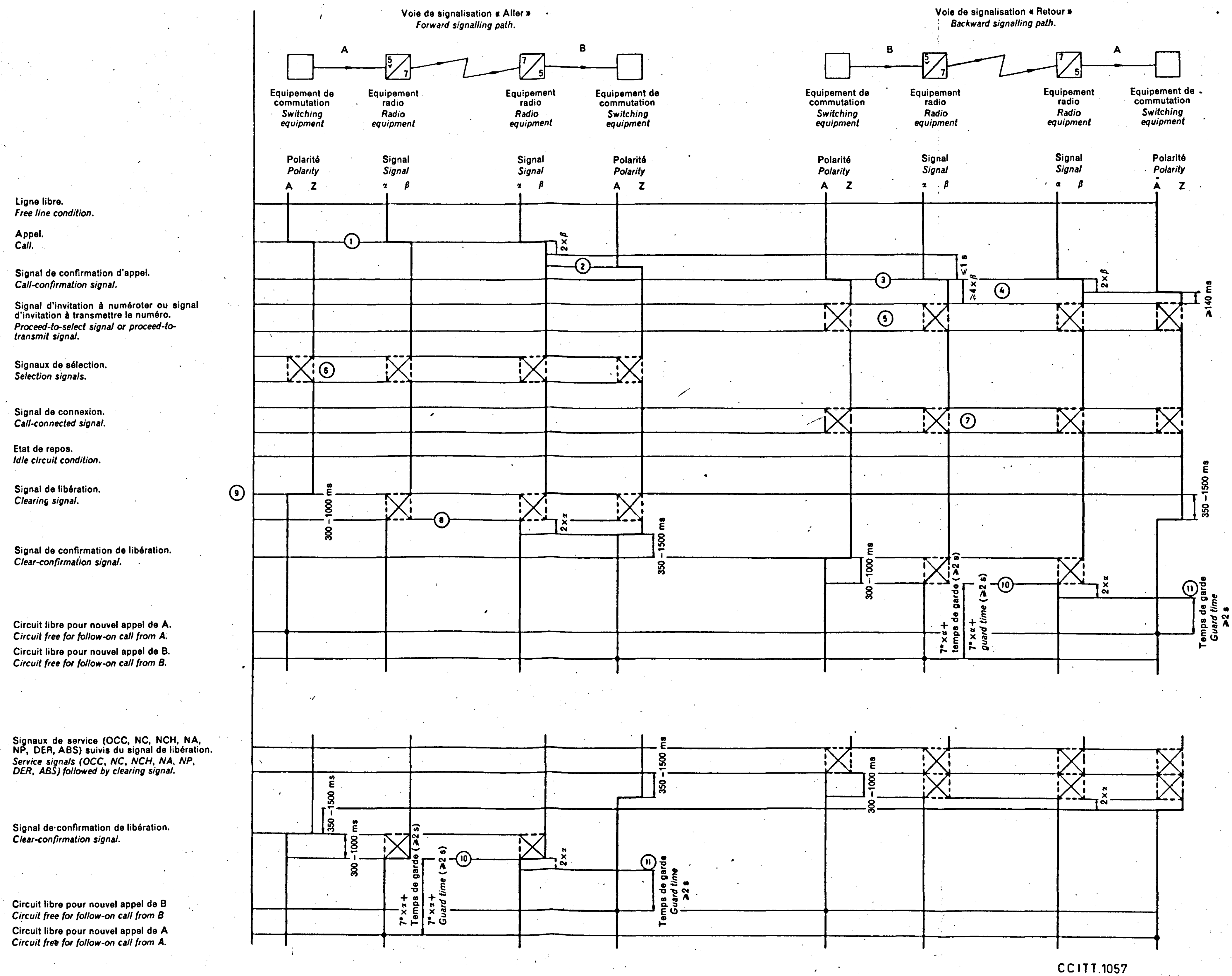
α = Equivalent of permanent start polarity.

β = Equivalent of permanent stop polarity.

X Teleprinter signals.

FRXD = Fully-automatic reperforator transmitter distributor.

This diagram does not show delays caused by propagation time, co-operation between start-stop and synchronous systems and possible repetitions.



Voie de signalisation « Aller »
Forward signalling path.
Voie de signalisation « Retour »
Backward signalling path.
A
B
Equipement de commutation
Switching equipment
Equipement radio
Radio equipment
Polarité
Polarity
Signal
Signal
A Z
α β
Ligne libre.
Free line condition.
Appel.
Call.
Signal de confirmation d'appel.
Call-confirmation signal.
Signal d'invitation à numéroter ou signal d'invitation à transmettre le numéro.
Proceed-to-select signal or proceed-to-transmit signal.
Signaux de sélection.
Selection signals.
Signal de connexion.
Call-connected signal.
Etat de repos.
Idle circuit condition.
Signal de libération.
Clearing signal.
Signal de confirmation de libération.
Clear-confirmation signal.
Circuit libre pour nouvel appel de A.
Circuit free for follow-on call from A.
Circuit libre pour nouvel appel de B.
Circuit free for follow-on call from B.
Signaux de service (OCC, NC, NCH, NA, NP, DER, ABS) suivis du signal de libération.
Service signals (OCC, NC, NCH, NA, NP, DER, ABS) followed by clearing signal.
Signal de confirmation de libération.
Clear-confirmation signal.
Circuit libre pour nouvel appel de B
Circuit free for follow-on call from B
Circuit libre pour nouvel appel de A
Circuit free for follow-on call from A.
2×β
≤1 s
≥4×β
≥140 ms
300–1000 ms
350–1500 ms
2×α
7*×α+ temps de garde (≥2 s)
7*×α+ guard time (≥2 s)
Temps de garde
Guard time
≥2 s
CCITT.1057

RECOMMENDATION U.21

OPERATOR RECALL ON A TELEX CALL SET UP ON A RADIOTELEGRAPH CIRCUIT

(New Delhi, 1960, amended at Geneva, 1964)

Experience has shown that, for telex calls set up over a radiotelegraph circuit, it was useful to enable the telex subscriber to cause an operator to re-enter on a call in progress without interrupting it.

Such re-entry may be of interest in the following cases as well as in the case of a defective connection:

1. When a subscriber decides, in the course of a call, to change from a plain text to a cypher he can call the operators in the terminal radio exchanges and ask them to interrupt the delay signal which might otherwise disturb the synchronism between the cyphering apparatus used at the two ends.

2. When a subscriber has sent a message but waits a very long time for a reply from his correspondent, he can ask the operator whether his message is still being stored or whether it is expected that any interruption to the radio circuit will continue. If need be, he can then choose another means of communication (telegram or telephone call) to send an urgent message to its destination.

Although it seems that re-entry by an operator will be limited mainly to national networks (for example by a subscriber calling the controlling telex operator on the radiotelegraph circuit), international standardization of an " operator recall " signal would be useful if the controlling telex operator on the radiotelegraph circuit is located in a transit country, and also for intermediate manual switches; this would no doubt prove to be a great advantage when this possibility is generally utilized.

The C.C.I.T.T. therefore *unanimously declares the following view:*

1. If the administrations concerned agree on the use of a special signal enabling a subscriber to recall an international telex operator's position making use of radiotelegraph circuits, such a recall must not cause release of a call in progress;

2. This " operator recall " signal will consist of the following sequence: combinations No. 28 (line feed) followed four times by combinations No. 27 (carriage return);

3. The detection device causing re-entry by the operator will be controlled by the receipt of four consecutive combinations No. 27; combinations No. 28 will only be used to

avoid superposition of the text on the receiving teleprinter and will not have to be recognized by the detection device.

4. The equipment for discriminating the operator recall signal will be switched off by a sequence of four consecutive combinations No. 19 (signal for transfer to data).

RECOMMENDATION U.22

SIGNALS INDICATING DELAY IN TRANSMISSION ON CALLS SET UP BY MEANS OF SYNCHRONOUS SYSTEMS WITH AUTOMATIC ERROR CORRECTION BY REPETITION

(New Delhi, 1960, amended at Geneva, 1964)

Traffic observations on radio telex channels have shown that the possible delay in the reception of text transmitted by one subscriber to another is a drawback from the operating point of view. The delay may be caused by repetitions and/or difference in the modulation rate of the teleprinters (traffic from Europe to the U.S.A.). In case of such delays a subscriber is left in doubt whether he simply has to await transmission of his message over the radio path or whether the delay is due to the tardy answering of his correspondent for which he will have to pay. Furthermore, in the case of delays due to long repetition periods a receiving subscriber may be tempted to answer prematurely, which causes garbling of the text.

To a certain extent this drawback can be offset by the application of a strict operating procedure (" + ? " signal to invite the correspondent to transmit) However, supplementary technical measures have proved to be desirable.

A good technical solution of this problem is to use combinations No. 32 as a delay signal in the following manner:

a) combinations No. 32 are returned to the transmitting subscriber at the rate of one every 5 seconds if he stops transmission during an interval of 10 seconds and the local storage device still contains untransmitted tape;

b) combinations No. 32 are sent to a subscriber at the rate of one every 1.2 second if transmission is delayed by repetitions whenever condition a) does not apply.

The slow delay signals inform a sending subscriber that his message has not yet been received by his correspondent. The rapid delay signals inform a receiving subscriber that the received message is not yet complete and that he should not cut in.

In the case of cipher messages where combinations No. 32 may result from the coding procedure, delay signals should not be used. Also in the case of full duplex working, waiting signals cannot be used. Furthermore, it is desirable not to transmit waiting signals during the setting-up of semi- or fully-automatic calls, since interpolated waiting signals would complicate the discrimination of the selection signals and the call-connected signals. Therefore, the best solution seems to be to put the switching on and off of the delay signal facility under the control of the subscribers: four consecutive combinations No. 8 or No. 14 could be used for this purpose.

The transmission of these delay signals can obviously not be imposed on an administration which makes the connection by an international land-line and a radio channel.

For these reasons, the C.C.I.T.T. *unanimously declares the view:*

1. That, when the administrations concerned agree that it is necessary to signal to telex subscribers about a delay in transmission over the radio telex channel, delay signals shall be used having the following characteristics:

a) combinations No. 32 at the rate of one every 5 seconds, returned to a sending subscriber when he has stopped transmission for a period of 10 seconds and if there is still text stored;

b) combinations No. 32 at the rate of one every 1.2 second sent to a subscriber whenever transmission over the radio channel is delayed by repetitions and condition a) above does not apply.

2. Sending of combinations No. 32 is cut off as soon as the subscriber starts to transmit again.

3. No delay signal will be transmitted while the call is being put thiough.

4. The calling and also the called subscriber can suppress sending of the waiting signal at the two ends of the radio circuit by transmitting four successive combinations No. 8. The waiting signal can also be started off again by transmitting four successive combinations No. 14.

5. The delay signal should be switched off upon reception of four consecutive combinations No. 19 (signal for transfer to data) for the duration of the call.

Note. — Administrations must take precautions to ensure that the reception of combinations No. 32 should not cause spacing of the paper on page-printing or tape-printing apparatus.

RECOMMENDATION U.23

USE OF RADIOTELEGRAPH CIRCUITS WITH ARQ EQUIPMENT FOR FULLY-AUTOMATIC TELEX CALLS CHARGED ON THE BASIS OF ELAPSED TIME

(Mar del Plata, 1968)

1. *Charging on the basis of elapsed time*

Where a radiotelegraph circuit equipped with ARQ equipment forms part of an international telex network and can be engaged in a telex connection established by fully automatic switching, the administrations are faced with a difficult problem regarding automatic charging of the calls.

The difficulty arises from the fact that in case of bad transmission conditions on the radiotelegraph circuit, signals recognized as erroneous are repeated. These repetitions can be numerous at certain times. For manual or semi-automatic operation, in order to establish the basis for charging, the administrations or recognized private operating agencies (R.P.O.A.) deduct the time during which the circuit has been transmitting repetitions from the elapsed duration of the connection.

The application of this method to fully-automatic calls—although desirable—is made difficult by the fact that the charge for these calls is made in the originating country and by automatic methods. When the call is not established through the intermediary of radiotelegraph circuits incorporating ARQ equipment, the charge is made according to the elapsed time of the communication. It would then be necessary to advise the originating country that the call has involved a radiotelegraph circuit which incorporates ARQ equipment, and to advise what correction should be applied to the elapsed time of the communication in order to account for the periods of inefficiency of the radiotelegraph circuit.

Means are being studied for finding a solution that is both technically and economically acceptable for the transmission and use of information necessary for corrected charging as a function of the inefficiency of the radiotelegraph circuit.

While waiting to introduce these technical methods and to determine whether they can be used by all administrations, administrations may utilize the method of charging according to the elapsed time, with safeguard measures designed to avoid, in certain cases, an excessive overcharge of the calling subscriber, as indicated in the present Recommendation.

2. *Safeguard measures*

When charges are to be based on elapsed time, the methods of safeguard are:

i) busying of an unoccupied radiotelegraph channel whenever transmission conditions on this channel are inadequate;

ii) forced release of an established connection on such a channel whenever transmission conditions are bad.

In the application of the latter type of safeguard (forced release of an established connection), there are two conflicting requirements:

a) the need to avoid substantial differences between the charged time and the time during which the connection was efficient;

b) the need to avoid, as much as possible, forced release of established connections.

A reasonable compromise solution should achieve the following main objectives:

a) the percentage of forced releases must not exceed three per hundred;

b) the average overcharge for a call must not exceed five per hundred;

c) the maximum overcharge for a call must not exceed twenty-five per hundred.

3. *Control of forced release*

Administrations employing radiotelegraph circuits incorporating ARQ equipment should choose one of the following two methods for controlling the forced release of an established connection:

— method A, based on the use of the efficiency factor as the only controlling factor,

— method B, based on the use of a store (or memory) of high, but limited, capacity situated at the input to the ARQ equipment. If the memory is full, forced release is ordered. In this method, the efficiency factor is used as a subsidiary control factor.

When method A is employed, an established connection will be cut whenever the efficiency factor, averaged over 60 consecutive seconds, falls below 80%.

When method B is used, the capacity of the controlling memory would be 750±50 characters (corresponding to approximately two minutes traffic at maximum speed). If the memory became filled up, the connection would be cut. A supplementary safeguard would be provided by cutting the connection if the efficiency factor remained zero for 30 seconds (such as during interruption of the radioelectric circuit).

(The figures of 750 characters and of 30 seconds could be reviewed after service trials of the proposed values.)

Method A, especially if it is applied to circuits which conform to the stability requirements specified in paragraph 9 below, ought not to result in more than two or three per cent of connections being interrupted; this figure is quite comparable with the number of fortuitous releases recorded in the use of cable circuits.

Under certain conditions, the use of method B would permit traffic to continue when method A would have broken off the connection but it incurs an added risk of overcharge and of disturbing the transmission of long messages, especially when these are transmitted at maximum speed.

4. *Control of busying*

At those times when its efficiency factor is too low, a circuit which is not carrying traffic should be busied at both ends so that it cannot be seized by a call until such time as the efficiency factor reverts to an acceptable value.

With both method A and method B, the circuit will be busied if the mean value of the efficiency factor, measured over an interval of 20 consecutive seconds, is less than 80%.

5. *Practical application of busying*

For a radiotelegraph system corresponding to 50 bauds (see Recommendation S.13), the maximum number of transmissible elements in a 20-second period is 20×48 and the corresponding number of characters is $\frac{20 \times 48}{7}$ i.e. 137. If r is the number of repetition cycles during 20 seconds, the efficiency factor is $\frac{137-4r}{137}$ [1]. Hence, it is sufficient to count the number of repetition cycles because if, in a period of 20 consecutive seconds, there are 7 [2] repetition cycles or more, then the mean efficiency factor is below 80% during that period.

The two most practical methods of dividing the time up into intervals of 20 seconds are the procedure of splitting the time into 20-second blocks and the method of using sliding periods of 20 seconds.

In the procedure of splitting the time into blocks, the time is divided into fixed intervals of 20 seconds. The repetition cycles are counted during each of these intervals and the count is recommenced for each interval, no account being taken of the result of the count for the preceding interval. In the sliding period method, the earliest count is eliminated and a new count added.

The block method uses simpler equipment than the sliding period method; it is a little less exact because of the fact that the influence of a bundle of repetitions arriving at about the same time as the division between successive blocks is spread over two successive and independent blocks.

After very close consideration of the discrepancies between the results given by the two methods, it was concluded that the effect of these discrepancies is small and of no practical importance as far as subscribers are concerned. The administrations may therefore select either method.

If, during a counting period, the number of repetition cycles had already reached a figure corresponding to a mean efficiency factor of lower than 80% over the 20-second period, the decision to order busying of the circuit will be made immediately, without waiting for the end of the current 20-second period.

The manner in which the order to busy the circuit is sent from the ARQ equipment to the switching centre is a matter which interests only the administration which operates the centre and the ARQ equipment; it is the administration's prerogative to select the most suitable signalling method and there is no need to issue an international recommendation on this matter.

The timing of intervals at the two ends of the same circuit is not synchronized, so that instants of busying or debusying a circuit at one end may differ from the corresponding

[1] This figure is 8 in the case of an 8-character-repetition cycle.

[2] 3.5 with an 8-character-repetition cycle.

instants at the other end by several seconds. As a result, while one end of the circuit is marked " busy ", a call can seize the circuit at the other end. This situation is considered as admissible, and the incoming call is accepted.

After a circuit is marked " busy ", the measurement of the efficiency factor proceeds in accordance with the same time-division process. If, during a 20-second period, the mean efficiency factor reaches or exceeds 80% the " busy " marking is removed. It follows that, whenever the efficiency factor is varying at about 80%, periods of busying and of return to service can succeed one another at intervals of about 20 seconds. This effect was considered to be permissible.

6. *Application of forced release*

A call can seize the radiotelegraph circuit only during a period when the circuit is not marked " busy ". In the case of a call arriving on the radiotelegraph circuit after the occurrence of the first marker denoting the termination of a 20-second period, the time division for method A will proceed on the basis of 60-second intervals (instead of 20-second ones), and everything which has been said about 20-second periods applies equally to 60-second periods.

In particular, if, during a 60-second period, it is already evident that the efficiency factor cannot reach an average value of at least 80%, forced release of the connection shall be ordered without waiting for the end of the period.

When method B is being used, the period controlling examination of the efficiency factor is of 30 seconds duration; forced release should be ordered if the efficiency factor is zero during a 30-second period; hence the release decision cannot be taken in less than 30 seconds.

If the efficiency falls so far that the connection must be cut at the calling end of the ARQ circuit, a long time could elapse, in the event of very adverse transmission conditions, before the release signal could be sent to the called subscriber.

Consequently, the called subscriber (especially in stations not supervised by a receiving operator) remains engaged and cannot be reached by other subscribers.

Also, the re-establishment of the call by way of another channel becomes impossible. Therefore, it is desirable to be able to effect a release at the receiving end in unfavourable conditions. The method of release employed at the receiving end, however, should not initiate release more easily than at the calling end.

For method A, it is proposed for this purpose that, once there is evidence at the receiving end that the mean efficiency factor has remained lower than 80% for two successive 60-second periods, release at the receiving end should follow.

For method B, evidence that the efficiency factor has remained zero for 30 seconds will similarly release the called end. (The conditions of release are symmetrical at the two ends.)

7. *Elimination of signals still registered in the memory*

Once the decision has been made to break the established connection at either end, the signals which are still recorded in the ARQ equipment memory must be destroyed.

It must be pointed out that in this case the forced release signal has been due to the bad conditions of transmission; it is very probable that the subscriber, at the receiving end, will be released by the auxiliary safeguard measures (two successive periods of 60 seconds with the efficiency factor below 80% for system A, 30 seconds with zero efficiency factor for system B); the signals that the memory would continue to dispose of in the forward direction will probably not reach the called subscriber. For this reason the elimination of the signals still registered in the memory has been decided.

8. *Advising the calling subscriber*

It has been proposed that the calling subscriber should be advised by a special service signal preceding the forced release signal; in this way the calling subscriber would know that he must reforward his whole message.

This service signal would above all have the advantage of enabling the automatic charging device to recognize that it is dealing with a connection which has been interrupted as a result of operation of the safeguard feature of an ARQ equipment and that the call must not be charged.

Although the principle of this solution may have escaped criticism, its application has provoked objections. The first would be the cost and complexity of equipment which would ultimately be used for only a very small proportion of calls. Another objection would be the fact that, in certain types of apparatus, automatic transmission could not be interrupted by the reception of signals; the only result would be mutilation on the local copy of the transmitted text and of the service code; the meaning of these mutilations could be obscure to the subscriber.

The aspect of the other end of the communication which could also have a message in the process of transmission to the calling subscriber must also be taken into account.

Finally, the use of the clearing signal only, without the use of a preliminary service signal, was proposed.

9. *Precautions to be taken before incorporating circuits with ARQ equipment in automatic switching networks*

In spite of these precautions, fully-automatic operation on a radiotelegraph circuit incorporating ARQ equipment can be considered only if this circuit possesses adequate stability.

Before incorporating a circuit with ARQ equipment in the fully-automatic switching network, the administrations (or the R.P.O.A.) must carry out extended trials.

These trials should be made under normal traffic conditions, over a minimum period of three consecutive hours chosen from the busy period (or periods), when heavy traffic is foreseen to occur on the route under consideration (allowing for the traffic, whether terminal or transit which prevails on the route according to the season).

The condition which must be fulfilled before a circuit can be accepted for use in the fully-automatic network is that its mean efficiency factor, measured over periods of 20 consecutive seconds each, shall not fall below 80% for more than 10% of the total time involved in the measurements.

The measurements must be repeated as often as will be necessary for the administration to have an assessment of the suitability of the circuit.

The attention of administrations is drawn to the fact that, before offering fully-automatic transit working on a radio route incorporating ARQ equipment, the grade of service on the route under consideration must be in accordance with that proposed in Recommendation F.68, point 11 b, i.e. only one call lost in 50.

If these conditions are not complied with, it would be better to retain semi-automatic operation.

For these reasons, the C.C.I.T.T. *unanimously declares the following view:*

1. Administrations (or R.P.O.A.s) operating radiotelegraph circuits equipped with ARQ systems which may be engaged in a fully-automatic telex call, such that the charging of the subscriber is made automatically in the originating country according to the elapsed time of the connection, must take precautions to avoid too great a difference between the charged time and the time during which the radiotelegraph circuit was efficient.

In this regard they will have the choice of two methods, method A and method B.

2. In method A (the efficiency factor method), if, in the course of an established connection, the mean value of the efficiency factor [1] is lower than 80% over a period of 60 consecutive seconds, the connection will be released and the clearing signal will be sent to the calling subscriber under the control of the ARQ equipment.

3. In method B (based on stored characters), a memory with a limited capacity (750 characters$\pm$50) will be placed at the input of the ARQ equipment. The clearing signal will be sent when this memory is full.

The clearing signal will also be sent if the efficiency factor remains zero for 30 seconds.

4. It is recommended that when the two terminals of a circuit using ARQ equipment are operated by two different administrations (or R.P.O.A.s) the same method be applied at the two terminals of the circuit.

5. With either method A or method B, applied on a circuit involved in a fully-automatic telex network, measurements will be made, at those times when the circuit is not held by a call, in order to determine the mean efficiency factor based on periods of 20 consecutive seconds.

If, during such a period, the mean efficiency factor falls below 80%, the circuit shall be marked " busy " on the first switching centre located backward of the ARQ equipment which assessed this situation.

If, during a period of 20 consecutive seconds, the mean efficiency factor rises above 80%, the " busy " marking shall be removed and the circuit will be able to be seized by a call.

6. When method A is being used, interruption of an established connection will occur, at the calling side, when, during a 60-second period, it becomes apparent, without waiting until the end of the period, that the mean efficiency factor during the period will be lower than 80%.

If, at the receiving side, the mean efficiency factor during two consecutive periods of 60 seconds is lower than 80%, the release of the communication will be given to the called end.

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[1] Definition of the efficiency factor (in time): definition 33.23 of the *List of essential terms.*

7. In case of a forced release of the connection, the clearing signal will be sent to the calling end (and eventually to the receiving end) from the ARQ equipment.

The signals which would still be stored in the memories at the moment of the sending of a forced release signal will be destroyed.

The " stop " polarity will be transmitted across the radiotelegraph circuit while the store is being destroyed.

8. In the case where two or more radioelectric circuits using ARQ equipment would be used in tandem on a connection, each circuit will operate on its own, independently of the conditions on the other circuit(s).

RECOMMENDATION U.24

REQUIREMENTS TO BE MET BY SYNCHRONOUS MULTIPLEX EQUIPMENT DESCRIBED IN RECOMMENDATION R.44, FOR TELEX AND GENTEX OPERATION

(Mar del Plata, 1968)

The C.C.I.T.T.,

considering

that it may be desirable to use synchronous systems described in Recommendation R.44 in the teleprinter switching networks;

that it is essential to transmit the full range of telex signals for types A, B and C signalling,

unanimously declares the view

1. that where it is necessary to receive signals with a nominal cycle of 7 units (reference Recommendation S.3, paragraph 4), it will be necessary to insert a suitable storage to reconcile the two character rates (400 and 411);

2. that type A and B signals in accordance with Recommendation U.1 and U.2 and type C signals in accordance with Recommendation U.11 should be accepted for transmission through the synchronous system. However, in the case of type A signalling, the delay between the start of the call-confirmation signal and the proceed-to-select signal should be increased to, at least, 150 ms;

3. that the call signal should be transmitted through the synchronous system with the minimum delay obtainable with the particular method of multiplexing in use, e.g., element interleaving, in order to reduce the incidence of head-on collisions with both-way operation. The maximum delay due to the multiplex equipment should be limited to 60 ms.

4. that the maximum delay on the call-confirmation signal due to the multiplex equipment should be 60 ms in the case of type A signalling, and 120 ms in the case of type B signalling;

5. that the maximum delay on the start of the reception confirmation signal due to the multiplex equipment should be 60 ms in the case of type C signalling;

6. that the maximum delay on the proceed-to-select signal due to the multiplex equipment should be 450 ms in the case of type A signalling, and 120 ms in the case of type B signalling;

7. that the maximum delay on the call-connected signal due to the multiplex equipment should be 450 ms (type A and type B signalling);

8. that the maximum delay on a teleprinter character due to the multiplex equipment should be 450 ms;

9. that the maximum delay on the clear and clear-confirmation signals due to the multiplex equipment should be 450 ms.

10. that the tolerance of the type A and B pulse signals after retransmission through the synchronous multiplex system will be as stated below:

10.1 *Call-confirmation and proceed-to-select signal—type B signalling*

The duration of the pulse after transmission through the synchronous system will not be less than 17.5 ms nor more than 50 ms.

10.2 *Dial pulses—type B signalling*

Speed — ±3% of the mean speed of input measured for digit " 0 " (normally 9 to 11 pulses per second).

Ratio — The duration of stop polarity pulses will not be less than 32 ms; the duration of start polarity pulses will not be less than 44 ms.

Under certain circumstances the retransmitted dial signals may include pulses of stop polarity having durations of up to 73 ms and pulses of start polarity having durations of up to 98 ms. Where this is so and the incoming switching equipment cannot accept pulses with these characteristics a dial pulse regenerator should be inserted between the output of the multiplex circuit and the input of the switching equipment.

10.3 *Service signals for ineffective calls — type B signalling*

The duration of the period of stop polarity, whether followed by teleprinter signals or not, will, after transmission through a synchronous system, be not less than 145 ms and not more than 292 ms.

If several synchronous systems are placed in tandem, the duration of the period of stop polarity of the service signal at the output of this group of systems should not exceed 440 ms.

At the input of a synchronous system, a service signal of the type B will cause the return of a clear-confirmation signal from the synchronous equipment without waiting for the return of the clear-confirmation signal from the distant end of the connection. Following the recognition of the clearing signal in the service signal, a permanent " start " polarity will be transmitted over the synchronous system.

10.4 *Call connect — type A signalling*

The duration of the pulse of start polarity after transmission through several synchronous systems will be within the limits 140 ms to 160 ms.

TABLE 1 — *Telex signalling through the multiplex equipment—Type A signalling*

Signalling condition	Signal received from telex (Recommendation U.1)	Signal on channel aggregate path	Signal transmitted to telex
Free line	Continuous A polarity on both signalling paths.	Continuous A polarity.	Continuous A polarity.
Call	Inversion to Z polarity on forward signalling path.	Inversion to Z polarity (within 9-35 ms from inversion in column 2) (Notes 1 and 2).	Inversion to Z polarity (maximum delay of 60 ms from inversion in column 2.
Call confirmation	Inversion to Z polarity on backward path within 150 ms of receipt of calling signal.	As for call.	As for call.
Proceed-to-select	Teleprinter signals or 40 ms pulse of A polarity (±8 ms) on backward path. Not to be returned within 150 ms of call confirmation.	Teleprinter signals or combination No. 22 (v).	Teleprinter signals or combination No. 22 (v) (Note 3).
Selection	Teleprinter signals on the forward path.	Teleprinter signals.	Teleprinter signals (Note 3).
Call connect	Teleprinter signals or 150 ms (±11 ms) pulse of A polarity followed by continuous Z polarity for 2 seconds minimum on the backward path.	Teleprinter signals or one alpha combination followed by continuous Z polarity for 2 seconds minimum.	Teleprinter signals or 145 5/6 ms pulse of A polarity followed by continuous Z polarity for 2 seconds minimum (Note 3).

For notes, see the end of the tables.

TABLE 1 (continued) — *Telex signalling through the multiplex equipment—Type A signalling*

Signalling condition	Signal received from telex (Recommendation U.1)	Signal on channel aggregate path	Signal transmitted to telex
Service signals	Teleprinter signals on the backward path followed by clearing signal (Note 4).	Teleprinter signals followed by one or two alpha combinations and then continuous A polarity (Note 5).	Teleprinter signals followed by continuous A polarity (Note 3).
Clear	Inversion to continuous A polarity on either signalling path (Note 4).	One or two alpha combinations followed by continuous A polarity (Note 5).	Inversion to A polarity (Note 3).
Clear-confirmation	Inversion to continuous A polarity in opposite direction to clearing after a delay of 350-1500 ms following receipt of clearing signal.	As clear.	As clear.

TABLE 2 — *Telex signalling conditions through the multiplex equipment—Type B signalling*

Signalling condition	Signal received from telex (Recommendations U.1 and U.2)	Signal on channel aggregate path	Signal transmitted to telex
Free line	As type A.	As type A.	As type A.
Call	As type A.	As type A.	As type A.
Call confirmation	A 17.5-35-ms pulse of Z polarity on the backward signalling path, returned within 150 ms of receipt of calling signal.	1 or 2 consecutive elements of Z polarity.	32-50 ms pulse of Z polarity (Note 7).

For notes, see the end of the tables.

TABLE 2 (continued) — *Telex signalling conditions through the multiplex equipment—Type B signalling*

Signalling condition	Signal received from telex (Recommendations U.1 and U.2)	Signal on channel aggregate path	Signal transmitted to telex
Proceed-to-select	As call confirmation signal. The interval of A polarity separating the signals to be 100 ms minimum.	As for call confirmation.	As for call confirmation. The interval separating the pulses may be reduced to 60 ms minimum. (Note 7).
Selection signals	Teleprinter signals or dial pulses having the following limits: Speed: 9-11 p.p.s. Ratio: 1Z-1.9A.	Teleprinter signals (Note 2) or dial pulses, when each start polarity interval is transmitted as 1-4 elements of A polarity and each stop polarity interval is transmitted as 1-3 elements of Z polarity. The mean speed of pulsing will be the same (±3%) as the input signals (Note 6).	Teleprinter signals (Note 3) or dial pulses at the same mean speed of the input (±3%) and having the following ratio limits: A polarity intervals: 44-98 ms; Z polarity intervals: 32-73 ms.
Call connect	Continuous Z polarity for 2 seconds minimum on the backward signalling path.	One beta combination followed by continuous Z polarity for 2 seconds minimum (Note 6).	Continuous Z polarity for 2 seconds minimum (Note 7).
Service signals (busy pulse)	165-260 ms of Z polarity on the backward path followed by A polarity for 1500 ms (±30%) continuously repeated. The Z polarity period may be followed by teleprinter signals when the tolerance of the A polarity period is reduced to ±20%.	One or two beta signals followed (possibly) by teleprinter signals, then by one alpha combination and A polarity as in the input signal (Note 6).	145-292 ms Z polarity, followed (possibly) by teleprinter signals and then by A polarity of minimum duration 950 ms (Note 7).
Clear and clear-confirmation	As for type A.	As for type A.	As for type A.

For notes, see the end of the tables.

TABLE 3 — *Type C signalling effected by multiplex equipment*

Signalling condition	Signal received from telex (Recommendation U.11)	Signal on channel aggregate path	Signal transmitted to telex
Free line	Continuous A polarity on both signalling paths.	Continuous A polarity.	Continuous A polarity.
Call signal (or automatic retest signal)	Inversion to Z polarity on the forward path for 150-300 ms followed by teleprinter signals.	Inversion to Z polarity (within 9-35 ms from inversion in column 2) (Notes 1 and 2).	Inversion to Z polarity (maximum delay of 60 ms from inversion in column 2). The period of Z polarity will be lengthened by a maximum of 450 ms.
Reception confirmation (or register congestion signal)	Inversion to Z polarity on the backward path for 450 ms (±10%) followed by teleprinter signals (or clearing signal).	As for call.	As for call.
Clear and clear-confirmation	As for type A.	As for type A.	As for type A.

Note 1. — Pulses of Z or A polarity from 0-9 ms (±1 ms) should be rejected by the multiplex equipment.

Note 2. — The start-stop stores of either signalling path should be switched into circuit after a maximum delay of one β combination for all types of signalling except type B with dial selection.

Note 3. — Recognition time of the clearing signal is 300-1000 ms.

Note 4. — The start-stop stores of either signalling path should be switched out of circuit after a maximum delay of two α combinations.

Note 5. — For type B signalling with dial selection the start-stop stores of both signalling paths will be switched into circuit after recognition of a maximum delay of 1 β combination on the backward path with Z polarity on the forward path.

Note 6. — In order to meet the timing requirements of the type B service signals it may be necessary to delay the initial inversion to Z polarity by an amount (450 ms maximum) corresponding to the delay with teleprinter signals. The call connect signal may also be similarly delayed. However, reversion to A polarity within 50 ms indicating a type B call confirmation or proceed-to-select signal should cancel any further delay on the transmission of these signals.

Note 7. — Delays given in these tables do not include the propagation time of voice-frequency telegraph channels.

RECOMMENDATION U.30

SIGNALLING CONDITIONS FOR USE IN THE INTERNATIONAL GENTEX NETWORK

(New Delhi, 1960)

The conditions in Recommendation U.1 concerning signalling in the international telex service, the specifications in Recommendation U.2 for standardization of dials and dial pulse generators in the international telex service, in Recommendation U.3 for the reduction of the effect of false calling signals, and in Recommendation U.5 on the characteristics of regenerative repeaters used in international calls, will hold good in the gentex network, except those referring specifically to manual or semi-automatic working. In some countries, indeed, no distinction is made between the gentex and the telex networks.

The differences between signalling conditions in the telex and the gentex networks are essentially due to the possibility of using overflow or waiting in the gentex network, and the absence of charges in it.

Hence, the C.C.I.T.T. *unanimously declares the following view:*

1. The recommendations in sections A and B of Recommendation U.1 (signalling conditions for use in the international telex service) shall also apply to the gentex network subject to the following changes:

Section B—paragraph 4 b) (Proceed-to-transmit signal)

The proceed-to-transmit signal is not used in the gentex network, since switching is always automatic.

Section B—paragraph 5 (Selection signals)

This paragraph should be read as follows for the gentex network:

c) If there is selection towards a system in which selection is by teleprinter signal, the prepare-for-digits signal will normally be combination No. 30 (figure shift). By agreement between the administrations concerned, this combination could be replaced by another combination for gentex calls over circuits used for gentex and telex traffic simultaneously, if the network of the country of arrival can ensure barring between the two kinds of traffic.

Section B—paragraph 9 (Service signals)

Should a call be waiting for connection to the called office (see Recommendation F.22, Article 16) the signal MOM can be sent to the calling exchange as soon as the waiting period begins. The waiting period cannot exceed one minute; it shall be followed by the transmission of the answer-back of the called station (or possibly by the answer-back of an overflow teleprinter if overflow facilities are provided) or, in the case where there is no teleprinter available at the expiry of the waiting period, by the transmission of the busy signal.

2. Table I b of the characteristics of signals of Section C of Recommendation U.1 applies to the gentex network.

3. Recommendations U.2 = Standardization of dials and dial pulse generators for the international telex service,
U.3 = Arrangements in switching equipment to minimize the effects of false calling signals,
U.5 = Requirements to be met by regenerative repeaters in international connections

apply to the gentex network.

RECOMMENDATION U.31

PREVENTION OF CONNECTION TO FAULTY STATIONS AND/OR STATION LINES IN THE GENTEX SERVICE

(former C.C.I.T. Recommendation E.9, Geneva, 1956)

The C.C.I.T.T.,

considering

that correct reception of the answer-back code at the beginning and end of a telegram should safeguard the correct transmission of the telegram;

that it accordingly becomes essential to provide adequate signalling for cases when a teleprinter is temporarily unable to participate in the international service, on account of paper trouble, faults, etc.,

A. *unanimously declares the view*

that faults during the transmission of a telegram shall be signalled as far as possible by the automatic transmission of a clearing signal;

recognizing, however,

that it will be impossible to signal all faults that may occur on an established connection,

unanimously declares the view

that it is essential that absence of paper on a receiving teleprinter should be signalled by the clearing signal;

B. *unanimously declares the view*

that, since the receiving administration is responsible for the receipt of the telegram when the answer-back signals have been correctly exchanged, it is responsible for making the necessary arrangements to ensure security of operation (for example, if the tape should break or become jammed);

that in the case of a faulty station line or teleprinter at the moment of the call, the existing automatic switching networks use one or more of the following signalling conditions: no " call-connected " signal, " busy " signal, service code " DER " or no return of answer-back. All these signalling conditions ensure that a telegram is not transmitted over a faulty connection;

that in the case of a faulty station line out of an office group it is essential that the faulty line should be busied out as quickly as possible so that traffic may be offered automatically to all the other lines in the group.

IMPORTANT NOTICE

1. An asterisk indicates that a question is urgent, i.e. that the study of the question has to be completed before the Vth Plenary Assembly.

2. Since Special Study Group D was set up by the Plenary Assembly, all questions relating to pulse code modulation (p.c.m.) have been assigned to this Study Group for the time being.

The Chairman of Special Study Group D will make arrangements with the other Chairmen for effecting liaison with the other Study Groups concerned as work progresses.

3. When a question is of interest to more than one Study Group and no Joint Study Group has been set up to deal with it, the mention of the other Study Group(s) concerned is intended for the information of the members of the Study Group to which the question has been assigned, to enable them to arrange for the necessary co-ordination *within their national* administrations, in accordance with a decision of the IVth Plenary Assembly.

LIST OF THE QUESTIONS ON TELEGRAPH TECHNIQUE TO BE STUDIED DURING THE PERIOD 1968-1972

STUDY GROUP VIII

(Telegraph apparatus)

Question No.	Title	Remarks
7/VIII	Error-detection via the return circuit	
9/VIII	Standardization of apparatus with Alphabet No. 5	Questions 6/I and C/Sp.A. To be examined by J.W.P. ALP

STUDY GROUP IX

(Telegraph transmission)

Question No.	Title	Remarks
3/IX	Noise limits for telegraphy	
5/IX	Noise measurements on circuits for telegraphy and data transmission	To be examined by J.W.P. LTG
6/IX	Study of distortion as a function of modulation rate using standard equipment, and consequent planning limits	
11/IX	Definitions concerning telegraph transmission quality	
12/IX	Effect on telegraph distortion of sudden changes of level	
14/IX	Frequency-modulated voice-frequency telegraph systems	
18/IX	Possible modifications of Recs. R.50, R.57 and R.75 to cover frequency-modulation systems and modern amplitude modulation systems	

Question No.	Title	Remarks
22/IX =11/X	Automatic maintenance tests of telegraph circuits	To be examined by J.W.P. on " Automatic telegraph maintenance ". See Question 11/X
24/IX	Time-subdivision of a telephone channel for synchronous telegraphy	Concerns S.G.s X and VIII
26/IX	Synchronous systems for special codes	Concerns S.G.s VIII and X
28/IX	Effect of sudden phase changes on telegraph distortion	To be studied in conjunction with S.G. IV (Question 3/IV)
29/IX	Telegraph frequency division multiplex systems for data signalling rates above 200 bits/s	
30/IX	Time subdivision of a telephone channel or a primary group for telegraphy and data transmission	Concerns Special Study Group A
31/IX	Time division of a P.C.M. system for telegraphy and data transmission	To be studied first by Special Study Group D (Question 1/D)
32/IX	Subdivision of standardized 50-baud telegraph channel	
33/IX	Frequency-shift modulated voice-frequency telegraph systems for modulation rates of 600 bauds and 1200 bauds	

STUDY GROUP X

(Telegraph switching)

Question No.	Title	Remarks
1/X	Standardization of signalling in the telex service and in the gentex network	
4/X	Telex and gentex signalling over radio circuits	

Question No.	Title	Remarks
6/X	Use of radiotelegraph circuits with ARQ equipment for automatic calls charged on the basis of elapsed time	Of interest to S.G. I
7/X	Automatic service over intercontinental circuits	
8/X	World-wide routing plan for telex and gentex services	Also Question 8/I, of interest to S.G. IX. To be studied by J.W.P. TGX
9/X*	New telegraph type network for message and data transmission	To be studied by the J.W.P. NRD; same Question 1/A, point H
11/X =22/IX	Automatic maintenance tests of telegraph circuits	To be studied by the J.W.P. MAT
12/X	Use of radiotelegraph circuits with ARQ equipment for automatic calls charged on the basis of efficient time	Of interest to S.G. I
13/X	Traffic forecasts	Of interest to S.G. I
14/X	Further category of ineffective calls, with service codes	Of interest to S.G. I

STUDY GROUP XIV

(Facsimile telegraph)

Question No.	Title	Remarks
1/XIV	Transmission of black-and-white facsimile on telegraph-type circuits	
2/XIV	Black-and-white facsimile transmission by numerical coding on telephone-type circuits	To be studied in liaison with Special Study Group A
3/XIV	Increase in speed of facsimile telegraphy in case of analogue transmission on telephone-type circuits	To be studied with the GM/LTG
4/XIV	Use of modern submarine cables for phototelegraph transmission	To be studied with the GM/LTG

Question No.	Title	Remarks
5/XIV*	Black-and-white facsimile transmission on telephone-type circuits	To be studied with the J.W.P. LTG; study to be made in liaison with the Question S+T of Special Study Group A
6/XIV	Use of the same leased telephone-type circuit for simultaneous transmission of facsimile and telegraph signals	To be studied with the J.W.P. LTG
7/XIV*	Facsimile service between subscribers	Of concern to Study Groups I and II
8/XIV	Facsimile transmission of colour documents	
9/XIV	High-speed facsimile transmission on wide-band circuits	To be studied in liaison with the study of Special Study Group A
10/XIV	Definitions for facsimile telegraphy	
11/XIV	Facsimile transmission over earth satellites	In co-operation with the C.C.I.R.

* Urgent question.

QUESTIONS ON ALPHABETIC TELEGRAPH APPARATUS TO BE STUDIED BY STUDY GROUP VIII

Chairman: Mr. G. BAGGENSTOS (Switzerland)
Vice-Chairman: Mr. I. SAVITZKY (Ukrainian S.S.R.)

Question 7/VIII—Error detection via the return circuit

(continuation of Question 7/VIII, 1964-1968, amended at Mar del Plata, 1968)

Would it not be desirable in certain cases to make use of the return circuit of telegraph connections with a view to ensuring an immediate check at the transmitting end that the text transmitted has been correctly received?

For this purpose the following systems might be considered:

1. A system in which:

a) the connections in question would be established over both-way simplex circuits;

b) the possible use of devices associated with the teleprinters to stop and start retransmission; these devices would be controlled by means of the appropriate signals;

c) the possible use of an automatic device in the sending apparatus to check that the texts coincide.

2. A simple system which does no more than indicate at the sending end that errors may have occurred.

Note. — See Supplements Nos. 13, 14, 15 and 16 of Volume VIII of the *Blue Book*, 1964.

ANNEX
(to Question 7/VIII)

Report of Study Group VIII concerning Part 1 of the Question

1. The return of received signals without correcting their distortion cannot be envisaged; distortions would most likely accumulate on the go and return channels.

Furthermore, the return of signals after printing would need very expensive devices and this particular proposal has been abandoned.

Consequently, the received signals should first be regenerated and then returned to the sending station either:

a) after regeneration but before translation (in practice, before tape-perforation); or

b) after translation (in practice, after tape-perforation).

In case a), it is easy to provide a clean text on the tape but there is no control on translation; in case b) the translation is kept under control but the eliminated signals appear on the tape.

2. This error correction system necessitates a duplex connection. It is therefore applicable only to leased circuits or to telex circuits capable of duplex operation.

It is clear that it necessitates regeneration equipment at the sending station, on the return channel, which is similar to the regeneration equipment at the receiving station, on the go channel.

3. The Study Group considers that the system working in accordance with the principle a) (return after regeneration, before translation) and the system in accordance with the principle b) (return after translation, before printing) are not necessarily incompatible.

4. The following points are to be standardized:

— number of signals to be repeated when errors are detected;

— signal indicating that a repetition takes place because of detected errors;

— protection of the signal indicating an error.

As to the number of signals to be repeated when errors are detected and having regard to compatibility of systems, several solutions need to be studied:

— stages of registration of signals with storage of different capacities according to the type of connection;

— selection of the number of signals to be repeated after a previous measurement of the propagation time, go and return;

— use of a storage device which has the capacity of a mean value.

The selection among these solutions may be more complicated if the intervention of an ARQ system into the channel is taken into account.

As to the signal which indicates the error, it has been agreed that this signal should be composed of a sequence of four times of a signal of Alphabet No. 2 (the secondary of this signal should not be a figure).

The study should be continued according to this suggestion.

As to the use of Alphabet No. 5 (I.S.O./C.C.I.T.T. alphabet with seven information units), the possibilities offered by this alphabet may result in very different solutions from those in which Alphabet No. 2 is used.

Question 9/VIII—Standardization of apparatus with Alphabet No. 5

(Mar del Plata, 1968)

What standards should be set for the characteristics of apparatus working at modulation rates up to 200 bauds and above with Alphabet No. 5, used by administrations and recognized private operating agencies for public service?

Points for study:

1. Should the interchange of traffic between the No. 5 and No. 2 Alphabet classes of machine be considered? If so, what are the requirements for optimum design of code converters for interworking?

2. Co-ordinated development of Alphabet No. 5 with Alphabet No. 2 machines may require correlation of machine parameters such as character rate. What parameters

should be recommended for the Alphabet No. 5 machines to allow co-ordinated mechanism development between the two families of machines?

3. What speeds of transmission should be recommended, bearing in mind 1) and 2) and also Study Group IX's considerations dealing with higher speed voice-frequency telegraph channels?

4. Study of the methods of applying control characters, i.e. HT (0/9) VT (0/11) and FF (0/12).

(see Supplement No. 1 of Volume VII of the *White Book*.)

Note. — Study of point 4 is connected with the Question 6/I of Study Group I and I/A, point C of Special Study Group A and has to be undertaken by the J.W.P. ALP.

QUESTIONS TO BE STUDIED BY STUDY GROUP IX: TELEGRAPH TRANSMISSION PERFORMANCE; EQUIPMENT SPECIFICATIONS AND DIRECTIVES FOR THE MAINTENANCE OF TELEGRAPH CHANNELS

Chairman: Mr. R. Brown (Australia)

Vice-Chairman: Mr. B. Kubin (Czechoslovakia)

Question 3/IX — Noise limits for telegraphy

(continuation of Question 3/IX, 1961-1964, amended at Geneva, 1964, and Mar del Plata, 1968)

(Question to be studied with the Working Group LTG)

Noise limits permissible on bearer circuits for V.F. telegraphy or time-division multiplex telegraphy.

Investigation of this matter should cover:

— the various ways in which the bearer circuits on routes longer than 2500 km (including satellite-circuits) are made up,

— for the modulation rates 50, 100, and 200 bauds, with start-stop and synchronous operation.

Comment

Question 10/C—Hypothetical reference circuits for very long systems—and Question 11/C—Conventional load of carrier systems—are to be studied by Special Study Group C which will most likely affect the final conclusions to be reached in the study of this question as a whole.

Note. — See Supplement No. 8 to Volume VII of the *Blue Book*, Geneva, 1964.

Question 5/IX — Noise measurements on circuits for telegraphy and data transmission

(continuation of Question 5/IX, 1964-1968, amended; also interests Study Groups XV and Special C; study to be entrusted to Joint Working Party LTG)

Continuation of the study of the use of the impulse-noise-measuring instrument specified in Recommendation H.13

Points to be studied are:

— the duration of measurements and the standards for the maximum number of counts;

— the use of filters allowing the measurement of noise over V.F. telegraph channels, placed at different positions on the bearer circuit.

ANNEX

(to Question 5/IX)

Extract from the Report of Study Group IX — Mar del Plata, 1968

Three filters corresponding to channel positions 1, 12 and 24 of 50-baud systems could be used to make noise measurements. However, long submarine circuits preclude the use of channel position 24 and channel position 22 might be used.

Administrations are requested to submit their test results using simultaneously instruments equipped with different filters suitable to each of these telegraph channels, or using the specified voice-band filter.

Question 6/IX — Study of distortion as a function of modulation rate using standard equipment, and consequent planning limits

(continuation of Question 6/IX, 1964-1968, amended at Mar del Plata, 1968)

Considering there is a requirement for administrations and private operating agencies to establish transmission plans for the distribution of distortion between national networks and international circuits, studies of isochronous and start-stop distortion as a function of modulation rate should be made, using standard equipment, in order to determine the limits of transmission quality which should be applied in planning international switched and point-to-point telegraph-type communications.

Limits should be specified for:

a) 75 bauds using equipment to Recommendations R.31 and R.35 (120 Hz);

b) 100 bauds using equipment to Recommendation R.37 (240 Hz);

c) 200 bauds using equipment to Recommendation R.38B (360 Hz);

d) 200 bauds using equipment to Recommendation R.38A (480 Hz).

Measurements should be made in accordance with Recommendation R.51 with suitable modulation rates. A particular point for study should be the effect of inter-channel interference.

Note. — There is also the case of obtaining distortion values for modulation rates greater than 50 bauds on channels with special characteristics but with 120-Hz spacing, but the importance of the study is not so great as with the above-mentioned cases.

ANNEX

(to Question 6/IX)

Results of measurements of isochronous distortion as a function of modulation rate carried out on frequency-modulated voice-frequency telegraph channels

(Extract from Contribution COM IX/No. 39—France)

1. *Channels with 240-Hz spacing normally operated at 100 bauds*

The measurements were made under the following conditions:

— the channel measured was placed in a rack with neighbouring channels at 50 bauds;

— the output and input of the channel coupler were connected by an attenuation with 600-ohm impedance. No noise was therefore injected in the line;

— the neighbouring 50-baud channels transmitted " text " signals at the nominal rate;

— bias distortion was eliminated at each rate;

— isochronous distortion was measured on a " text " signal.

The average isochronous distortion obtained as a function of modulation rate is shown in Figure 1.

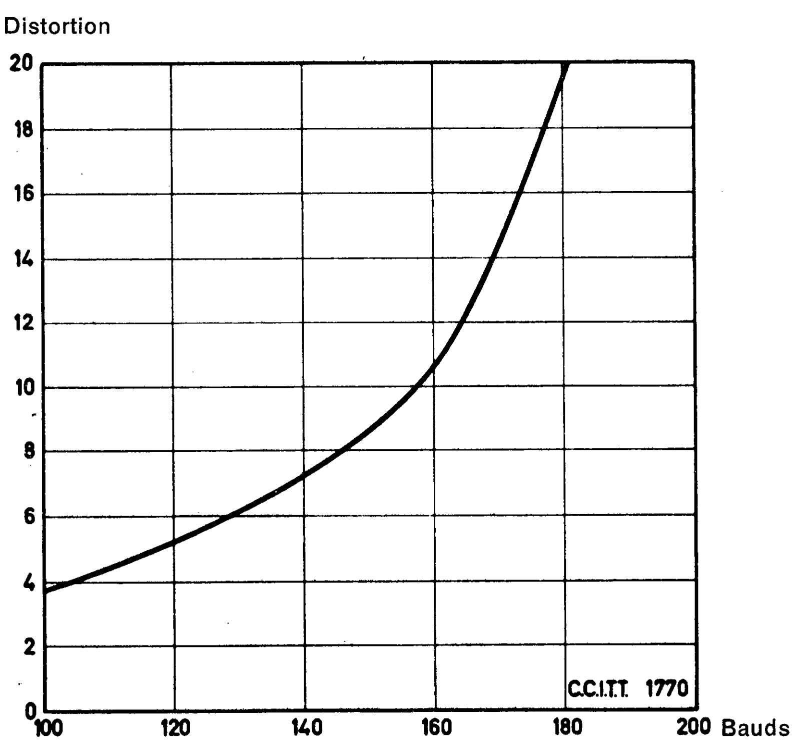


FIGURE 1. — **Isochronous distortion. 100-baud channels according to Case 1**

2. *Channels with 480-Hz spacing normally operated at 200 bauds*

The measurements were made on positions 3 and 4.

Two series were carried out:

2.1 the channel measured was placed by itself in a rack;

— the output and input of the channel coupler were connected by a loop quadripole with 600-ohm impedance. No noise was injected in the line;

— bias distortion was eliminated at each rate;

— isochronous distortion was measured on a " text " signal.

The results are shown in Figure 2.

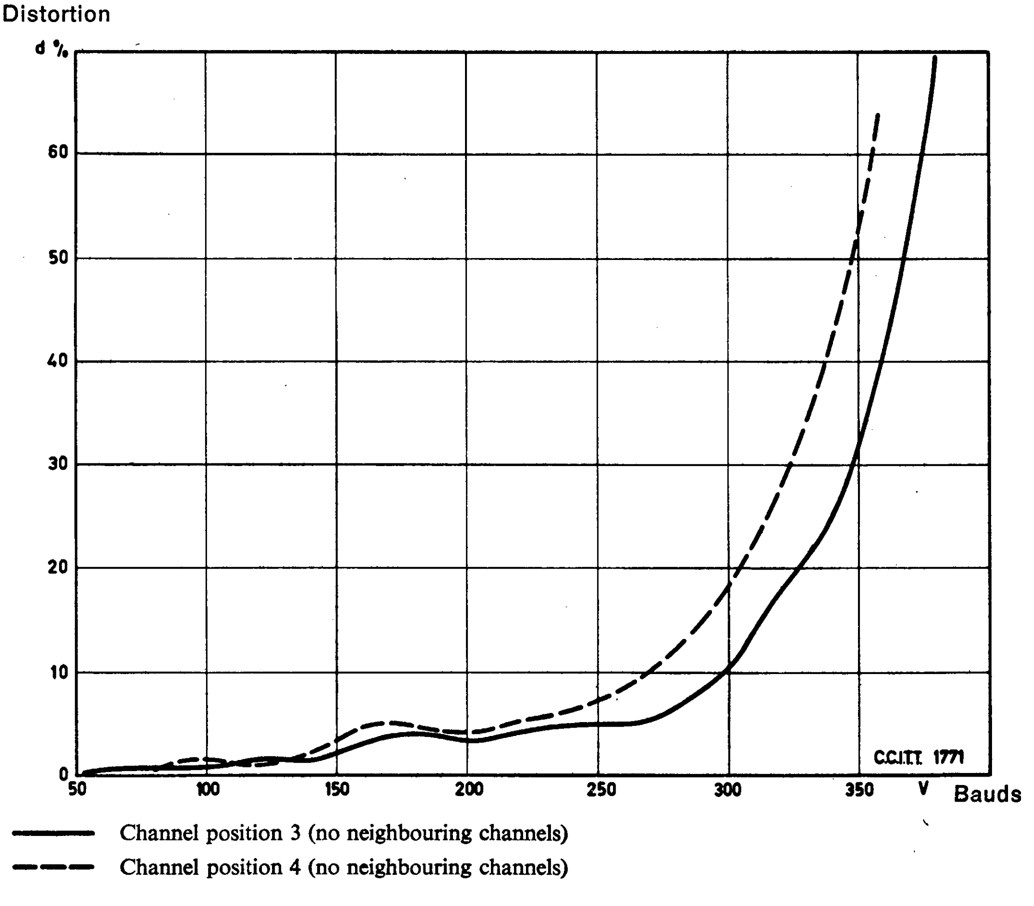


FIGURE 2. — **Distortion as a function of modulation rate**

2.2 the channel measured was placed in a rack with 50-baud neighbouring channels transmitting 2/2 signals at nominal rate. The other measuring conditions remained the same.

The results are shown in Figure 3.

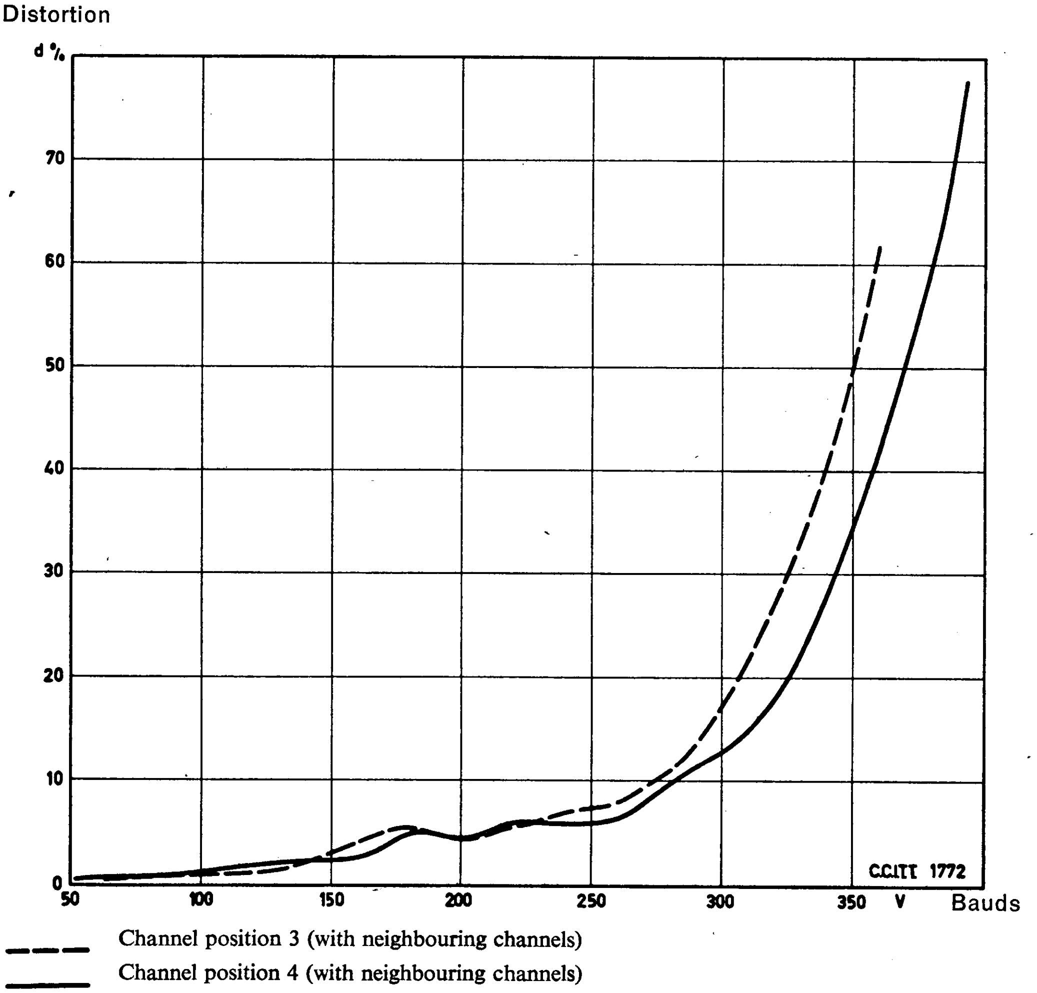


FIGURE 3. — **Distortion as a function of modulation rate**

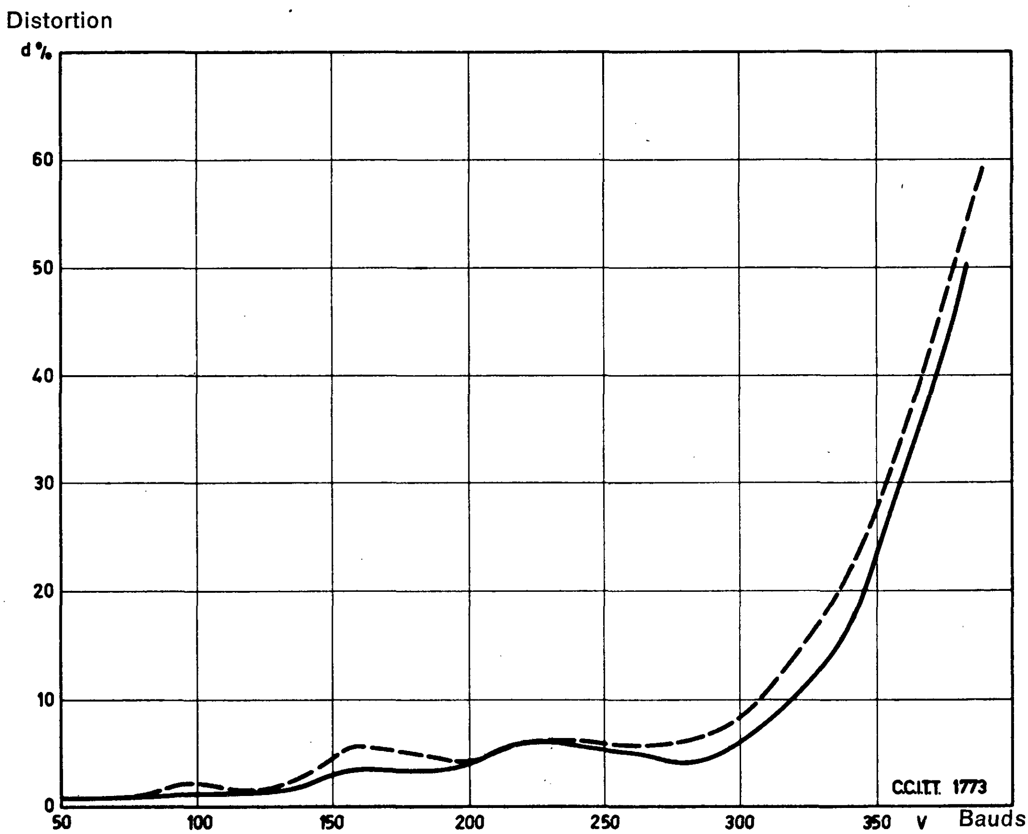
3. *Channels with 480-Hz spacing and with special adjustment*

These were normal 200-baud channels in which the discriminator was regulated for 300-baud instead of 200-baud modulations.

As before, two series of measurements, with and without 50-baud neighbouring channels, were carried out under the same conditions.

The results are shown in Figures 4 and 5.

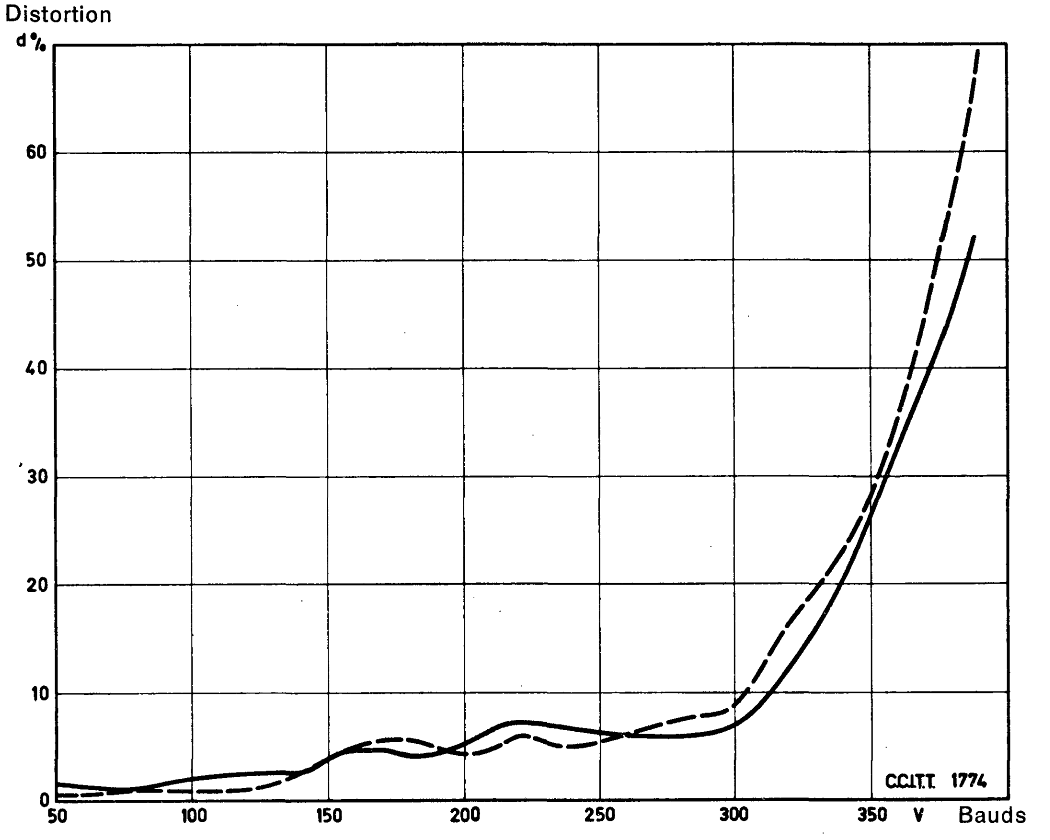
Note. — See also Supplements Nos. 2 and 3 of this Volume VII of the *White Book*.



Channel 3 — 200 bauds, with special adjustment, no neighbouring channel

Channel 4 — 200 bauds, with special adjustment, no neighbouring channel

FIGURE 4. — **Distortion as a function of modulation rate**



Channel 3 — 200 bauds with special adjustment with neighbouring channels

Channel 4 — 200 bauds with special adjustment with neighbouring channels

FIGURE 5. — **Distortion as a function of modulation rate**

Question 11/IX — Definitions concerning telegraph transmission quality

(continuation of Question 11/IX, 1961-1964)

Revision of definitions relating to telegraph transmission quality:

1. to make them clearer and more coherent;
2. to render them applicable to high-speed transmissions (such as data transmissions).

Note. — New and amended definitions which have been approved by the IVth Plenary Assembly of the C.C.I.T.T. shall appear at the head of Series R Recommendations as well as in the *List of definitions of essential telecommunication terms.*

Question 12/IX — Effect on telegraph distortion of sudden changes of level

(continuation of Question 12/IX, 1961-1964)
(item 1 to be studied jointly with Study Group IV)

What maximum transitory distortion can be tolerated on signals when the transmission equivalent of circuits carrying voice-frequency telegraph channels suddenly varies?

The further study of this question should be pursued in the following manner:

1. What are the duration, amplitude and frequency of occurrence of the level variations?

2. Are the resulting distortions tolerable when their frequency of occurrence is taken into consideration?

Note. — See Supplements Nos. 6 and 7 to Volume VII of the *Blue Book*, Geneva, 1964; see also Supplements Nos. 4, 5 and 6 in Volume VII of the *White Book*.

ANNEX 1

(to Question 12/IX)

Report by Study Group IX — June 1963

1. A more detailed analysis than that made so far of the duration of changes in level is in fact necessary to study the effect of these changes on fortuitous telegraph distortion.

Study Group IX considers that the duration of sudden changes in level should henceforth be subdivided into durations of less than 1 millisecond, durations between 1 and 5 milliseconds, and durations between 5 and 10 milliseconds during the measurement tests carried out by Study Group IV.

2. It is clear from a study made by the Federal Republic of Germany that the influence on distortion of changes in level depends very much on whether the other channels of the system are in service or not. The study shows that variations in level lasting 0.5, 1 or 2 milliseconds introduce up to 25% distortion when all channels are loaded. (See the graphs of Figure 4.) The studies confirmed with a few measurements (in the case of $\Delta a = \infty$) were made for amplitude modulation, the loaded channels transmitting a permanent tone, so that the most stringent conditions were reproduced.

A test has been performed by the United Kingdom on two channels of an F.M.-V.F. telegraph system; the maximum degrees of distortion measured are shown in the graphs of Figure 5.

The Study Group proposes that administrations carry out similar tests, on both amplitude-modulated and frequency-modulated systems.

The measurements should be made with the whole system being looped on an artificial line, all causes of distortion other than those due to sudden changes in level having been eliminated.

A series of three measurements should be made for each system, the loading conditions for channels other than the channel under test being as follows (see Figures 1 and 2):

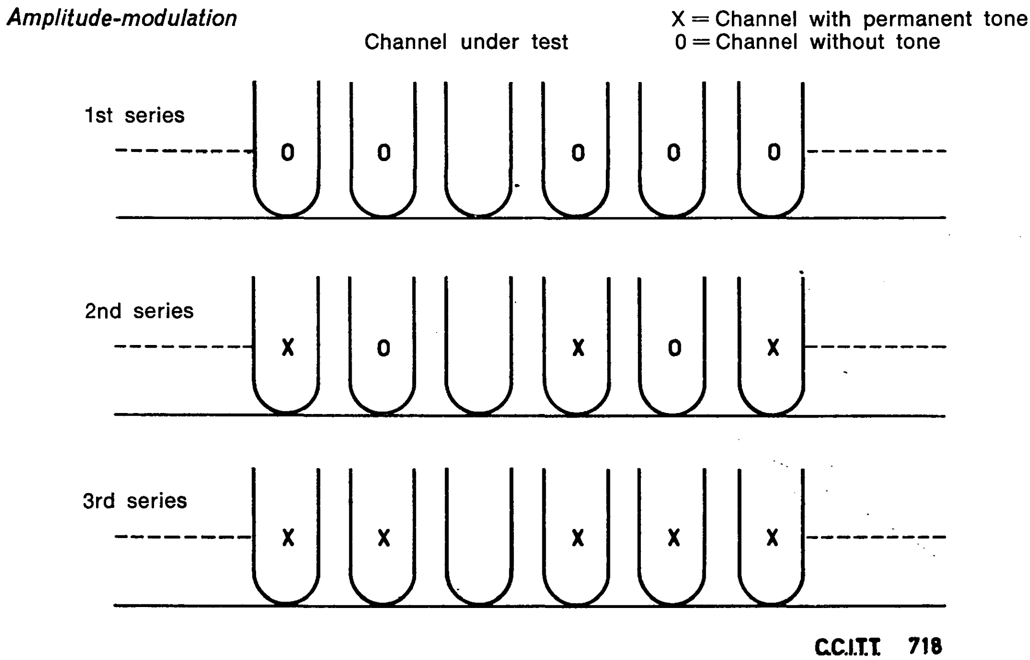


FIGURE 1

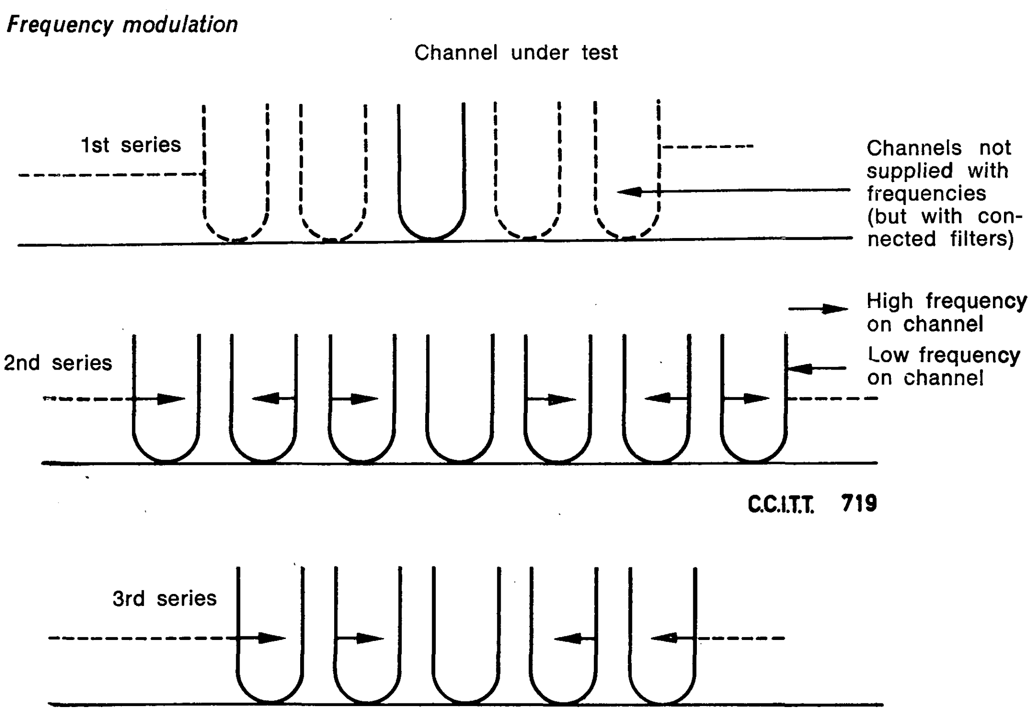


FIGURE 2

A sudden variation in level is taken to mean a variation which is established in a time negligible in comparison with the duration of the variation; the duration of the variation is the period of time for which the disturbed level is maintained.

Results will be indicated, as in the diagram (Figure 4), by showing the distortions as ordinates and durations T of reductions in level as abscissae, and by characterizing each curve by the value Δa of the change in level.

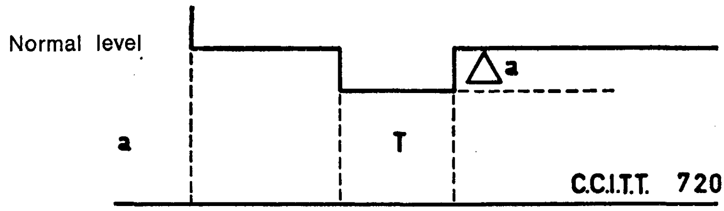


FIGURE 3

T will have the following values in these measurements:

0.5 ms
1 ms
3 ms
5 ms

as well as other T-values, as administrations wish.

The values of Δa will be:

5.2 dBm (0.6 Np)
8.7 dBm (1 Np)
∞ (interruption of circuit).

The channel being tested will be controlled by 2/2 symmetrical signals at 50 bauds, without distortion.

During the test, the changes in level will be repeated a sufficient number of times to permit the measurement to be made, but their occurrence should not be synchronized with the transitions in the 2/2 alternations and the interval between the occurrence of two successive level variations must be greater than several unit intervals of the alternations.

In principle, the tests should be made on all channels in a given system; the Study Group notes that this would entail a minimum of 600 measurements for each system tested. Administrations may make a choice to avoid testing channels having the same characteristics as one which has already been measured.

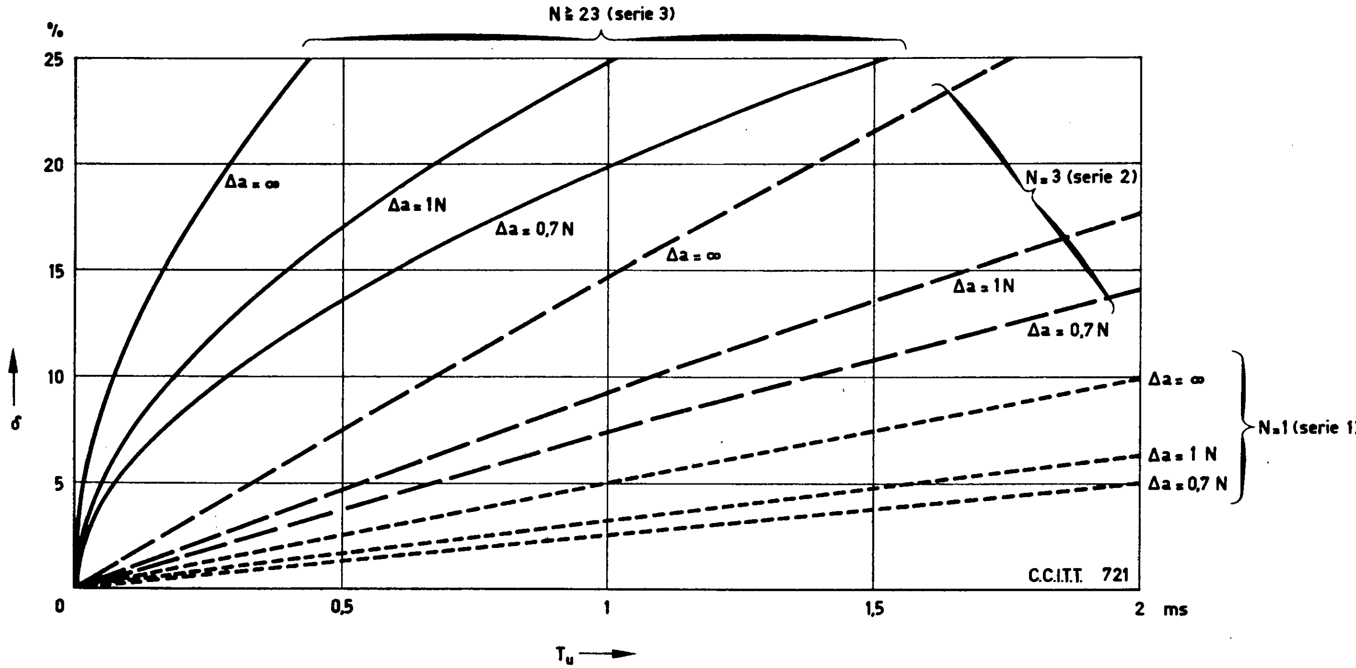
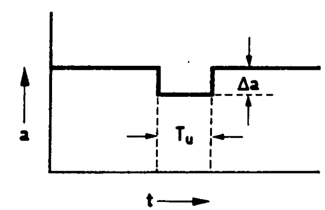


FIGURE 4. — **A.M.-V.F. telegraph systems**



Individual distortion occurring with a probability of about 10^{-4} for various sudden variations in level Δa, as a function of the duration of the sudden variation T_u, allowance being made for one channel only ($N = 1$), for two neighbouring channels ($N = 3$), and for any number of neighbouring channels ($N = 23$).

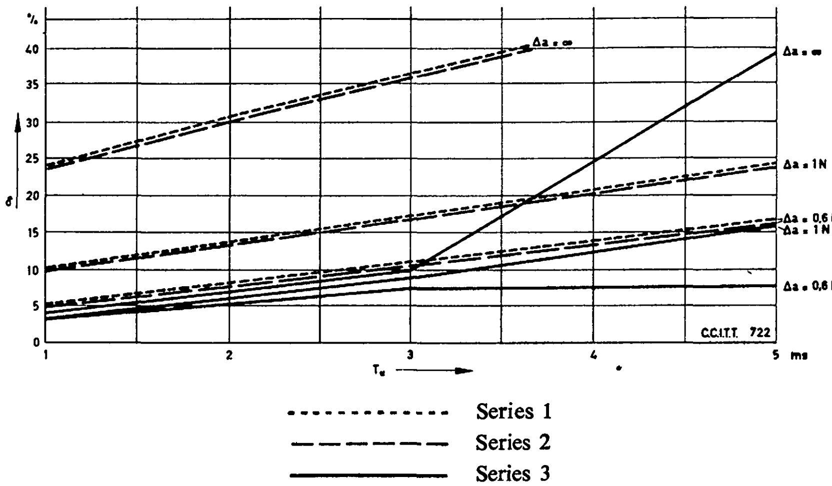


FIGURE 5. — **F.M.-V.F. telegraph systems**

ANNEX 2

(to Question 12/IX)

Report of Study Group IX to the Plenary Assembly, October 1968

The results of measurements carried out so far have led to the following general conclusions:

1. The value of the distortion is a monotonic function of the level variation.

2. The individual distortion depends upon the time of the level variation with respect to the significant instant of modulation.

For amplitude-modulation systems, the individual distortion varies mainly as a function of the phase and the maximum value occurs when the change coincides with the significant instant.

For frequency-modulation systems the variation is not so great.

3. If the duration of the variation in level does not exceed about one-third of the duration of the unit interval corresponding to the nominal modulation rate, the value of individual distortion increases monotonically with the duration of the variation in level. When that limit is exceeded, the results of the measurements carried out by various administrations are contradictory. The Study Group has decided to await further results from the administration concerned in order to reach final conclusions in the future.

4. The distortion appearing in a channel as a result of a sudden level variation depends upon the state of the neighbouring channels, and the influence of those channels is the greater the closer they are to the channel under test. This is true for frequency modulation as well as for amplitude modulation.

The studies of Study Group IX have shown that interruptions as short as 0.5 ms have a large effect on telegraph distortion. That is why measurement of the distribution of interruptions in the three ranges 0.5 to 1 ms, 1 to 2 ms, 2 to 5 ms is of great importance to Study Group IX. The Study Group expresses the wish that these measurements envisaged by Study Group IV for its next programme will be carried out by as many administrations as possible.

Question 14/IX — Frequency-modulated voice-frequency telegraph systems

(continuation of Question 14/IX, 1964-1968, amended at Mar del Plata, 1968)

Further study for standardization of 50-, 100- and 200-baud frequency-modulated voice-frequency telegraph systems (Recommendations R.35, R.36, R.37, R.38 A, R.38 B).

1. Frequency spectrum of signals transmitted by equipment conforming to Recommendation R.38 B.

2. Method of measurement and fixing a definitive limit for the unbalance δ due to the modulation process.

3. Application of the outcome of the studies called for in Question 12/IX to the laying-down of:

a) limits for the inherent isochronous distortion in the event of abrupt variations in reception level;

b) level for which the channel should come back to the operating condition when the signal level climbs back after falling to 2.7 Np (23.5 dB) below the nominal figure.

Note. — See Supplement No. 15 to Volume VII of the *Blue Book*, Geneva, 1964.

Question 18/IX — Possible modifications of Recommendations R.50, R.57 and R.75 to cover frequency-modulation systems and modern amplitude modulation systems

(continuation of Question 18/IX, 1964-1968, amended at Mar del Plata, 1968)

What figures should be entered in Recommendations R.50, R.57 and R.75 so that they may apply to chains made up exclusively of frequency-modulation channels or of modern amplitude-modulation channels?

ANNEX

(to Question 18/IX)

Study Group IX examined the following questions:

1. Is it certain that the FM systems always give better performance than the AM systems in practical service?

2. Whether a small decrease of tolerable limits of distortion specified in Recommendations R.50, R.57 and R.75 is really significant and important in practice, when various practical conditions such as modulation methods, vacuum tube type or transistorized systems, deterioration in condition of equipments, maintenance procedures, etc. are taken into account.

3. With extensive use of telegraph switching networks, the connection of telegraph channels in tandem will generally be at random and it is impossible for maintenance staffs to know how the connection has been established, e.g. FM or AM channels only, or a mixture of both channels.

4. In connection with the question of automatic maintenance tests, which is studied by the MAT Joint Working Party, whether two (AM or FM) or more (with discrimination between

modern and old types) different values for the distortion limits should be specified for automatic maintenance tests. If so, it makes these tests very complicated.

The Study Group considers that the revision of these Recommendations should also be applied to modern amplitude modulation systems.

Question 22/IX — Automatic maintenance tests of telegraph circuits

(see Question 11/X)

Question 24/IX — Time-subdivision of a telephone channel for synchronous telegraphy

(Question of interest to Study Group VIII; continuation of Question 24/IX, 1964-1968, amended at Mar del Plata, 1968)

What characteristics should be standardized to provide for the use of a channel with telephone characteristics by a direct time-subdivision synchronous telegraph system, to provide for simultaneous transmission of the signals corresponding to a number of start-stop telegraph channels operating at 50 bauds and possibly higher modulation rates?

The possibilities of channels operating with Alphabet No. 5 should be taken into account in the study of this question.

This study should deal mainly with the following points:

1. Composition of the telegraph modulation to be transmitted over the synchronous channel.

2. Type of transmission of signals corresponding to the significant conditions.

3. Relation between the number of telegraph channels which can be provided and the modulation rate on the synchronous channel.

4. Maximum rate of two-condition telegraph modulation which can be transmitted on a single channel or several channels in tandem with telephone characteristics:

   a) ordinary telephone channels with 4-kHz spacing;

   b) submarine cable telephone channels with 3-kHz spacing.

5. Method of transmitting such modulation on the telephone channel.

6. Method of transmitting phasing and re-phasing signals.

7. Signals to be transmitted when channels are not used or not equipped.

8. Study of combination of direct time-multiplexing and other modulation processes for optimum use of telephone channels.

9. Means of ensuring that an acceptable error rate is obtained in the presence of the expected performance of telephone bearer circuit (see Recommendation F.10).

Note. — See Supplement No.14 of Volume VII.

Question 26/IX — Synchronous systems for special codes

(continuation of Question 26/IX, 1964-1968, also of interest to Study Group VIII and to Study Group X)

What procedure and equipment should be used to permit interconnection of circuits worked by means of synchronous systems using special codes with circuits on which the International Telegraph Alphabet No. 2 is used? (see Recommendation S.13).

In particular, the study should be made to fix the minimum storage capacity and to specify what the user can expect to receive in the way of information if the storage device is full.

As to the use of combination No. 32 in connection with signal storage, more comprehensive studies on use of combination No. 32 are requested (see Recommendation U.22).

The question of the efficiency of radio circuits is of great importance in fixing the capacity of storage devices, at least in the case of those used on telex and gentex circuits (see Recommendation U.23 and Question 6/X).

Comments

1. The radiotelegraph channel is defined as being in conformity with Figure 1 given below.

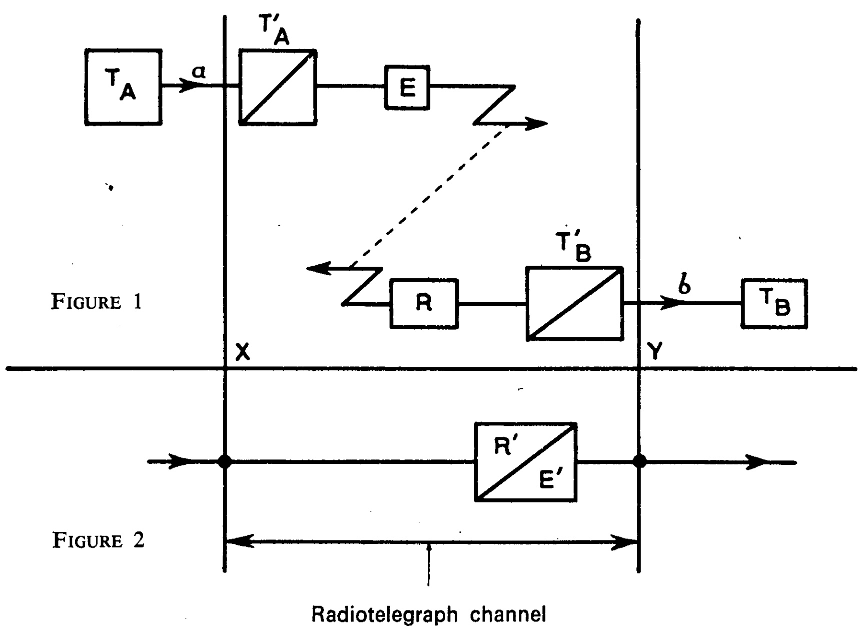


FIGURE 1

FIGURE 2

In this diagram the radiotelegraph channel includes all the equipment contained between lines X and Y, that is to say the radio transmitter E and radio receiver R proper, as well as the repeaters T'_A and T'.

T_A and T_B are start-stop teleprinters linked to the radio channel by parts a and b of the network. These may include any number of channel sections, relays, repeaters or regenerative repeaters, etc.

In the study of this question it might be useful for the radio channel, as defined above, to be linked to a repeater (Figure 2) comprising a receiving element R' and a transmitting element E'.

2. The study of the operating conditions to be imposed on the radio channel could be usefully carried out in accordance with the following:

a) In the case of systems using storage, the delay in the retransmission of the signals;

b) What arrangements are to be recommended for the interconnection of two or more channels in tandem as may be required in international telex working?

c) As there is some objection in certain circumstances to the use of perforated tape as a means of signal storage at the input to a synchronous telegraph system, what alternative arrangements can be recommended?

Note. — See Supplement No. 25 to Volume VII of the *Blue Book*, Geneva, 1964.

Question 28/IX — Effect of sudden phase changes on telegraph distortion

(to be studied in conjunction wiih Study Group IV)

(Mar del Plata, 1968)

The study of this question should be carried out in the following manner:

— what constitutes a “ sudden ” phase change?

— what amount of phase change could have a noticeable influence on telegraph distortion?

Note. — Study Group IV is studying the following Question:

“ **Question 3/IV — Sudden phase changes**

“ What are the actual values of sudden phase changes observed under working conditions on carrier telephone circuits used for special services, for example voice-frequency telegraphy, data transmission etc.?

“ In a note to Question 3/IV, Study Group IV indicates that ‘there is no reason to suppose that any particular value of phase change is most probable, all values up to 180° seem to be equally likely’. ”

It has been observed that, apart from sudden phase changes that occur at irregular but rather long intervals, a spurious phase or frequency modulation may occur during transmission on some international connections.

Question 29/IX — Telegraph frequency division multiplex systems for data signalling rates above 200 bits/s

(Mar del Plata, 1968)

a) Is it desirable to consider the frequency division of a primary group into several telegraph channels for the purposes of data transmission?

b) If so, how should this division be made? For example:

— What spacing should be adopted between the channels and what should be the position of the channels in the complete band?

— What type of modulation should be used?

— What modulation rates should be adopted ?

— What levels should be recommended?

— How should the combined systems (co-existence of channels with different modulation rates in the same group) be designed?

c) Should the use of supergroups, etc. also be considered?

Comment

In data transmission networks to be operated at high data signalling rates, the distortion in the various channels should be sufficiently low to ensure that the distortion at reception does not exceed the acceptable limits, since the connections between terminal stations consist of several channels in tandem.

Question 30/IX — Time subdivision of a telephone channel or a primary group for telegraphy and data transmission

(Mar del Plata, 1968)

Is it desirable to standardize the time division of the lower-cost short-distance telephone channel or primary group into a number of telegraph channels by using a system independent of the code transmitted to obtain:

a) less expensive telegraph channels than with the existing V.F. methods;

b) less expensive channels dedicated to data transmission at data signalling rates above 200 bits/s.

If so, what characteristics should be standardized?

Question 31/IX — Time division of a P.C.M. system for telegraphy and data transmission

(Mar del Plata, 1968)

It is undesirable to use the voice channels of a P.C.M. system directly as bearers for VF telegraphy and data transmission owing to the high degree of distortion which they produce.

a) Is it economically feasible and technically desirable to use a P.C.M. voice channel time slot in a standardized time division manner for V.F. telegraphy and for circuits dedicated to data transmission?

b) Are there other ways in which part of a P.C.M. frame could be standardized for these uses?

If so, what characteristics should be standardized:

1. for channels intended for general use?

2. for channels intended for use at fixed modulation rates with nominated codes?

If a complete P.C.M. type digits link could be used as an economical solution, would this alter the answers to 1 and 2?

Note. — This Question is to be studied first by Special Study Group D—Questions 1/D and 11/D.

Question 32/IX — Subdivision of standardized 50-baud telegraph channel

(Mar del Plata, 1968)

1. Is it desirable to standardize systems for use on 50-baud voice-frequency telegraph channels to provide facilities for up to four different users at correspondingly reduced rates of transmission?

2. If so, what characteristics should be recommended?

ANNEX

(to Question 32/IX)

Contribution GM/SYN — No. 7 (Italcable, Italy)

In many instances there are requests for leased telegraph circuits which will operate at character rates that are fractions of the standard rate of 400 characters per minute normally transmitted on 50-baud telegraph channels.

One method of meeting this requirement—fitting a device to limit the speed at the user's terminal—leads to under-utilization of the capacity of the telegraph channel.

In order to avoid this, a time division multiplex system (TIM) has been developed which, in effect, subdivides the telegraph channel into four sub-channels A, B, C and D—each providing fractional character rates of 100 characters per minute.

It is also possible to combine two sub-channels to provide a fractional rate of 200 characters per minute. At the user's terminal, a stepping pulse controlled automatic transmitter is used on the transmitting side while a standard teleprinter is employed on the receive side.

Principle of operation

The stepping pulse controlled automatic transmitters connected with the sub-channels of TIM use the normal 5-unit teleprinter code (C.C.I.T.T. International Alphabet No. 2) with a total time per character of 150 ms. " Start " element and 5-unit code elements have a length of 20 ms each while the " stop " element lasts for 30 ms.

A stepping pulse, generated by the time division multiplex is sent to each automatic transmitter (see Figure 1). The stepping pulses are arranged in such a way that the automatic transmitters send characters one by one to converters associated with TIM.

Each converter stores a character, which is transmitted in turn to the other terminal when the multiplex deals with it.

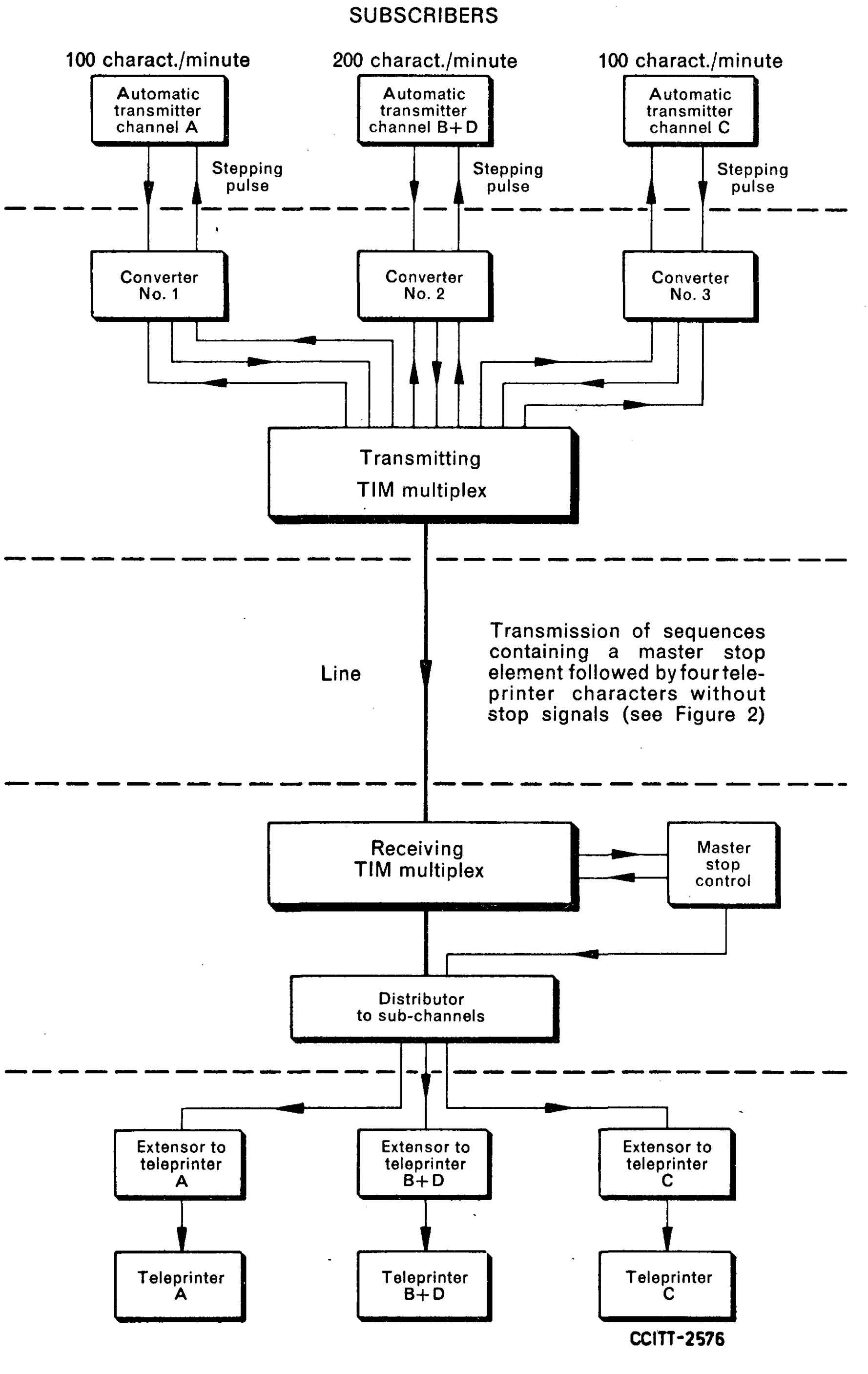


FIGURE 1. — **Cable time division multiplex (TIM). Layout and principle of operation**

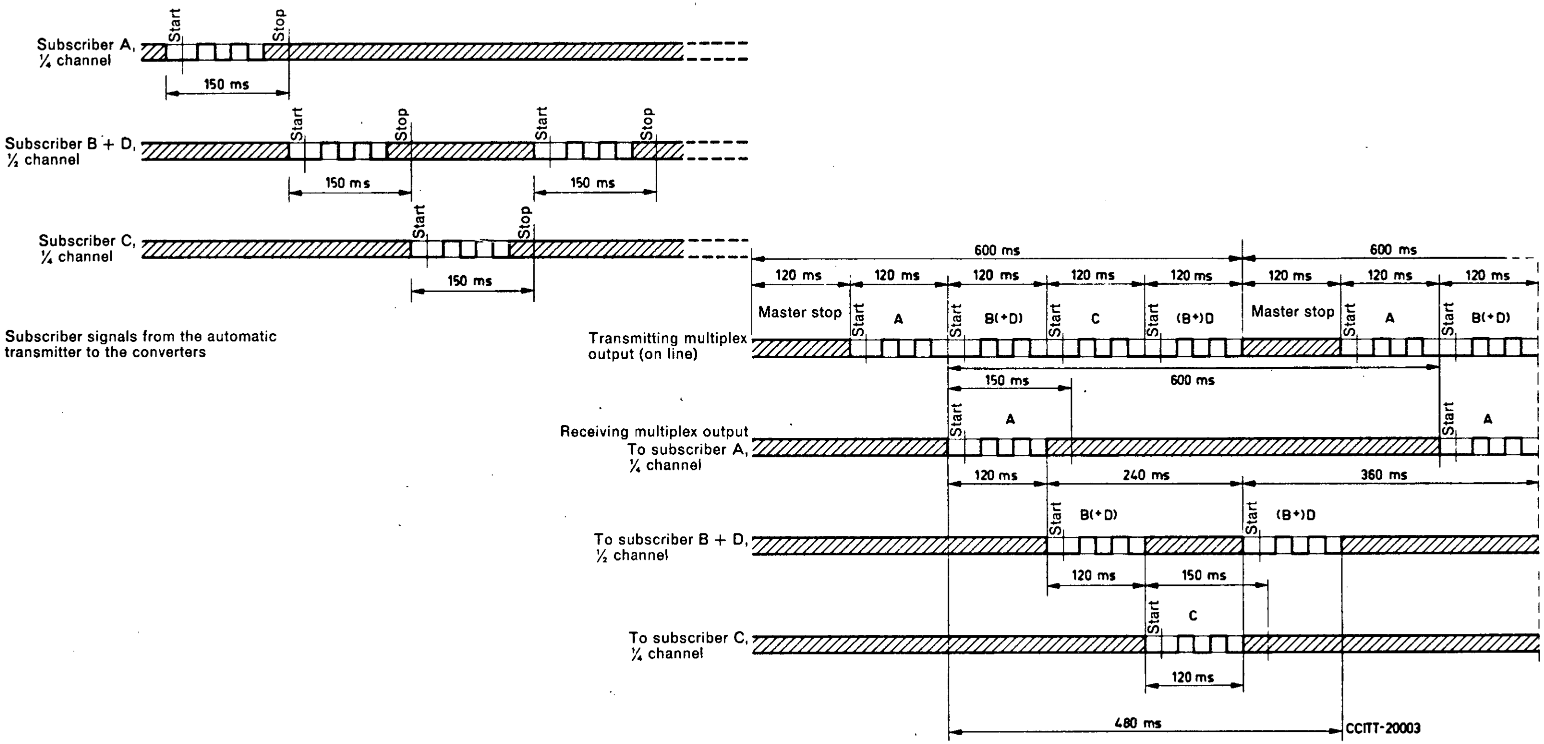


FIGURE 2. — TIM signal composition

Figure 2 shows the signals at the output of the automatic transmitters of three subscribers A, (B+D) and C. In this figure, it is supposed that there are only three automatic transmitters and that the subscribers of sub-channels A and C use the speed of 15 words/minute while the subscriber B+D uses 30 words/minute.

Therefore one stepping pulse is sent to subscribers A and C every 600 ms (that is the time corresponding to the transmission of four characters) while during the same interval of time two stepping pulses are sent to subscriber B+D.

TIM suppresses the individual sub-channel "stop" elements and creates a special signal, the master stop, which is transmitted every 600 ms, before the transmission of the characters of sub-channels A, B+D and C.

The master stop signal consists of 120 ms steady stop polarity; and since the characters of sub-channels A, B+D and C consist of a "start" pulse of 20 ms, and five elements, without any stop pulse, no other 5-unit code character will correspond to the master stop. Therefore this signal can be detected at the receiving end.

The start of a four-character cycle will be recognized as the occurrence of a start element following six or more stop elements. Only the "master stop" can have six stop elements so that only the start element immediately following the master stop can fulfil this condition. In this way it is possible to start the receiver pulse generator which distributes the appropriate parts of the multiplex signal to the proper sub-channel outputs.

As the individual stops (lasting 30 ms) are suppressed in the transmission over the VFT channel, a time of 30 ms $\times$ 4 = 120 ms is made available in a standard four teleprinter character transmission (which requires 150 ms $\times$ 4 = 600 ms in standard practice). In this way no additional time is required for transmitting the auto-synchronizing pulse, which is the master stop.

It is useful to point out that the multiplex is arranged in such a way as to transmit "letters shift" any time an automatic transmitter is not connected with the associated converter, and to transmit combination No. 32 any time the automatic transmitter is connected but is idle. At the receiving end a timer is associated with the multiplex; it provides for the transmission of "start" polarity to the receiving teleprinter after 20 seconds of reception of "letters shift" or "stop" polarity to the same teleprinter after 20 seconds of reception of combination No. 32.

In this way all the conditions existing at the transmitting terminal are reproduced at the receiving end (see Figure 3).

Types of sub-channels

A 50-baud telegraph channel can be subdivided to obtain:

— two sub-channels each of 200 characters per minute;

— or four sub-channels each of 100 characters per minute;

— or one sub-channel of 200 characters per minute and two sub-channels of 100 characters per minute.

For telegraph channels capable of a modulation rate of 75 bauds, the following subdivision can be obtained:

— two sub-channels each of 300 characters per minute;

— or four sub-channels each of 150 characters per minute;

— or one sub-channel of 300 characters per minute, and two each of 150 characters per minute.

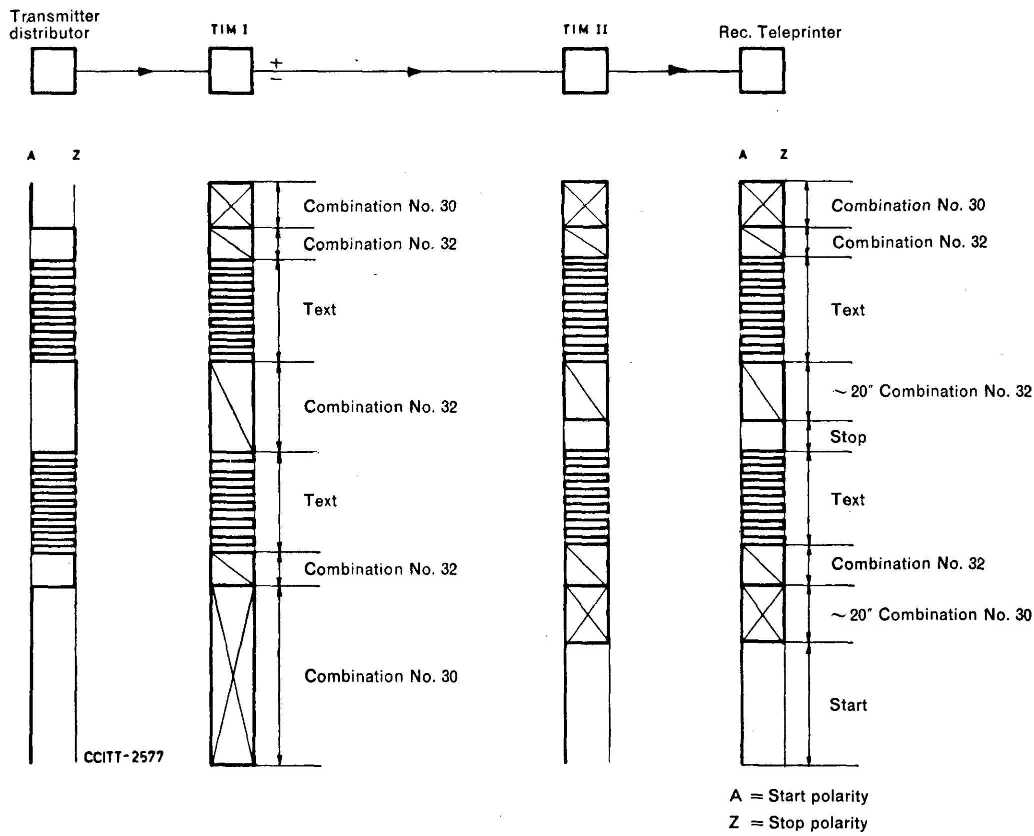


FIGURE 3. — TIM-pulse diagram for a connection between two subscribers

In this case, automatic transmitters and teleprinters operating at 50 bauds may be used as terminal equipment since the converters store each character and retransmit them to line on reception of a " request-to-send " pulse from the transmitter pulse generator.

At the receiving end the TIM can distribute 50-baud signals to the receiving teleprinters in the event that 75-baud signals are received from line. It follows that the transmission speed between the user's terminal and the multiplex may be different from that used on the line.

The TIM can also be used on telegraph channels operating at modulation rates of 200 bauds. At this speed the TIM can subdivide the channel into four sub-channels each of 400 characters per minute. For the same reason as given above, equipment operating at 50 bauds may continue to be used at the user's terminal.

Submarine telegraph cable

The TIM can be used over this type of cable providing a modulation rate of at least 50 bauds and transmission of the standard teleprinter code are possible.

Question 33/IX — Frequency-shift modulated voice-frequency telegraph systems for modulation rates of 600 bauds and 1200 bauds

(Mar del Plata, 1968*)*

Is there a requirement to standardize the characteristics of frequency-shift modulated voice-frequency telegraph systems for modulation rates of 600 and 1200 bauds?

If so, what characteristics should be recommended?

Note. — This question is related to point J of Study Group Special A.

QUESTIONS TO BE STUDIED BY STUDY GROUP X: TELEGRAPH SWITCHING

Chairman: Mr. A. JANSEN (Netherlands)
Vice-Chairman: Mr. D. FAUGERAS (France)

Question 1/X — Standardization of signalling in the telex service and in the gentex network

(continuation of Questions 1/X and 2/X, 1964-1968, amended at Mar del Plata, 1968)

The point to be stressed in the new study is:

Requirements for handling the communication of information other than by the five-unit International Telegraph Alphabet No. 2 bearing in mind Recommendation V.10 (Part II).

Question 4/X — Telex and gentex signalling over radio circuits

(continuation of Questions 4/X and 5/X, 1964-1968, amended at Mar del Plata, 1968)

Point for study:

Is there a need for the development of standards for the operation of telex exchange subscriber lines over radio circuits incorporating error protection?

Note. — C.C.I.R. Report No. 348 (Volume III, Oslo, 1966) is of interest.

Question 6/X — Use of radiotelegraph circuits with ARQ equipment for automatic calls charged on the basis of elapsed time

(continuation of Question 6/X, 1964-1968, amended at Mar del Plata, 1968; interests Study Group I)

—Study of any amendments to Recommendation U.23 which would result from practical experience.

—Fixing of definitive figures for method B.

Note. — See Supplement No. 10 of this Volume VII.

Question 7/X — Automatic service over intercontinental circuits

(continuation of Question 7/X, 1964-1968, amended at Mar del Plata, 1968)

Automatic service over intercontinental circuits with signalling in accordance with Recommendations U.1 and U.20.

The points to be stressed in the study are the following:

1. Setting-up time in the case of transit working via one transit centre only;

2. Speed of transmission of selection signals over the intercontinental circuits (transmission of dial pulses or five-unit signals);

3. Problems raised by the use of telecommunications satellites.

Note. — See Supplement No. 9 in this Volume VII.

Question 8/X — World-wide routing plan for telex and gentex services

(continuation of Question 8/X, 1964-1968, amended at Mar del Plata, 1968; also Question 8/I; to be studied by Joint Working Party TGX)

Continuation of the study of the world-wide routing plan for telex and gentex services with a view to amending Recommendations F.68, F.69 and U.11 on the basis of experience acquired in intercontinental operation of the telex and gentex networks.

Preparation of a world-wide routing plan for telex and gentex services.

Note. — See Supplement No. 9 of this Volume VII.

ANNEX

(to Question 8/X)

The study of future routing in the intercontinental service will begin with the distribution of the following questionnaire:

Q.1 Will an intercontinental transit centre conforming to Recommendation F.68 and U.11 be in service in your country by the end of 1970?

(It is pointed out that intercontinental transit exchange would be directly connected to intercontinental transit circuits and would provide facilities to interconnect intercontinental transit circuits and trunks to international terminal exchanges. It would also provide facilities for the interconnection of intercontinental transit circuits.)

Q.2 If the answer to Q.1 is no, do you intend to connect your network(s) to an intercontinental transit centre in another country?

Q.3 Do you intend to use the intercontinental transit network to pass your gentex traffic? If so, will a separate route be provided to the intercontinental transit centre(s) for this purpose?

Q.4 If your centre is the first transit centre of the intercontinental connection, what signalling conditions would you offer to the calling network?

Q.5 If your centre is the last transit centre of the intercontinental connection, what type of signalling would be available outgoing to the terminal network?

Q.6 When your network is the terminal network for an intercontinental telex call, by what date will you be able to return a call-connected signal applicable to fully automatic operation?

Q.7 What methods of operation (semi-automatic or fully automatic) would be permitted between the calling networks and the intercontinental centre?

Q.8 Do you propose to adopt semi-automatic or fully automatic operation for intercontinental traffic originated from your network?

Q.9 What restrictions, if any, are there relating to incoming and outgoing gentex traffic?

Q.10 What telex network identification code(s) will you use for your register code?

Q.11 To what continental and intercontinental routes will you have direct connections from your intercontinental transit centre in 1970 and 1975? What signalling conditions would you employ on each route?

Q.12 Give details of your terminal traffic originating from your country and passing over the intercontinental transit network, as expected in 1970 and 1975. The details to be shown are:

— mean busy hour in the relation in G.M.T.

— traffic in erlangs at the busy hour

— busy hour to day rate: $\dfrac{\text{average traffic per busy hour}}{\text{average traffic per business day}}$

Q.13 Will the circuits on the routes given in the answer to Q.11 be operated both-way or unidirectionally?

Q.14 What routes will normally employ ARQ radio channels exclusively?

Q.15 What routes will normally be constituted partially with circuits over ARQ radio channels? The proportion of circuits of this type should be stated for each route.

Q.16 In the event of a breakdown of a route connected to your intercontinental transit centre not normally employing ARQ radio channels, would the traffic be diverted to overflow or would you restore the route by:

a) other circuits not employing ARQ radio channels; or

b) other circuits using ARQ radio channels?

What reduction in traffic capacity will result from these arrangements?

Q.17 Are you prepared to accept overflow transit traffic for all your intercontinental routes? If not, on what routes would transit traffic be restricted?

The inquiry will consist of two stages. In the first stage administrations will be asked to confirm and give details of the situation forecast for the end of 1970 for intercontinental transit exchanges. For this purpose the Secretariat will send out the first part of the questionnaire containing points Q.1, Q.4, Q.5, Q.7, Q.10, Q.11, Q.13 and Q.17.

When the 1970 list of intercontinental exchanges has been drawn up the second part of the questionnaire will be sent out so that it may be completed taking these exchanges into account.

Question 9/X* — New telegraph type network for message and data transmission

(continuation of Question 9/X, 1964-1968, amended at Mar del Plata, 1968);
(this question is also Question 1/A-point H of Study Group Special A; interests S.G.s I, VIII and IX; to be studied by Joint Working Party NRD)

Study Programme

1. *What should be adopted for modulation rate steps?*

It is understood that the 0-200-baud range is the minimum admitted; further upper limits envisaged should be specified.

2. *What signalling should be proposed between international switching centres?*

The aim in view is to seek agreement on a uniform signalling system which would be satisfactory as regards:

— the mean time for setting up calls, which should be short;

— the problem of verification of the identity of the obtained subscriber.

As regards signalling to set up and clear down calls, the Study Group feels that the list of signals and functions mentioned in the left-hand column of Table 1 in Recommendation U.11 could serve as a basis for the list of signals and functions to be provided in the new network. This list would of course be adapted to the conditions of the new network. The signalling system would have to allow for the use of communication satellites (long propagation times) and the use of digital transmission over a pulse code modulation system.

Certain administrations are of the opinion that the draft signalling plan with the use of a special circuit for signalling between switching centres (as proposed for telephone system No. 6) should be considered.

It is very important that the signals used for selection should be very strictly standardized, whereas the message transmission should be able to be independent of the code. Hence, the selection signals and the message signals could be of a different nature.

With regard to verification of the identity of the obtained subscriber, it should be possible to effect this automatically. This verification is bound up with the call-connected signal, it being clearly understood that the call-connected signal and the verification signals (which will be known as the selection verification signals) correspond to two separate functions. Two methods were described: in one of them, the call-connected signal is first returned to the calling subscriber, then the verification is checked by the terminal equipment of the calling subscriber; in the second method, the selection is checked by the outgoing switching centre—if the result is positive, a proceed-to-transmit signal is then sent to the calling subscriber.

The method of checking the selection obtained must be studied bearing in mind that the subscriber terminal equipment may not always include a teleprinter.

3. *Should it be possible to choose freely the code, modulation rate and telegraph transmission method (start-stop or synchronous)?*

— the system should accommodate both the start-stop method and the synchronous method;

— it should be possible to choose the message transmission code freely, provided it is a two-condition code.

It should be noted that the clearing signal may impose some restriction on this principle of the independence of the system from the code. The question of the transmission plan must be studied in relation with the question of independence vis-à-vis the code and speed.

— that any modulation rate included in the range (or ranges) finally admitted must be permitted for message transmission.

4. *If it is not possible to adapt existing national systems soon, should the connection of a subscriber in country A to a switching unit in country B be offered as an interim solution? What signalling should be adopted on the line connecting such a subscriber to the switching centre?*

The reply to the first part of this question is obviously a matter for agreement between the administrations concerned. However, it should be noted that when transfer is made from the interim situation to the definitive situation—i.e. when country A brings its own switching system into service—there is a risk that the subscriber equipment in country A might become useless if the signalling system between a subscriber and his exchange has not been internationally standardized or if this standardization has not been applied. It must be recognized that the introduction of such standardization is conditioned by the prior standardization of signalling between switching centres.

Hence, it is possible to settle this case only by bilateral agreement for the time being.

5. *Which method of working (half-duplex or duplex) should be permitted for users?*

The network (i.e. the switching centres and the links between switching centres) should allow for duplex operation.

The question remains open as regards the subscriber's line and terminal equipment.

As mentioned under point 4, standardization of subscriber lines and of the terminal selection and signalling equipment should not be considered to be a purely national affair. An international standardization would simplify international signalling and would be a great help to developing countries.

6. *Under which rules should the rates be fixed and international accounting organized?*

This question must be studied in liaison with Study Groups I and III. The projected system will be able to supply automatically a large amount of information for the establishment of charges.

7. *What transmission paths should be used for modulation rates higher than 200 bauds?*

The study will have to be carried out in liaison with Study Group IX and, as regards the use of P.C.M., with Special Study Group D which has already been notified of the question.

8. *To what extent are existing national switching systems suitable for transmission at higher rates?*

Certain administrations indicated that it would be difficult to use their existing telex network for the new service.

The administrations which feel able to adapt the existing telex network to higher speeds should indicate to what extent (modulation rates, codes) this adaptation would be possible.

9. *Which basic switching methods (circuit switching or message retransmission) should be used?*

The projected network is a world-wide network. Since many subscribers will wish to have the possibility of duplex operation or the immediate exchange of information, it considers that the circuit-switching method will have to be the basic one.

However, it notes that storing of messages with subsequent retransmission will be necessary for certain special services.

Among these special services, consideration must be given to:

— connections between equipments working at different speeds (in particular, interconnection with the telex networks);

— service with multiple addresses, such as broadcasting, conference;

— storage of the message in case of occupation of trunk circuits or of the called subscriber's lines. This storage should be requested by the calling subscriber; in this case, subsequent routing of the message is controlled by the switching centre where the storage takes place. It is important to pay attention to the choice of the place for this storage, when the called subscriber's line is engaged.

It should be noted that this question of auxiliary storage devices will raise problems concerning the alphabet and the speed.

10. *Should this new telegraph-type network be interconnected with the telephone network for the use of data transmission; if yes, how should it be done?*

This study programme was prepared with a circuit-switched network in mind, with message retransmission for certain auxiliary services.

ANNEX 1

(to Question 9/X)

Bibliography

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Question 11/X — Automatic maintenance tests of telegraph circuits

(continuation of Question 11/X = 22/IX, 1964-1968, amended at Mar del Plata, 1968; concerns Study Groups IX and X; to be studied by Joint Working Part MAT)

Points to be stressed are:

1. Possible amendments to Recommendation R.79 required in the light of practical experience;
2. Systems based on loop tests (not necessarily with reversals only).

ANNEX

(to Question 11/X)

Automatic maintenance tests on telegraph circuits in the United Kingdom

(Extract from contribution GM/MAT No. 4 — United Kingdom)

1. Tests have been carried out on three main telex trunk routes in the United Kingdom to check if distortion measurements using reversals on a looped circuit formed a valid method for assessing the performance of the trunk circuits.

2. The trunks tested were all single link MCVFT circuits on the London-Birmingham, London-Bristol and London-Manchester routes.

3. Measurements were made manually, no prior adjustments being made on the circuits. Initially the isochronous distortion of 2:2 reversals at 50 bauds was measured in both directions of transmission.

All looped measurements were made from the London terminal. The loop at the provincial end of the circuit was established via a relay specially adjusted to introduce no additional distortion. A measurement was then made of the isochronous distortion of the 2:2 reversals round the looped circuit. The signalling potentials on the relay contacts were then reversed and the distortion again measured.

4. The criterion of acceptability was that given in Recommendation R.57, so that an individual channel was considered faulty if a distortion in excess of 4% was measured and on the loop tests a circuit was considered faulty if a distortion in excess of 7% was measured.

5. A summary of the results is given in Table 1. An analysis of the faulty circuits not detected as faulty by the loop test is given in Table 2.

TABLE 1

Summary of distortion tests on United Kingdom trunk routes

Route	Type of VFT equipment	Number of faulty trunks (distortion in excess of 4% in either direction)	Number of faulty trunks correctly detected by loop test	Number of trunks erroneously classed as faulty by loop test	Number of faulty circuits not detected by loop test
London-Birmingham	AM	78	63	16	15
London-Bristol	AM	25	19	3	6
London-Manchester	FM	64	47	1	17
Total	—	167	129	20	38
Percentage of total	—	—	77%	11%	23%

TABLE 2

Analysis of the 38 faulty circuits not detected by loop test

Number of circuits having distortion greater than:						
4%	5%	6%	7%	8%	9%	10%
38	16	5	2	2	2	0

Question 12/X — Use of radiotelegraph circuits with ARQ equipment for automatic calls charged on the basis of efficient time

(Mar del Plata 1968)
(question of interest to Study Group I)

Note. — See Supplement No. 10 of this Volume VII.

ANNEX

(to Question 12/X)

Annex 3 to the Report of the Joint Working Party on " Efficiency Factor "

Document COM I—No. 31, COM X—No. 15—Source: United Kingdom

1. *Use of the efficiency factor in automatic switching*

The problem involved is the control of fully automatic telex calls on radio circuits by means of the efficiency factor. An earlier United Kingdom contribution expressed reservations concerning this method of control, especially at the high levels of efficiency required for charging on the basis of elapsed time. This contribution describes an alternative method by which the call charges for transit connections may be based directly on the performance of a remote radio circuit. Such an arrangement would conform to that generally employed for operation over direct radio circuits.

Where the call timing and ARQ equipments are close together, the chargeable duration for each call may be obtained by counting the character release (ZK) pulses returned from the ARQ equipment. A method has been devised to enable the same charging principle to be employed on tandem switched connections which include, for example, a cable circuit between the originating country and the transit country and a radio circuit between the transit country and the destination country, without requiring a separate additional path for relaying the character release pulses back from the ARQ equipment over the cable link. The necessary information is conveyed over the backward path of the cable circuit by means of special signals.

The proposed method does not preclude use of the efficiency factor for technical reasons or for traffic reasons other than charging.

2. *Signalling principles*

The signalling principles described below are illustrated in Appendix A.

During an established call either traffic signals or permanent stop polarity are transmitted over the backward signalling path from the radio ARQ equipment towards the calling telex subscriber. The condition of permanent stop polarity corresponds to either the idle circuit condition or to periods of error correction, and the presence or absence of character release (ZK) pulses from the radio equipment permits discrimination between these conditions.

By replacing the permanent stop polarity with special signals which distinguish between the idle circuit condition and ARQ, information relating to both traffic and the state of the radio circuit can be sent over the backward signalling path. Also because of the synchronous nature of the backward path signals it is possible, by timing them, to discriminate, at a point remote from the ARQ equipment, between the special signals and normal traffic signals. When a call is set up over a connection comprising a cable circuit and a radio circuit in tandem, this principle can be used to signal over the backward path of the cable circuit to the originating point information regarding the radio ARQ conditions in addition to signalling the normal traffic. Details of the specific signals used are as follows:

a) Automatic correction is indicated by combination No. 15 (80 ms pulse of start polarity) substituted for stop polarity in periods 2 and 4 of each correction cycle (or portion of a correction cycle) comprising four character periods.

b) Idle circuit condition is indicated by combination No. 29 (20 ms pulse of start polarity) substituted for stop polarity in even periods of each consecutive sequence of idle periods. This necessitates an even number of periods in each sequence. Consequently, storage for one teleprinter character is required in order to accommodate sequences received over the radio circuit which comprise an odd number of periods of stop polarity. Only the special signals are preceded by a period of stop polarity exceeding 140 ms and this constitutes a ready means of detecting them.

It is necessary for the receiver unit to prevent the special signals being transmitted to the calling subscriber.

3. *Switching the signalling units*

The preceding paragraphs illustrate the principles proposed for the indication of ARQ and idle circuit conditions over an immediate link or links. It is necessary to consider also how the units for transmitting and receiving the special backward path signals might be provided economically and switched into circuit when required on automatically-switched connections.

In any intercontinental exchange it is necessary for charging purposes to be able to divide the traffic into two groups—locally originated and transit switched. In the United Kingdom, these will be separate traffic systems as shown in the simplified trunking diagram in Appendix B. In other countries a common group of registers might be used for all traffic but the same distinction could be made regarding the two traffic streams.

It will be seen from the routing diagram—Appendix C—in which for simplicity the United Kingdom division of traffic is assumed throughout, that it is necessary to associate the transmit units only with transit traffic, when this is extended over radio circuits, and to associate the receive units only with locally-originated traffic when this is offered to outgoing cable routes and may be subsequently transit switched, i.e. type C circuits in the intercontinental network.

It is essential that the special signals should not be introduced by the transmit unit earlier than the call-connect signal or they could correspond to irregular backward path signals, especially with type C signalling, causing the call to be rejected. Also a succession of the special signals, combination No. 29, could possibly give premature indication of call connect.

It is essential that a receive unit should only be introduced when a corresponding transmit unit has also been introduced, otherwise genuine characters corresponding to the special signals may be suppressed.

Again assuming the United Kingdom trunking arrangement, as in Appendix B, a practical method of meeting these requirements in an economical manner would be to provide both the transmit and receive units as common equipment. In addition to switching them into the connection, it is necessary to specify also when the transmit and receive units should be brought into operation. The following criteria apply:

a) Transmit access relay sets would be provided only for outlets of second group selectors of the transit traffic stream outgoing to radio circuits. A transmit unit would be connected via an access relay set each time there was a transit call, but would be brought into operation to transmit the special signals only upon recognition of the call-connect signal.

b) Receive unit access relay sets would be provided for outlets of second group selectors of the locally originated traffic stream outgoing to Type C routes, as these are the only ones intended to carry outgoing transit traffic involving radio circuits. As a very large proportion of the traffic via these routes will terminate in the succeeding country, it would be economical to connect the receiver units only when an outgoing call was required to be subsequently transit-switched.

When called into circuit, the receive unit would return an uninterrupted train of ZK pulses for timing the call, corresponding to no ARQ on the radio circuit. Following recognition of the call connect signal, the receive unit would be brought into operation upon receipt of a group of the special signals covering a period of four consecutive characters, i.e. two repetitions of 140 ms stop polarity each followed by either combination No. 15 or No. 29. On receipt of this group, any further special signals would be suppressed by the receiving unit and if the special signals indicated ARQ, the locally generated ZK pulses would also be suppressed.

As an additional safeguard, receipt of stop polarity for 500 ms following the call connect signal could be taken to indicate that the connection had been established via cable throughout and that no suppression would be required.

The above makes it unnecessary for the centre at which the receive units are located to know whether or not the call is eventually transit switched to include a radio circuit. This arrangement permits any centre to substitute radio for cable circuits under breakdown conditions without the need to inform a large number of other administrations. It also facilitates the use of routes comprising some cable and some radio circuits.

4. *Progressive introduction of the scheme*

The progressive introduction of such a scheme requires that a transit exchange should be prepared to remove the special signals to prevent their return to originating countries not yet equipped with receive units. The block schematic diagram in Appendix C shows receive units in transit country A on incoming circuits from originating country X for this purpose. Such an arrangement could be maintained permanently in the case of originating countries preferring to use elapsed time charging.

5. *Radio circuits in tandem*

To meet the requirement that the information, necessary for the accurate assessment of call charges by count of the character release pulses, should always be available in the originating exchange, consideration must also be given to the case of two radio links in tandem.

Appendix C shows a transit country A with a radio link incoming from originating country Z and the inclusion of a radio control unit (RC) in this path. This is a receive unit adapted to control the incidence of ARQ in the incoming radio circuit according to the reception of the special backward path signals. Comparison would be made of the ZK pulses from the incoming radio circuit and those reconstituted from the special signals and the transmission efficiency of the incoming radio circuit reduced to that of the second radio circuit in the connection in the event of the latter being lower. In the event of the incoming radio circuit having the lower efficiency no adjustment is necessary. Use of the special signals, in conjunction with a modified form of receive unit in this way permits any combination of cable and radio circuits to form a connection.

6. *Test results*

The results given below have been obtained from tests that have been conducted using experimental electronic equipment, namely the transmit unit, to insert the necessary special signals as indicated by the signals received from the ARQ equipment, for transmission over the backward path of the intervening cable circuit, and the receiving unit, to discriminate and translate these special signals into character release pulses for operation of the timing equipment at the originating exchange.

A first series of tests was conducted using laboratory equipment throughout, the error-correcting radio equipments being interconnected by a simulated radio path. In the course of these tests 11 7533 telegraph characters were transmitted over the system, with varying conditions of cycling artificially introduced into the radio path, and no characters were lost or mutilated. The metering equipment registered to within $\pm$ 1 character the total number of character release pulses generated by the radio equipment to a total of 14 5372 release pulses.

A second series of tests was carried out with the equipment connected to a London-Hong Kong circuit to verify the effect of actual radio conditions on the equipment's performance. For these tests telegraph characters were transmitted as normal telex calls, the experimental equipment being brought into operation for the duration of each call. 280 calls were made during which a total of 62 0555 character release pulses were returned from the ARQ equipment. The accuracy of the character release pulses reconstituted by the release unit was better than 99.9% and there were 12 incidents of errors in the received copy of the backward path signals.

A third series of tests was made to check the effect of interruptions to the cable link, by short-circuiting the bearer circuit. Interruptions of 15 ms and 40 ms were used for each value of interruption and three tests, each of one hour's duration, were made, corresponding to continuous traffic on the backward signalling path with no cycling, idle condition on the backward path with no cycling and continuous cycling. Even with an excessive interruption rate of 200 per hour, additional mutilation of characters received by the test equipment, compared with characters received via a second VFT channel, was of the order of 1 in 4000 characters and again the accuracy of the character release pulses was better than 99.9%.

Finally, tests were satisfactorily carried out to check the use of the switching criteria for bringing the transmit and receive units into operation.

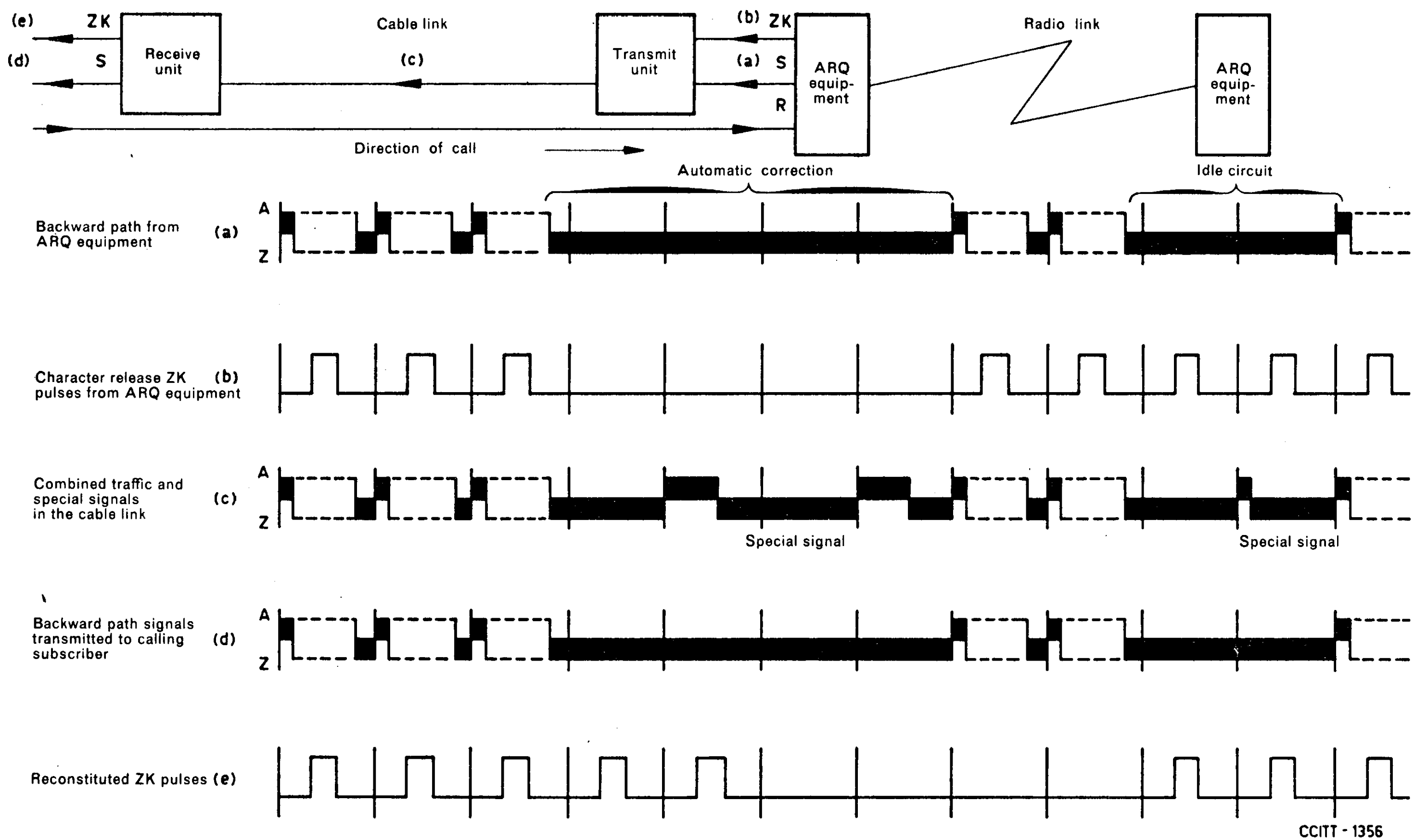
7. *Conclusion*

Tests carried out indicate that special signals can be transmitted over a cable circuit in addition to normal traffic signals to give an indication of the performance of a remote radio link in a transit connection and to permit the reconstitution of character release pulses in the originating country, from which an accurate assessment of call charges may be made.

The U.K. Administration is of the opinion that the greater charging accuracy obtained with this method may justify the added complication and expense of the equipment required. It considers that the results of the tests so far carried out reinforce the views already expressed regarding the use of the efficiency factor for charging purposes. It also considers that further investigation of all aspects of the problem should be carried out before any standards based solely on the efficiency factor are adopted and would welcome the co-operation of other administrations in this matter.

APPENDIX A (to Question 12/X)

Indication of ARQ conditions over an intermediate cable link



APPENDIX B (to Question 12/X)

Block schematic of main items of intercontinental switching equipments

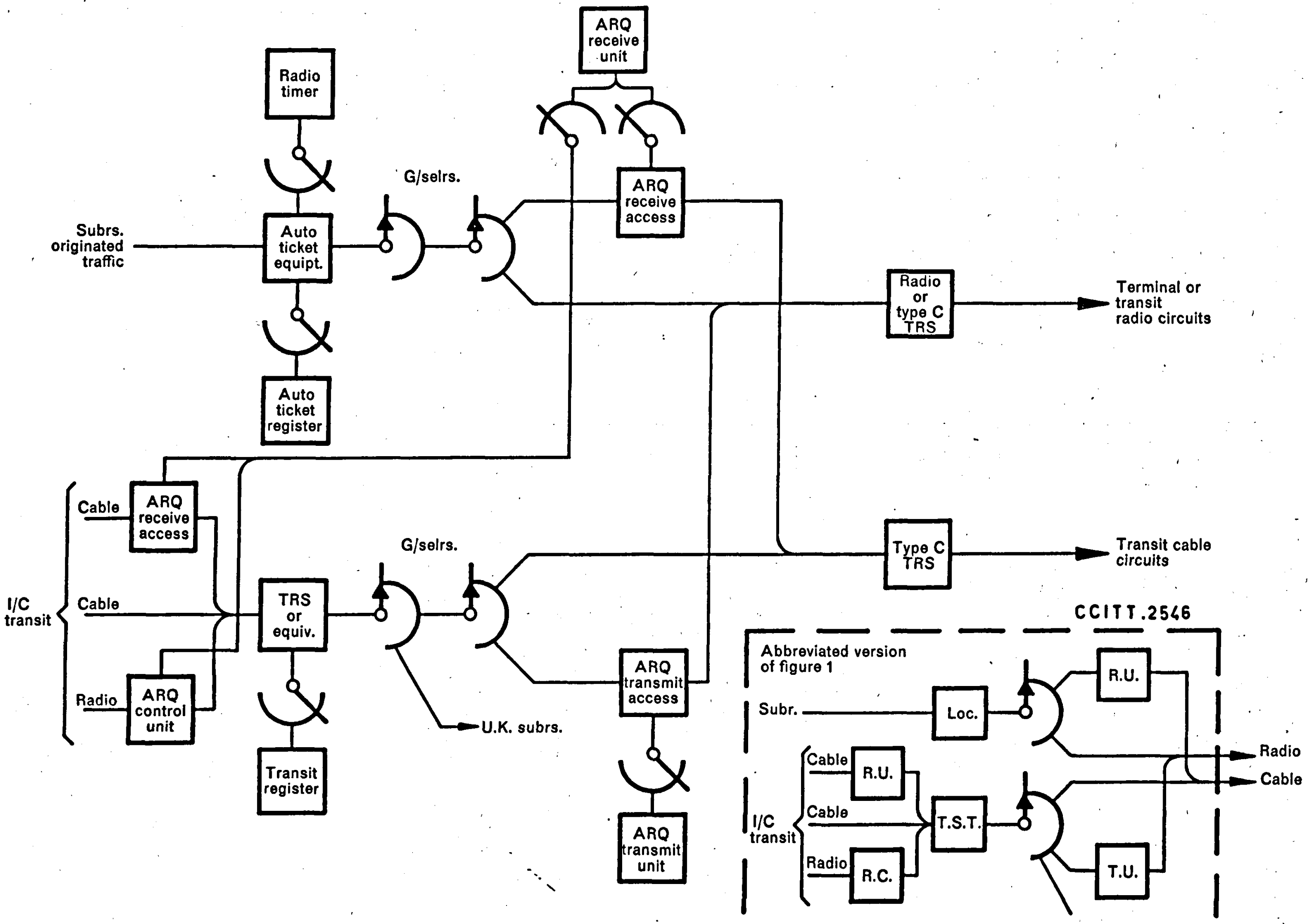


FIGURE 1. — London exchange

Note. — Abbreviations listed in Appendix C apply

APPENDIX C (to Question 12/X)

Transit A to transit B: cable

Transit A to transit C: cable/radio mixed

Transit A to destination N: cable/radio + radio

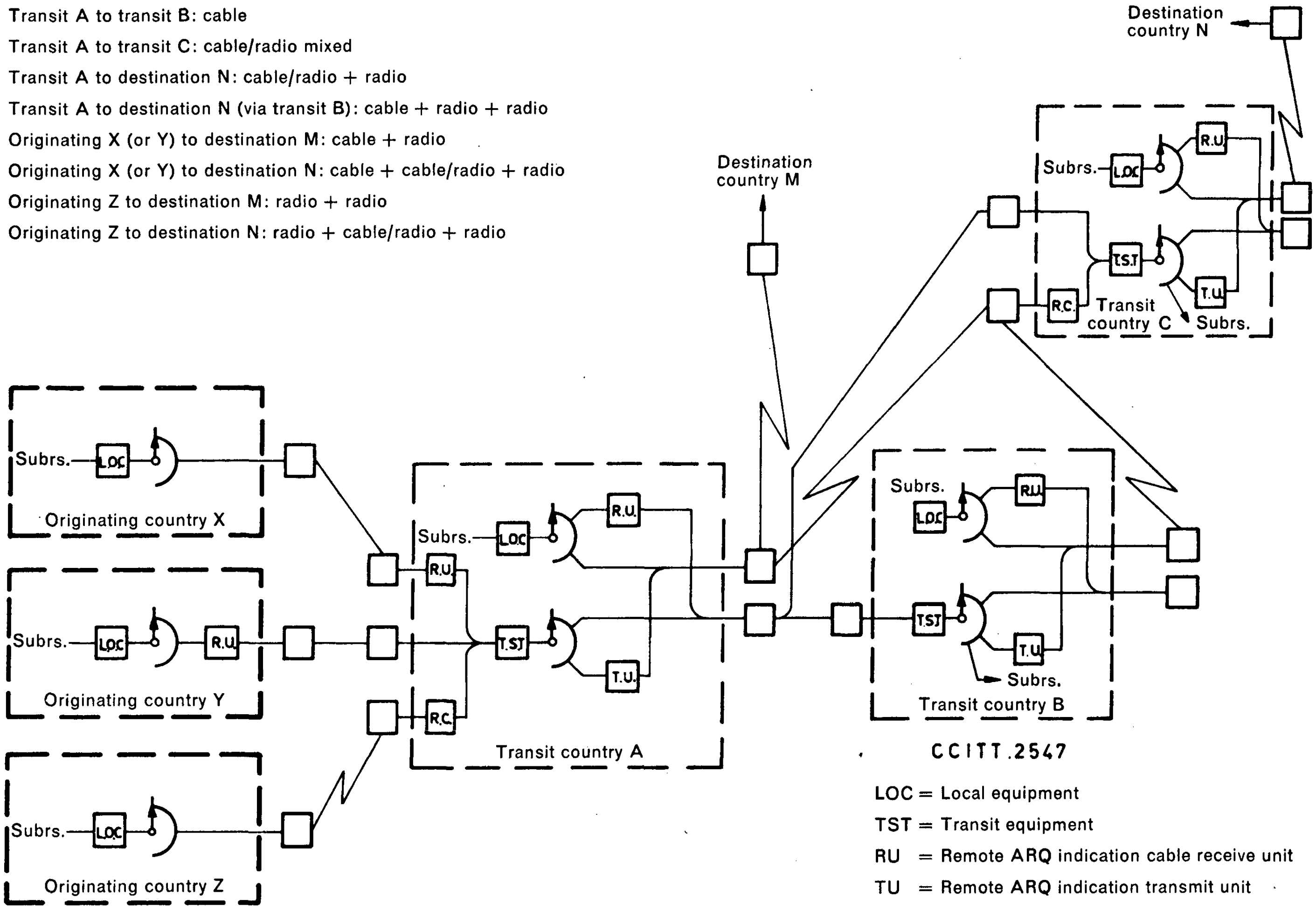
Transit A to destination N (via transit B): cable + radio + radio

Originating X (or Y) to destination M: cable + radio

Originating X (or Y) to destination N: cable + cable/radio + radio

Originating Z to destination M: radio + radio

Originating Z to destination N: radio + cable/radio + radio



CCITT.2547

LOC = Local equipment

TST = Transit equipment

RU = Remote ARQ indication cable receive unit

TU = Remote ARQ indication transmit unit

RC = Remote ARQ indication radio control unit

Question 13/X — Traffic forecasts

(Mar del Plata, 1968; question of interest to Study Group I)

Methods of forecasting traffic volume in order to determine the numbers of circuits to be provided in a given relation:

— in the telex network
— in the gentex network
— in the message retransmission network.

Question 14/X — Further categories of ineffective calls with service codes

(Mar del Plata, 1968; interests Study Group I)

There appears to be a case in new systems for a further category or categories of ineffective calls, with additional service code or codes specified, and for more precise definition of existing codes.

ANNEX

(to Question 14/X)

a) Recommendation U.1, section 9, categories ineffective calls as follows:

busy
no circuits
out of order
office closed
number changed
number unobtainable

These have led to the use of the following service codes (taken from Article 17 of Recommendation F.60):

OCC
NC
DER
ABS
NCH
NA
NP

NA normally being restricted to barred access operation. DER appears to have been limited in most systems to " faulty subscriber line ". One system, that of the Netherlands (*Blue Book*, Volume VII, Supplement No. 29, page 400), in addition returns DER when the called subscriber's answer-back device does not operate.

b) The Australian system, for example, is able to recognize a number of fault conditions in addition to the faulty subscriber line. These are trunk faulty, register faulty, invalid digits received, called subscriber's answer-back device does not operate, failure to receive the call connected signal at the first exchange. The choice must be made in these cases between returning the code DER or the code NC. Following what appears to be the usual practice in European systems NC is returned from the Australian National Network in all these cases although this code appears inappropriate and its usage in this sense reduces its value as a congestion signal.

TABLE 1

Service code conditions

Condition	Service code
Called subscriber busy	OCC
Network congestion (no circuits) (e.g. no free trunk, no free register, no free exchange path)	NC
Number not connected (not a working line)	NP
Connection not admissible (access barred)	NA
Office closed (absent subscriber)	ABS
Number changed	NCH
Faulty station line or termination (e.g., the local end with its termination, including machine. As examples, this service code would be returned if the line were open circuit, the subscriber terminal unit faulty, the machine power off or motor fail, failure to trip answer-back in those networks which automatically call for answer-back)	DER
Telex system fault (e.g. trunk faulty, register faulty, invalid digits received, call connect not received)	XXX (code to be chosen)

There appears to be a case in new systems for a further category or categories of ineffective calls, with additional service code or codes specified and for more precise definition of existing codes. For example, a table could be constructed as follows for new systems as shown in Table 1.

An additional service code or codes coupled with closer definition of the conditions covered by each service code would permit more effective observations on the grade of service in international telex traffic and would permit more effective control of maintenance effort in national networks.

c) Format of service codes

Recommendation U. 1 further specifies that printed service codes be preceded by carriage return, line feed and letter shift signals and be followed by line feed (preferably together with carriage return). The Australian system proposes for the present to return " letters shift " plus one character defining the exchange before returning the specified service code sequence while the situation remains in which the service code NC is returned for fault as well as genuine congestion conditions. This does not appear in fact to be contrary to Recommendation U.l, Section B.9.a. It is proposed, however, that this paragraph should be amended to specifically refer to the return of an identifying code prior to the service code. It is proposed that the third paragraph of Recommendation U.l, Section B.9.a should be followed by the additional sentence: "Before sending the code expression exchange identifying characters may be sent ".

d) It is noted that the code format specified in Recommendation U.l is slightly altered in Recommendation U.ll, Table 1 (Volume VII, Blue Book, page 165) to carriage return, line feed, space, letters shift followed by the code expression, then carriage return, line feed. It is proposed that Recommendation U.l, Section B.9 be amended in this respect to bring the two Recommendations into line, as follows:

" In this case, the code expression should be preceded by the carriage return, line feed and letter shift signals but may include other additional non-printing characters and should be followed by line feed (preferably together with carriage return) and then immediately by the clearing signal in all cases. "

QUESTIONS TO BE STUDIED BY STUDY GROUP XIV: APPARATUS AND TRANSMISSION FOR FACSIMILE TELEGRAPHY

Chairman: Mr. H. BITTER (Federal Republic of Germany)

Vice-Chairman: Mr. W. VINOGRADOV (Poland)

Question 1/XIV — Transmission of black-and-white facsimile on telegraph-type circuits

(Mar del Plata, 1968)

Is the use of telegraph circuits for black-and-white facsimile transmission advisable from the operational and economical point of view?

In the affirmative:

a) What are the correlations, for a given definition, between the line frequency and the nominal modulation rates (bauds) of the telegraph circuits?

b) How will telegraph distortion affect the quality of the facsimile transmission?

Study should be made of analogue transmission as well as transmission by numerical coding.

Comments:

1. Since facsimile signals are basically binary signals, telegraph-type circuits may offer some significant advantages as compared with the facsimile transmission over telephone-type circuits, e.g.:

— no problems of phase distortion and attenuation distortion;

— telegraphy may provide with transmission channels at practically all the modulation rates between those provided by a normal telephone circuit up to a group of a carrier system.

2. The modulation rates of the telegraph channels recommended at present in the series R Recommendations are too low for the purpose of facsimile transmission. It should, however, be noted that Study Group IX has proposed a new question with the aim of standardizing telegraph channels for modulation rates higher than 200 bauds, and Study Group X is studying the switched telegraph network for a modulation rate of 200 bauds or higher.

Question 2/XIV — Black-and-white facsimile transmission by numerical coding on telephone-type circuits

(Mar del Plata, 1968)
(to be studied in liaison with Special Study Group A)

Is it possible to obtain a worthwhile reduction in transmission duration by transmitting black-and-white documents by a procedure involving the emission of coded data indicating the position of the blacks with respect to the document recording medium?

If so, what would be the most suitable coding system to reach this aim?

In particular, the following points should be examined:

a) encoding and decoding sequences;
b) appropriate date signalling rate;
c) requirement for error-detection and correction;
d) relative efficiency of transmission comparative to analogue facsimile transmission method;
e) signal regeneration.

Question 3/XIV — Increase in speed of facsimile telegraphy in case of analogue transmission on telephone-type circuits

(continuation of Questions 2/XIV and 3/XIV, 1964-1968, amended at Mar del Plata, 1968)
(to be studied in co-operation with the LTG Joint Working Party)

What means might be considered to increase the operating speed of facsimile apparatus in the international service (including photo-telegraph apparatus)?

These studies should cover, first of all, the use of phase distortion correctors with automatic adjustment and the use of vestigial sideband modulation.

If so:

a) what frequency band should be used on carrier circuits?
b) which characteristics should be recommended for the phase distortion correctors and for the generators of a typical signal in order to effect automatic adjustment of the phase correctors?
c) what should be the characteristics of vestigial sideband modulation?

Note. — The influence of attenuation distortion in the transmission channel on a symmetric sideband operation must also be investigated.

ANNEX 1

(to Question 3/XIV)

In the case of circuits occasionally used for facsimile transmissions, the additional cost of inserting phase compensators would not be justified by the resulting advantages, especially since these circuits might have a complicated make-up which makes phase compensation difficult.

The use of phase compensators, therefore, is to be envisaged only for circuits permanently allocated or usually used for facsimile transmissions. The time is not yet come for proposing an international recommendation about the regular use of phase compensators. In fact, certain administrations consider that such compensators are too costly and that the preliminary adjustments which have to be made before each transmission result in the time gained due to the increase in transmission speed being lost. Administrations which wish to use phase compensators to increase transmission speed on certain circuits will make bilateral agreements about the method to be used. Administrations which do in fact use phase compensators are invited to supply detailed information with a view to subsequent standardization.

The above considerations apply to classical methods of facsimile transmission (including phototelegraphy) using frequency modulation or double sideband amplitude modulation. Vestigial sideband transmission is also dealt with in Annex 3.

ANNEX 2

(to Question 3/XIV)

Extract from the contribution of the Federal German Republic

(Contributions COM 8—No. 9 or COM 1—No. 95—November 1957)

The delay distortion on the telephone channels of German long-distance traffic carrier systems are shown hereinafter in another diagrammatic form (Figure 1). The *b* curves show the distortions likely on *one* channel of a carrier system when amplitude-modulation is employed (carrier = 1900 Hz). At the same time, the *a* curves show what values of distortion can be considered admissible if index 352 or index 264 is used, with varying drum speeds. According to these indications, the limit for correct facsimile transmissions, in the most favourable instance, is 120 or 160 r.p.m. (352 or 264). These figures are confirmed by experience too.

The use of phase distortion correctors maintaining group propagation time in the band 450 to 3250 Hz within admissible limits would make it possible to increase the transmission speed to 150 or 200 r.p.m. Incidentally, amplitude modulation is no longer applicable at higher speeds, because the available bandwidth of 2800 Hz is then exceeded. For economical reasons, it is impossible to use phase distortion correctors for the individual correction of circuits designed for facsimile transmission. Since, contrary to audio-frequency circuits phase distortion on carrier channels remains within known limits, the use of standardized phase distortion correctors in conjunction with phototelegraph equipment could well be envisaged. In such cases, these phase distortion correctors should correct the curve of average values of propagation time. Because of possible variations around this average value, there will inevitably be some residual distortion. The *c* curves in Figure 1 show the values that may be attained by such residual distortion in conjunction with German carrier systems, assuming an accuracy in the correction of phase distortion of $\pm$ 0.08 millisecond. Whence it will be seen that by the use of standardized phase distortion correctors of the kind described, the transmission speed could be increased to about 140 r.p.m. with index 352 or to about 190 r.p.m. with index 264. The gain in relation to 120 or 160 r.p.m. is negligible.

In practice, connections between two phototelegraph stations are often made up of *several* carrier sections in tandem. In such circumstances, the outcome of phase distortion correction by

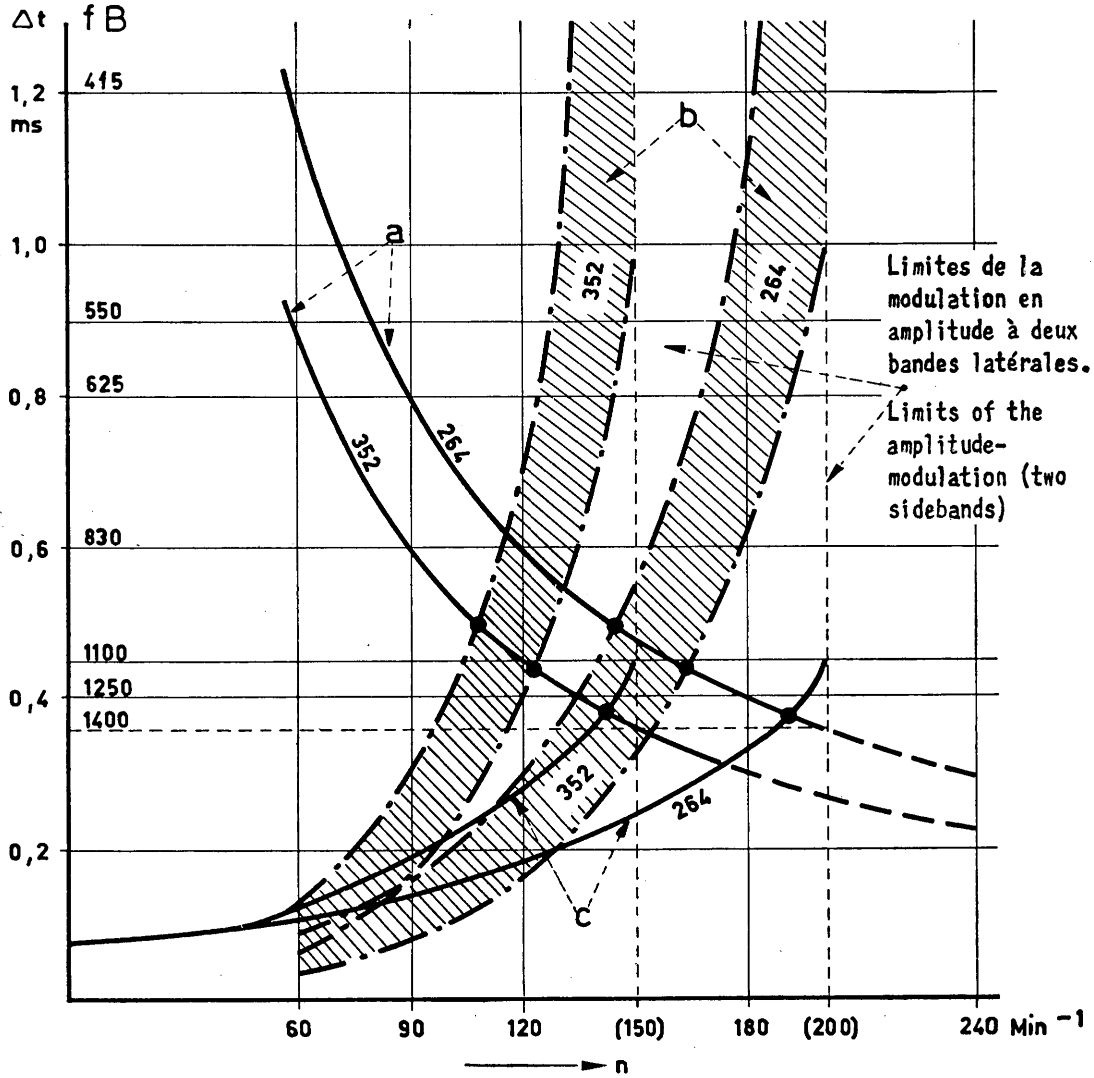


FIGURE 1

a = Delay distortion admissible in the band transmitted.

b = Residual delay distortion in a telephone channel of non-compensated V60 systems.

c = Maximum delay distortion on a V60 system telephone channel if a standard phase distortion corrector is inserted.

standardized correctors is doubtful, because dispersions are added thereto statistically. And in international service, we have to reckon with a wider range of dispersion.

We hold that an adequate phase distortion correction is possible only if the phase distortion correctors, before each transmission, are adjusted to an optimum figure as staggered-action correctors. In this case, we shall also have to equip transmitting phototelegraph stations with a control-signal generator, and the receiving ones with an oscillograph. It is doubtful, in our view, whether the almost negligible increase in transmission speed justifies such an outlay.

Besides which, we consider that the question of phase distortion correction is of importance for the transmission of half-tones only. For black-and-white transmissions, in which a perfect reproduction of the picture in all its details is less important than the intelligibility of the message transmitted, greater phase distortion is tolerable. There should be no increase in the cost of facsimile apparatus for the transmission of black-and-white (which will probably be used in greater numbers in the very near future) by mounting an additional phase distortion corrector. Equipment should be conceived for speedy, simple operation.

ANNEX 3

(to Question 3/XIV)

The general expression " asymmetric sideband operation " in the wording of this question could apply to the two methods shown in Figures 1 and 2. It should be clearly understood that it is the method shown in Figure 1 which is concerned, and which in the C.C.I.F. has for many years been called " vestigial sideband transmission ", the method also being used for television transmissions on cables. The method shown in Figure 2 is described under " transmission with partial sideband suppressed ", usually also called in English " vestigial sideband transmission ". Wherever the expression " asymmetric sideband " occurs in connection with this question it should be understood to mean the same thing as " vestigial sideband " as in the case of Figure 1.

The results obtained in the U.S.S.R. with asymmetric sideband transmission (at speeds of 240 and 360 revolutions per minute) were examined.

It appears that such results are possible with standardized phase correctors only with circuit equipment having the same characteristics. It is feared that the existing diversity of certain equipment used in carrier circuits for international communications would be an obstacle to widespread use of such a method of phototelegraph transmission.

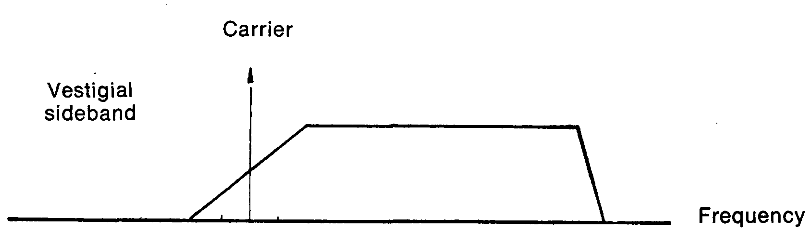


FIGURE 1

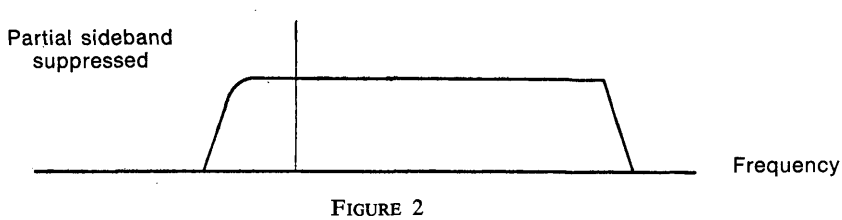


FIGURE 2

Administrations should study this question both for phototelegraphy and for facsimile with direct recording. Some sort of study should be made of the costs of the additional apparatus.

Attention is drawn to the effect, from a transmission point of view, resulting from the use of vestigial sideband transmission:

1. So as to reduce the effect of quadrature distortion on facsimile transmission, the ratio of white level to black level should be reduced. For example, it has been proposed to reduce this ratio to 12 or 14 dB instead of 30 dB in the case of double sideband amplitude modulation. Reduction of this ratio results in an increase in mean signal power. A detailed study of the permissible power for this type of modulation has been made. It is probable that the maximum permanent white signal level for the existing system could not be increased by comparison with double sideband amplitude modulation.

2. Partial suppression of the upper sideband in sending and receiving equipment must be achieved in such a way that the sum of the amplitudes at frequencies equally spaced on the two sides of the carrier frequency is equal to the total signal amplitude, and this may give rise to difficulties on a circuit on which there is attenuation distortion, when the carrier is at a relatively high frequency.

3. The carrier frequency and amplitude should be chosen with these considerations in mind. In particular, the higher the vestigial sideband reduction factor, the higher may be the carrier frequency. The following frequencies have been suggested:

3100 Hz by the U.S.S.R.

2850 and 2550 Hz by the Federal German Republic.

ANNEX 4

(to Question 3/XIV)

Correction of phase-response characteristics of the telephone channels used for phototelegraphy

(Contribution COM XIV—No. 31, U.S.S.R.—April 1967)

Unequalized phase responses of the telephone circuits limit the speed and the distance of the phototelegraph transmission and deteriorate the quality of the received picture. For the circuits permanently used for phototelegraphy and operating over long distances with a number of l.f. retransmissions, it is possible to compensate phase distortions by means of connection of some delay equalizers (C.C.I.T.T. Recommendation T.12).

Installation of permanent delay equalizers for all the telephone circuits which can be used for phototelegraphy would be financially unprofitable. Therefore, when phototelegraph connections are put through over the circuits, arbitrarily selected from the groups of the modern telephone circuits (e.g. by dial switching), it is expedient to use the delay equalizers, which are tuned for each path and connected only during the period of phototelegraph transmission. The most convenient is the utilization of the delay equalizers with automatic tuning. Such equalizers, connected between the sectioning telephone circuit and phototelegraph apparatus, permit (for the period of time, which is too small in comparison with the phototelegraph transmission time) the preparation of the route for phototelegraph transmissions of high quality independently of the number of l.f. retransmissions. Furthermore, with sufficiently high precision of correction, it is possible to use the SSB transmission methods widely for increasing the speed of phototelegraph transmissions of high quality.

In 1964 an automatized corrector (equalizer) of response characteristics of the telephone circuit group delay (AGD) was developed in the U.S.S.R.; it can be used in phototelegraph transmission routes for the objectives, mentioned above. The set of the group delay responses, inverse to the responses of the telecommunication circuits, can be obtained by means of the AGDE (Automatized Group Delay Equalizer). When the equalizer is connected to the particular circuit, the procedure of its tuning consists of selecting some definite response giving, together with the circuit response, the minimum group delay irregularities. The set of the group delay responses in the equalizer (AGDE) can be received by means of two corrective devices. The responses, inverse to those of the channels, having maximum GD slope are formed in the first and basic network (CN basic) (Figure 1). The CN bas. consists of a group of cascade-connected

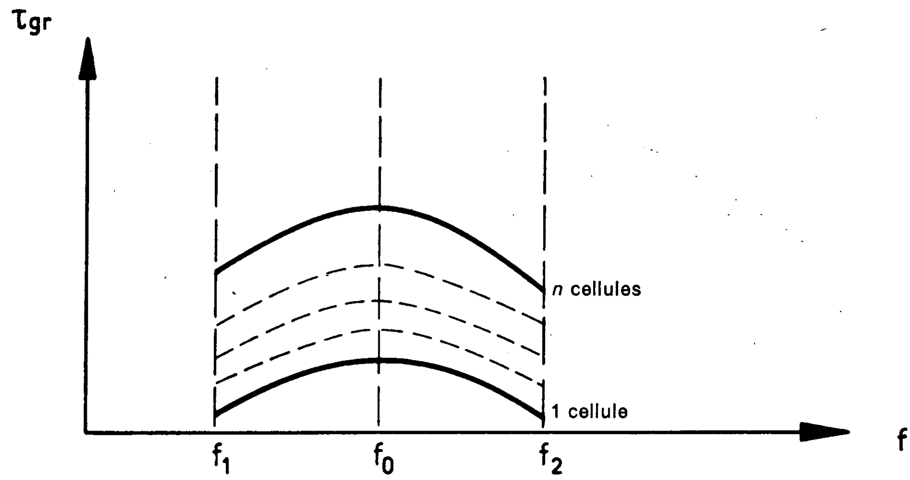
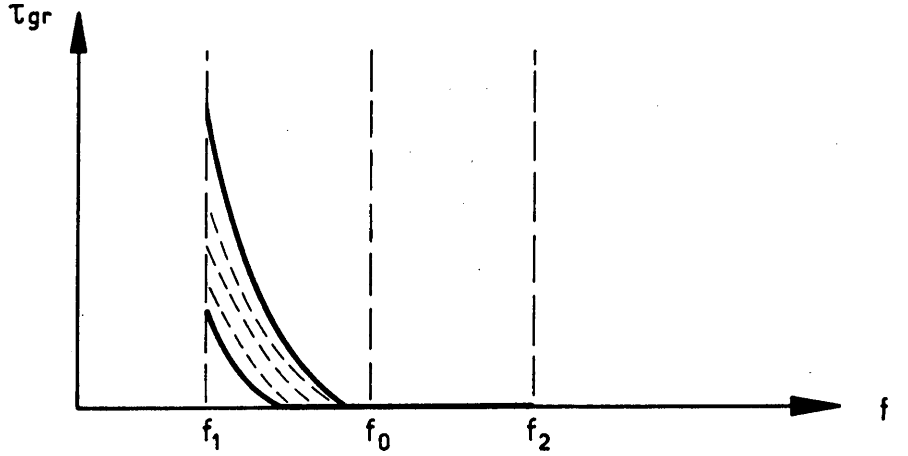


FIGURE 1. — **Frequency responses of the phase link of the CN basic**

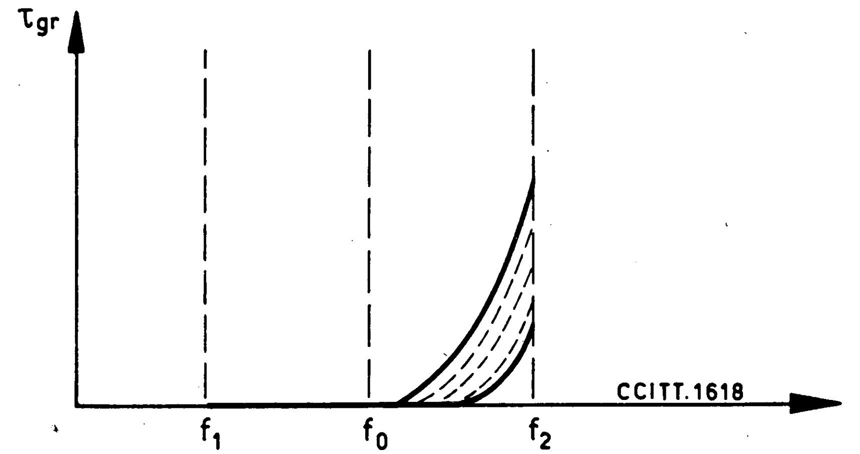
phase links; each of them compensates GD irregularity corresponding to the maximum GD irregularity *T*gr of the half of the retransmission section. The second and auxiliary corrective network (CN aux.) decreases the irregularity of the group delay response, obtained after CN bas. from the maximum value, up to the value, which corresponds to the GD irregularity of the real circuit. CN aux. is a cascade connection of high-pass filters (HPF), having preset responses of the *T*gr in the range of $f_1 < f < f_0$ and *T*gr = const. in the range $f_0 < f < f_2$ (Figure 2a), at the same time CN aux. is a cascade connection of low-pass filters (LPF), the group delay of which changes in the range of $f_0 < f < f_2$ according to the preset law, and with $f_1 < f < f_0$, the *T*gr = constant (Figure 2b).

Tuning is made by comparison of the GD at the frequencies f_1, f_0 and f_2 (Tgr_1, Tgr_0 and Tgr_2).

The Nyquist method is used for measuring *T*gr. By means of balance modulation the transmitter forms the tuning signal, representing three groups of voltage with frequencies $f_0 \pm \Delta f$, $f_1 \pm \Delta$ f and $f_2 \pm \Delta f$. The following values are adopted: $f_1 = 412.5$ Hz, $f_0 = 1650$ Hz, $f_2 = 3300$ Hz, and Δ f = 12.5 Hz. The tuning signal in the receiver passes through the CN bas. and CN aux. and gets to the analysis circuit, which compares Tgr_1 and Tgr_2 Tgr_0. The connection of the phase links of the CN bas. to the route by means of selectors is taking place up to the time when the conditions of $Tgr_1 < Tgr_0$ and $Tgr_2 < Tgr_0$ exist.



a) *Frequency responses of the group delay time of the HP*



b) *Frequency responses of the group delay time of the LP*

FIGURE 2. — **Frequency responses of the CN additional**

After that the HPF and LPF (CN aux.) are connected and the tuning is made at the edges of the frequency band. The circuit is considered to be corrected with $Tgr_1 = Tgr_0$ and $Tgr_2 = Tgr_0$.

After the tuning is finished, the transmitter and the analysis circuit are disconnected.

The main characteristics of the designed AGDE are as follows:

a) Performing correction of phase-frequency distortion of the telephone circuits with the effective bandpass of 300 to 3400 Hz; the number of low-frequency retransmission sections being five. The equalization of the telephone circuit group delay is possible; these circuits are characterized in the following way:

— GD of each retransmission section conforms to the C.C.I.T.T. standards;

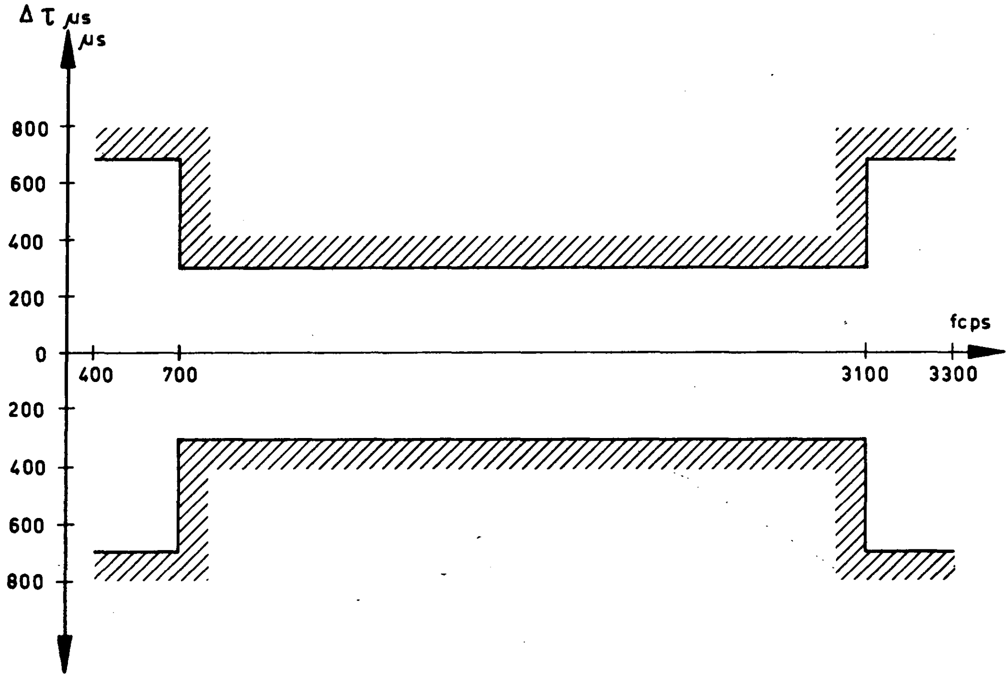


FIGURE 3

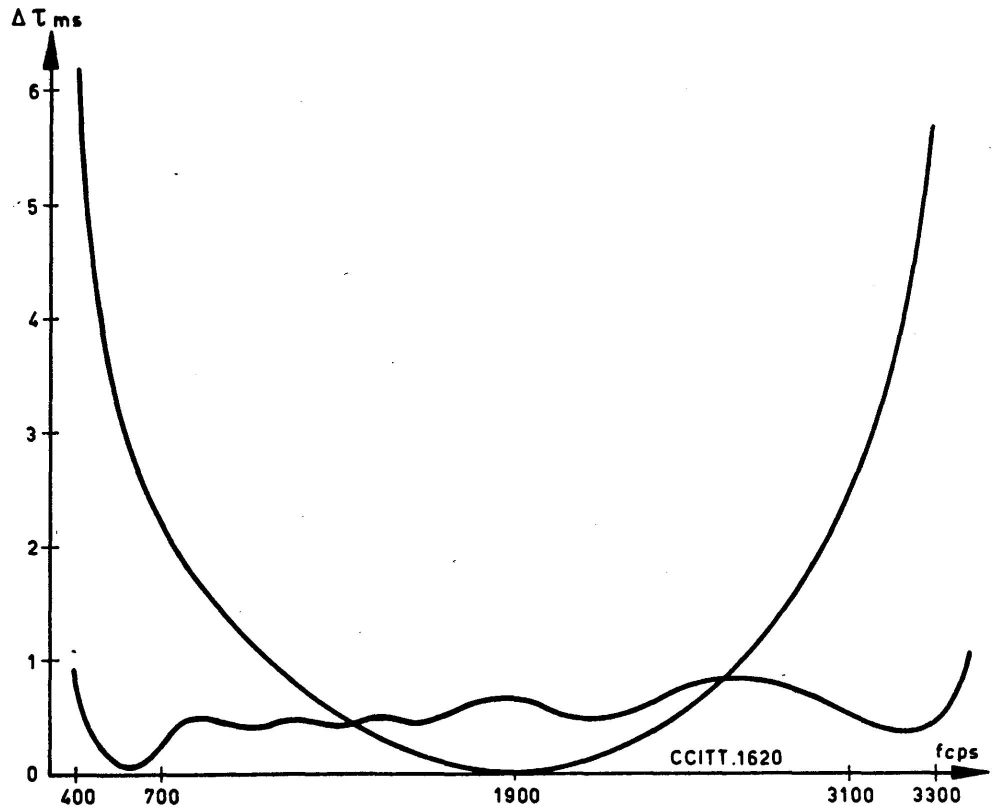


FIGURE 4

— the equivalent variation does not exceed $\pm$ 0.5 Np at the period of tuning;

— Interference level (white noise, random pulse noise) does not exceed –3Np at the zero relative level point;

b) The equalization is made in the frequency band of 400 to 3300 Hz. The GD response characteristic of the equalized route corresponds to that shown in Figure 3.

c) AGDE tuning is made automatically for the period which does not exceed 2 to 3 s. The transition to the manual tuning is possible.

d) AGDE is connected to the four-wire part of the circuit.

e) The effective level of the tuning signal is equal to –1 Np at the zero relative level point.

The GD response characteristic of the compound telephone circuit with five l.f. retransmissions before equalization (curve 1) and the GD response characteristic of the route, equalized by means of the AGDE (curve 2) are given in Figure 4.

Question 4/XIV — Use of modern submarine cables for phototelegraph transmission

(continuation of Question 4/XIV, 1964-1968, amended at Mar del Plata, 1968)
(to be studied in co-operation with LTG Joint Working Party)

Recommendations T.11 and T.12 in Volume VII of the *White Book* define the conditions to be observed from the point of view of phototelegraph transmission when telephone-type circuits are used for these transmissions.

What conditions will be applicable if the phototelegraph transmission is via telephone circuits in long modern submarine cables with or without the use of a speech concentrator, e.g. TASI and what conditions should be specially fixed for the use of such circuits?

In particular, should the circuits which are used permanently or occasionally for phototelegraph transmissions be withdrawn from the speech concentrator?

Should characteristic frequencies other than those recommended in Recommendation T.1 be adopted for amplitude modulation, frequency modulation or special transmission method (e.g. use of compandors), taking into account the specifications for 16-channel terminal equipments with 3-kHz spacing?

ANNEX

(to Question 4/XIV)

Extract from Contribution COM XIV—No. 19, March 1966 (France)

In collaboration with correspondents in New York, the French Administration conducted phototelegraph transmission tests on circuits with 3-kHz spacing. The tests were made, without any special precautions, at 60 and 120 revolutions/minute with amplitude modulation and frequency modulation; in the case of frequency modulation it was possible to correct the circuit phase roughly by means of correctors designed for data transmission. The index of co-operation was 352.

The frequencies used were 1900 ± 400 Hz for frequency modulation and 1500 Hz or 1800 Hz for amplitude modulation.

Three further tests were made from the Paris station looped to New York at 120 revolutions/minute with frequency modulation.

Tests at 60 revolutions/minute gave satisfactory results in every case.

At 120 revolutions/minute, the results obtained without phase correction were poor. The quality of documents received is noticeably improved when even makeshift correctors are used.

The phase distortion requirements to be met by terminal equipments with 3-kHz spacing are relatively strict. In actual service, however, because of maladjustment or ageing of equipment, group delay distortion may be greater than that measured when the equipment was brought into service; in this case, improvised phase correctors may produce considerable improvement in transmission quality.

Question 5/XIV * — Black-and-white facsimile transmission on telephone-type circuits

(continuation of Question 5/XIV, 1964-1968, amended at Mar del Plata, 1968)
(to be studied in co-operation with the LTG Joint Working Party)
(study to be made in liaison with the Question S+T of Special Study Group A)

Recommendations T.10 and T.10 *bis* define the conditions to be observed from the transmission standpoint when either leased or general network telephone-type circuits are used for black-and-white facsimile transmissions.

A number of questions relating to this type of transmission are still under study:

a) What would be the repercussion of the results of an investigation being carried out with a view to evaluating the total transmission loss between subscribers in the international telephone service and, in particular, what action is required when subscriber-subscriber loss is more than the apparatus is capable of sustaining?

b) Should a certain level be recommended for facsimile signals at the transmitter output?

Note. — See Supplements Nos. 28, 29 and 30 to Volume VIII (Data transmission) of the *White Book.*

Question 6/XIV — Use of the same leased telephone-type circuit for simultaneous transmission of facsimile and telegraph signals

(Mar del Plata, 1968)
(to be studied in co-operation with LTG Joint Working Party)

To make the best use of a leased international telephone-type circuit it might be employed both for facsimile (or phototelegraphy) transmission and to provide telegraph channels at 50 bauds or more.

In such a case, what should the following be:

a) The division of the telephone-type channel into bands of varying widths for these purposes?

b) The characteristics of facsimile transmission on such a circuit?

c) The permissible levels of the facsimile and telegraph signals in order to meet the conditions prescribed for the telephone-type circuit in the event of simultaneous communications?

d) The channels in a carrier group which should preferably be subdivided?

Note. — This question has a bearing on Question 1/A, point J.

ANNEX

(to Question 6/XIV)

Use of telephone-type circuit for simultaneous transmission of data and V.F. telegraph signals

(Extract from report by GM/LTG on Question 1/A, point J)

i) The simultaneous working of a data transmission system at the nominal power level and at most three V.F. telegraph channels with the power per channel specified for 24-channel V.F. telegraph system may be admitted.

ii) When this limit of V.F. telegraph channels is exceeded, a proportional division of powers [1] is necessary.

iii) For the case of facsimile and V.F. telegraphy, similar provision can be applied. The case of amplitude-modulated phototelegraphy may require a special study.

Question 7/XIV * — Facsimile service between subscribers

(continuation of Question 7/XIV, 1964-1968, amended at Mar del Plata, 1968)

Recommendations T.2 and T.4 were drawn up for a service expected in the near future. Perhaps some modifications to these recommendations will be necessary after the experience in practical services. In particular the following points should be studied:

a) Can cheaper arrangements be adopted for identifying the called subscriber in unattended operation?

b) What arrangements are necessary for a signal to be provided to enable a receiving subscriber to interrupt a transmission in progress?

c) What arrangements are necessary for self-contained groups of subscribers to interwork amongst themselves over the international switched telephone network?

d) Further study of the value of the mean frequency;

e) Further study of the receiver sensitivity.

Note. — This Question also interests Study Groups I and II.

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[1] Recommendation H.31 (Phototelegraph transmissions on telephone-type circuits) applies when the whole of the bandwidth is devoted to facsimile transmission only at any other time. When the band is divided among two or more types of transmission the power levels permitted by the recommendation should be reduced by the quantity 10 log 3100/x dB (5 ln 3100/x dNp), where x is the nominal bandwidth in hertz occupied by the transmission concerned.

Question 8/XIV — Facsimile transmission of colour documents

(Mar del Plata, 1968)

Recommendation T.1 contains provisions for phototelegraph apparatus to be used for the transmission of documents where their luminance varies between black and white. Recommendation T.11 contains provisions to be observed for the transmission of such phototelegraph signals on the telephone-type circuits.

— Are these provisions also applicable to the case of facsimile transmission of colour documents?

— or would it be necessary or advantageous to fix special conditions for colour phototelegraphy?

Question 9/XIV — High-speed facsimile transmission on wide-band circuits

(Mar del Plata, 1968)

For high-speed facsimile transmission (of complete newspaper pages, for example), it is contemplated using vestigial sideband amplitude modulation on wide-band circuits (corresponding to carrier groups or supergroups).

Is it desirable to have part of the band available to set up an associated telephone or telegraph channel to be used for operational needs?

For this purpose:

a) What conditions should be prescribed for the facsimile equipments?

b) What steps should be taken so that the facsimile transmission should not disturb the correct operation of the pilots on wide-band groups or conversely?

c) What groups or supergroups should be assigned for high-speed facsimile in order to obtain the best possible performance?

d) What is the maximum permissible number of groups or supergroups which can be interconnected in series in order to establish the entire wide-band circuit?

e) What conditions should be prescribed for multi-destination transmissions?

Note. — This Question has a bearing on Question 1/A, point Z.

Question 10/XIV — Definitions for facsimile telegraphy

(continuation of Question 10/XIV, 1964-1968)

Revision of the definitions for facsimile telegraphy (including phototelegraphy) in order to cover all facsimile equipment and circuits.

Note. — In the period 1964-1968, the definitions in Series 36 (Facsimile and Phototelegraphy) of the *List of Definitions* (2nd edition—1961) have been entirely revised and will be published in the next issue of the *List of Definitions*.

Question 11/XIV — Facsimile transmission over earth satellites

(Mar del Plata, 1968)
(to be studied in co-operation with the C.C.I.R.)

What are the technical conditions to be met by phototelegraph and facsimile transmissions using circuits established via earth satellites?

Note 1. — The study should cover the various types of satellites (synchronous or non-synchronous).

SUPPLEMENTS TO SERIES R, S, T, U RECOMMENDATIONS

TABLE OF CONTENTS

Supplement No. 1

SAGEM (FRANCE) *(Contribution COM VIII—No. 22—December 1967)*

TABULATION IN TERMINAL PRINTING EQUIPMENT

In conjunction with the I.S.O., the C.C.I.T.T. has worked out a 7-unit alphabet for the transmission of data and messages called Alphabet No. 5.

This alphabet includes two format effectors: (F E_1) (0/9) HT or horizontal tabulation; (FE 3) (0/11) VT or vertical tabulation. They are defined as follows:

— H.T. Horizontal tabulation — A format effector which controls the movement of the printing position to the next in a series of predetermined positions along the printing line.

— V.T. Vertical tabulation — A layout character which controls the movement of the printing position to the next in a series of predetermined printing lines.

The use of these functions should be made quite clear to ensure the requisite compatibility between apparatus of different makes.

I. *Horizontal tabulation*

Study of this problem has indicated three different ways of interpreting the horizontal tabulation function. There are probably other possibilities.

1. *Operation of typewriter-type equipment*

Each apparatus has tabulation indices. Correspondents have to agree on the correct setting of the indices before this system can be used. Two serious drawbacks are involved:

a) The operator has to be present at the receiving station. This cancels one of the advantages of the teleprinter, namely, reception of messages without an operator;

b) With automatic transmission, the shift from one tabulation position to the next has to be effected during the translation cycle of the combination 0/9 to enable the following character to be printed in the right place.

If there is a fairly large distance between the two consecutive index positions, it is very difficult to pass from one to the other in less than one cycle at a speed of 200 bauds without the use of techniques based on much more expensive printing equipment.

Otherwise, provision would have to be made for the use of fill-up signals in accordance with a procedure to be defined.

2. *Operation of automated typewriter-type equipment*

Operation is as above except that, to avoid the presence of an operator at the receiving end, the tabulation indices would be set by remote control from the sending end by means of special signals, e.g. outside the code (escape or DLE).

This is not an easy problem. The remarks made in paragraph 1.b above are again applicable. To make such a system internationally compatible, the special signals required as well as the index-setting procedure must be specified.

3. *Programmed repetition of " space " signals at the sending end*

In this case the tabulation is entirely prepared and controlled by the sending station.

The programme can be obtained by a system of indices set by the operator at the sending station or by some other appropriate means.

Tabulation is then carried out by means of successive " space " signals which are produced automatically until the next pre-set position is reached.

This system requires neither the presence of an operator at the receiving end, nor the use of fill-up signals.

One drawback is that the average transmission time is much longer than in the case of the systems discussed above. On the other hand, the system has the enormous advantage that tabulated reception is possible with any type of equipment even if it has no special tabulation device.

Signal 0/9 (HT) is not used in this case unless it is required for the purpose of starting the tabulation programme at the other end.

II. *Vertical tabulation*

The operational characteristics are the same as for horizontal tabulation.

There are the same three possibilities as for horizontal tabulation which give rise to the same types of problems.

The following problems are specific to vertical tabulation:

1. Vertical tabulation is hardly possible without the use of preprinted forms with a maximum number of lines to be defined.

It should be noted that signal (FE_4) (0/12) FF—form feed—is merely one specific case of vertical tabulation.

2. Automatic line feed repetition for moving from one printing position to the next seems to be the only normally acceptable solution. There are two possibilities:

a) The number of line feed combinations transmitted by the sender corresponds to an equal number of functions performed by the receiver;

b) The receiver has a special device for detecting the end of a form (e.g. additional side perforation or counter) and is insensitive to line feed signals when a reference position has been reached. In this case detailed standardization of operational methods is required to minimize the risk of incompatibility between different types of equipment.

Conclusions

This review shows the difficulty of using signals 0/9 (HT), 0/11 (VT) and 0/12 (FF) as defined at the present time. It also shows how necessary it is for international organizations—and in particular the C.C.I.T.T.—to work out a precise definition of these signals and to delineate their scope.

Supplement No. 2

FEDERAL REPUBLIC OF GERMANY *(Contribution COM IX—No. 12—October 1965)*

MEASUREMENTS OF DISTORTION AS A FUNCTION OF THE MODULATION RATE

1. *Type of voice-frequency telegraph channels*

The measurements apply only to frequency-shift modulated voice-frequency telegraph channels with 120-Hz spacing between the mean channel frequencies, which conform to C.C.I.T.T. Recommendation R.35. Channels with special characteristics were not considered. This contribution therefore concerns only the transmission systems which are mainly used in the switched telegraph networks at the usual modulation rate of 50 bauds.

2. *Measuring conditions*

To ascertain how such channels function even when noise is present, the measurements were carried out with white noise. The degree of isochronous distortion in a frequency-shift modulated voice-frequency telegraph channel which conforms to Recommendation R.35 was measured in accordance with Recommendation R.51 and with alternations of 1:1 as a function of the modulation rate, noise being present. The adjacent channels were out of service during the measurements. In accordance with Table 1 in C.C.I.T.T. Recommendation R.35, the channel level was −2.6 Nm. The levels of absolute noise shown in Figures 1 and 2 relate to the bandwidth 3.1 kHz, which corresponds to the voice-frequency band. After the noise bandwidth has been narrowed by the receiving filter, approximately 80 Hz wide, the effective noise level at the receiver input is approximately 1.8 nepers less than the noise level measured in the voice-frequency band.

The following relationship is therefore obtained between the absolute noise level, normalized with respect to the voice-frequency band, and the signal/noise ratio (normalized with respect to the frequency band in the voice-frequency telegraph receiver):

Noise level in the voice-frequency band	−6.6	−5.6	−4.6	−3.6	−3.1	Nm
Signal/noise ratio at −2.6-Nm signal level	5.8	4.8	3.8	2.8	2.3	Np

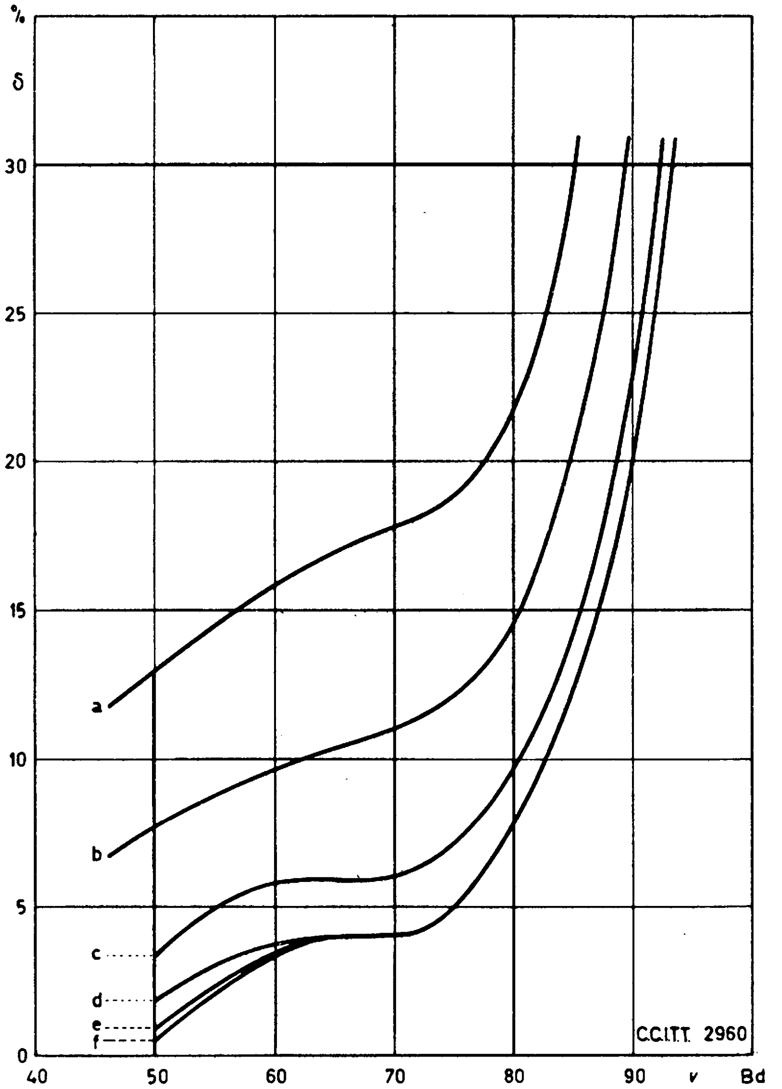
The observation period for each measurement lasted approximately 30 seconds.

The receiver was adjusted at neutral only for the nominal modulation rate of 50 bauds.

3. *Remarks on the measurement results*

The curves measured for the standard text (Figure 1) and for the 1:1 signals (Figure 2) show that the isochronous distortion of the channel concerned increases very rapidly above a rate of 85 bauds. When this is compared with the distortion which occurs without white noise, we find that the noise levels measured in the voice-frequency band which are less than −5.6 Nm cause very little distortion. It is only at noise levels above −4.6 Nm that a notable increase in isochronous distortion is observed.

The measurements show that, on transmission sections with an average-to-high signal/noise ratio, voice-frequency channels which accord with Recommendation R.35 are suitable for synchronous operating up to a rate of approximately 85 bauds.



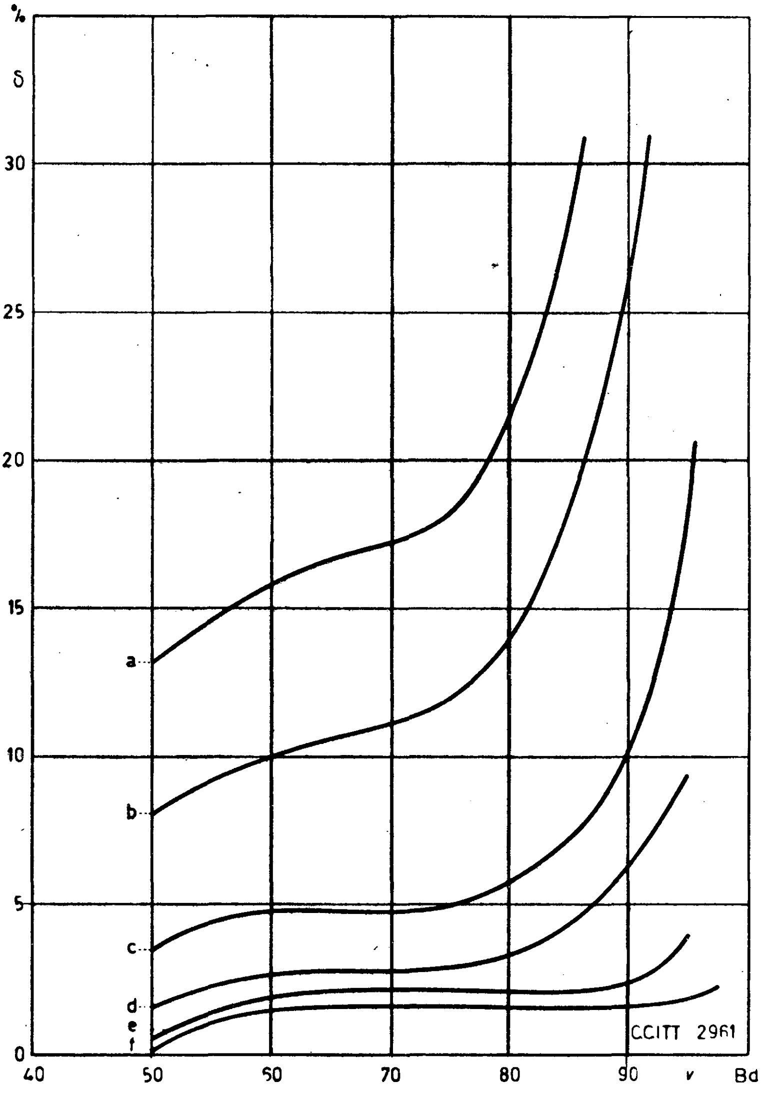
Parameter: noise level Pr

Signal level: −2.6 Np

Signals: C.C.I.T.T. text

a) Pr = −3.1 Nm
b) Pr = −3.6 Nm
c) Pr = −4.6 Nm
d) Pr = −5.6 Nm
e) Pr = −6.6 Nm
f) Without noise

FIGURE 1 — **Isochronous distortion δ as a function of the modulation rate v**



Parameter: noise level Pr

Signal level: −2.6 Np

Signals: 1:1

a) Pr = −3.1 Nm
b) Pr = −3.6 Nm
c) Pr = −4.6 Nm
d) Pr = −5.6 Nm
e) Pr = −6.6 Nm
f) Without noise

FIGURE 2 — **Isochronous distortion δ as a function of the modulation rate v**

Supplement No. 3

KOKUSAI DENSHIN DENWA CO., LTD. OF JAPAN *(Extracts from Contribution COM IX—No. 14—October 1965)*

APPLICATION OF 120-Hz-SPACED FMVFT CHANNELS TO MODULATION RATES GREATER THAN 50 BAUDS

1. *Introduction*

In recent years, with the expansion of the submarine telephone cable systems, voice-frequency telegraph systems are widely used on the intercontinental circuits as well as the ordinary international circuits. Most of these voice-frequency telegraph systems are FMVFT systems with channel separation of 120 MHz in conformity with Recommendation R.35 of the C.C.I.T.T. On the expensive long-distance circuits via submarine cables, the FMVFT channels spaced at 120 Hz are being applied to modulation rates greater than 50 bauds for the purpose of more effective utilization of channels, although systems for modulation rates greater than 50 bauds have already been standardized by Recommendations R.36, R.37 and R.38 of the C.C.I.T.T.

This trend was brought about together with the adoption of synchronous telegraph systems which perform the function time-division multiplex and also signal regeneration. It may also be desired that 75-baud start-stop telegraphy is accommodated in the FMVFT channels spaced at 120 Hz, if they are used on valuable long-distance circuits.

Considering these factors, Kokusai Denshin Denwa Co., Ltd. (K.D.D.) made a series of transmission tests on greater modulation rates, in which the FMVFT channels spaced at 120 Hz proved to be available up to 96 bauds. The tests, however, suggested a need of additional specifications in Recommendation R.35 to cover greater modulation rates for FMVFT systems which may be applied to this purpose.

2. *Possibilities and questions*

The Annex describes the transmission tests of 96-baud ARQ multiplex signals on FMVFT channels spaced at 120 Hz over several intercontinental submarine cable circuits.

An example of the effect of channel-separating filters on transmission quality is shown in Figures 1, 2 and 3. The data were obtained from a local experiment made by K.D.D. Figures 1 and 2 show the characteristics of the sending and receiving filters used in the experiment respectively. Two filters A and B of different characteristics were used as a sending filter. Figure 3 shows telegraphic distortion vs. modulation rate characteristics of a FMVFT channel with the channel-separating filters shown in Figures 1 and 2. Measurement was made on K.D.D.'s FMVFT equipment which meets the specifications of Recommendation R.35. The sending filter A showed apparently better performance than the filter B for modulation rates greater than 80 bauds, while little difference was observed in the performance of both filters at a modulation rate of 50 bauds.

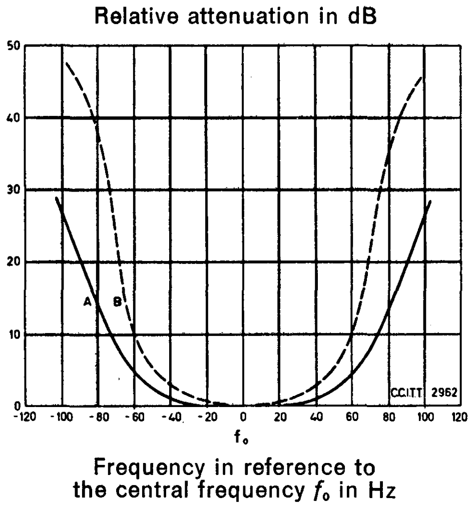


FIGURE 1 — **Characteristics of the sending filters**

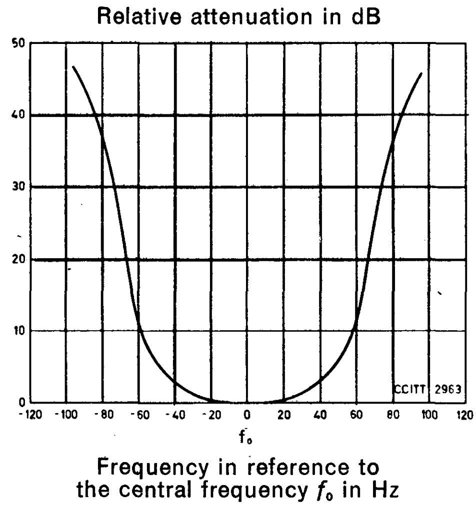
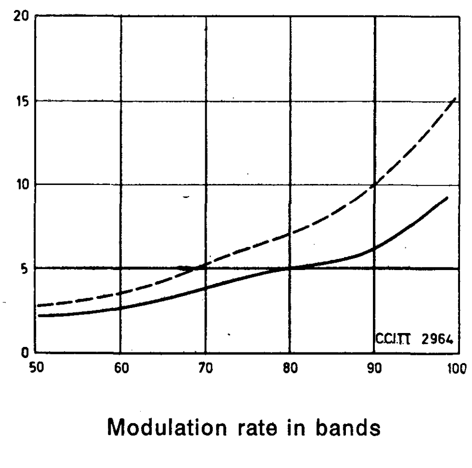


FIGURE 2 — **Characteristics of the receiving filter**



Notes:

Curves A and B:	for the sending filters A and B shown in Figure 1 respectively
Channel:	a FMVFT channel spaced at 120 Hz in conformity with Recommendation R.35
Connection:	back-to-back connection
Signal:	Q9S text
Adjacent channels:	Q9S signals of the same modulation rate
Bias distortion:	eliminated at every modulation rate

FIGURE 3 — **Telegraphic distortion vs modulation rate**

Matters concerning the designing sending and receiving filters are left in the hands oj manufacturers at present. So, on the international circuits where, in most cases equipments made by different manufacturers are used at each end of the circuits, poor performance of FMVFT systems will be probable due to improper combinations of sending and receiving filters for modulation rates greater than 50 bauds, even if, in designing each equipment, its application to greater modulation rates is taken into consideration.

In order to avoid the disadvantage, as experienced in the 96-baud transmission tests, the C.C.I.T.T. will have to make a study on international standardization of sending filters for FMVFT systems with channel separation of 120 Hz to be applied to modulation rates greater than 50 bauds. Standardization of sending filters will eliminate the need for the modification of receiving parts for each circuit, and will ensure better transmission quality. The receiving part will be designed properly by every manufacturer if only the sending part is standardized.

3. *Standardization of FMVFT systems for modulation rates greater than 50 bauds*

Questions involved in applying FMVFT channels spaced at 120 Hz to modulation rates greater than 50 bauds have various aspects in addition to the standardization of sending filters.

ANNEX

Transmission tests of 96-baud ARQ multiplex signals

Kokusai Denshin Denwa Co., Ltd. (K.D.D.) carried out transmission tests of 96-baud ARQ multiplex signals on FMVFT channels spaced at 120 Hz in conformity with Recommendation R.35 of the C.C.I.T.T. The tests were made on some channels of three FMVFT systems now in service over the intercontinental circuits via submarine cables. Telegraphic distortions and mutilation rates were measured for the ARQ multiplex signals which transmitted idle alphas on channel A and idle betas on channel B. On each circuit, unweighted noise level was about -40 dBm0 and sub-carrier level was approximately -24 dBm0.

Results of the tests for the three circuits (a), (b) and (c) are shown in the table. At an early stage of the test, much distortion and many mutilations were observed on the circuits (b) and (c), whereas circuit (a) showed good performance. Circuits (b) and (c) were improved by modifying the receiving part of K.D.D.'s FMVFT equipment. Data shown in the table are those taken after the improvement. As to the cause of the poor performance, a local experiment made by K.D.D. indicated that the bandwidth of the sending filters of the FMVFT equipment at the other ends of the circuits might have been narrower than expected in designing K.D.D.'s equipment.

TABLE

Results of transmission tests of 96-baud ARQ multiplex signals on FMVFT channels spaced at 120 Hz on intercontinental circuits via submarine cables

Circuits	(a)	(b)	(c)
Telegraphic distortions	within ±15%	within ±15%	within ±15%
Mutilation rates	2×10^{-5}	3×10^{-5}	5×10^{-5}
Adjacent channels	96-baud ARQ signals	50-baud telegraphy in service	50-baud telegraphy in service

Supplement No. 4

NIPPON TELEGRAPH AND TELEPHONE PUBLIC CORPORATION *(Extract from contribution COM IX—No. 11—October 1965)*

EFFECT ON TELEGRAPH DISTORTION OF SUDDEN CHANGE OF LEVEL

N.T.T. has made fundamental experiments using an artificial telegraph circuit consisting of AM and FM carrier telegraph systems which are now in use. The artificial circuits were made by connecting with wires a sending repeater and a receiving repeater which connect carrier telegraph equipment to telephone lines.

A sudden variation in level is produced on the connection by changing the insulating resistance between wires. The telegraph distortion induced was measured with a statistical analyser.

Measurements were carried out under the conditions of Recommendation R.80 and of the Final Report by SGIX for the IIIrd Plenary Assembly in Geneva.

1. *Relation between maximum degree of distortion and duration of reduction in level*

So far as distortion induced is concerned, 24 channels are divided into two groups. One consists of channels No. 1 and No. 24. The other consists of all the other channels.

N.T.T., having made experiments on channel No. 24 and on one of the intermediate channels, the results of the measurements on these channels will be shown.

The following figures show maximum isochronous individual distortion induced by 1000 sudden variations in level.

(The variation interval is 8.5 times the unit element length.)

The variation in level is extremely fast, so that declivity and acclivity of the variation are almost perpendicular (see Figure 10).

Duration of the variation is from 0.5 ms to 15 ms.

Maximum indication of the statistical analyser is 40%, of which the accuracy is within ± 1%.

1.1 *Amplitude-modulated carrier telegraph system* (see Figures 1 and 2)

Ca_1: All channels without tone except the channel under test
Ca_2: Alternate channels with permanent tone, except the channel under test
Ca_3: All channels with permanent tone except the channel under test

1.2 *Frequency-modulated carrier telegraph system* (see Figures 3 and 4)

Cf_1: All channels without tone except the channel under test
Cf_2: All channels with alternative tone of mark and space except the channel under test
Cf_3: All channels with permanent tone nearer line frequency of channel being measured except the channel under test

2. *Relation between duration of reduction in level and distribution of distortion (of FM system)*

The frequency of maximum degree of distortion induced by variation in level, and probability of exceeding a certain degree of distortion are functions of duration of the variation.

Figure 5 shows various degrees of distortion of reversals induced by 1000 variations.

They are classified into three groups of distortion of 20%, 30% and 40% plus.

They were measured by the statistical analyser.

The abscissa indicates duration of variation in level and the ordinate the number of elements with distortion.

3. *Noise caused by variation in level*

It is confirmed that the influence of variations in level on telegraph distortion depends very much on whether or not the other channels of the system have tones, and that this influence is caused by the induced noise by the variation in level.

N.T.T. quantitatively measured noise power by a storage-type oscilloscope. Measurements were carried out under the same conditions as for Ca_1 Ca_2 Ca_3 and Cf_1 Cf_2 Cf_3 mentioned above.

3.1 *On AM carrier telegraph system*

Figure 6 shows induced noises of variations in level by channel No. 15 with tone, which are measured at the output of each channel-receiving filter.

Figure 7 shows induced noise power on channel No. 15 without tone by the other 23 channels with permanent tone for abrupt variations in level. Duration of the variations is from 0.5 ms to 15 ms, where variations Δa are infinitive, 1 Np and 0.6 Np.

The noise powers shown in Figure 7 are the maximum of 100 variations.

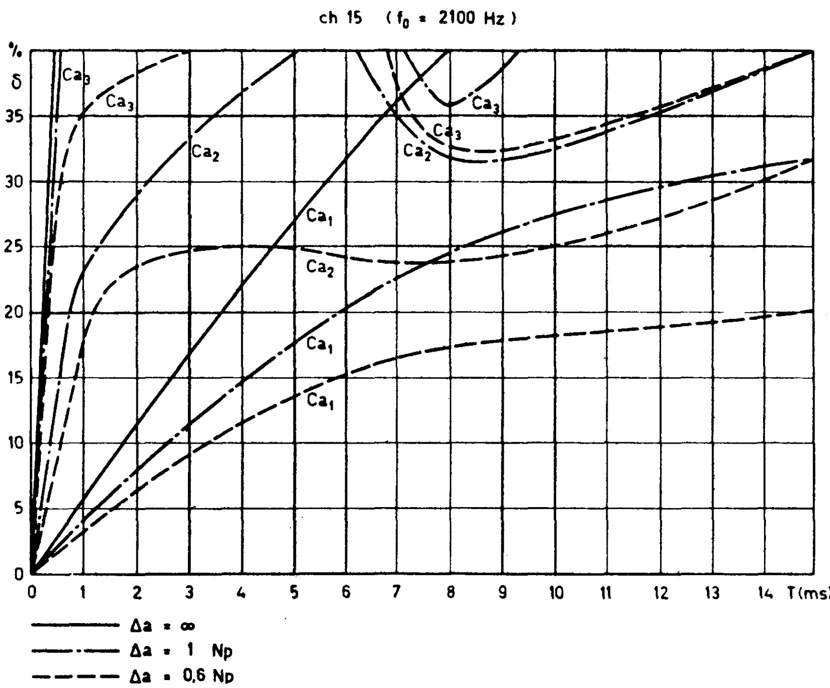


FIGURE 1

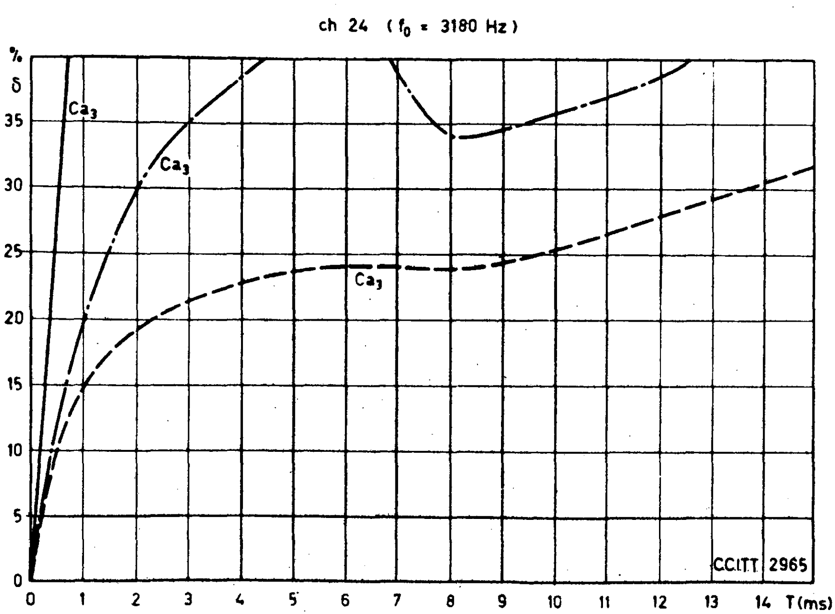


FIGURE 2

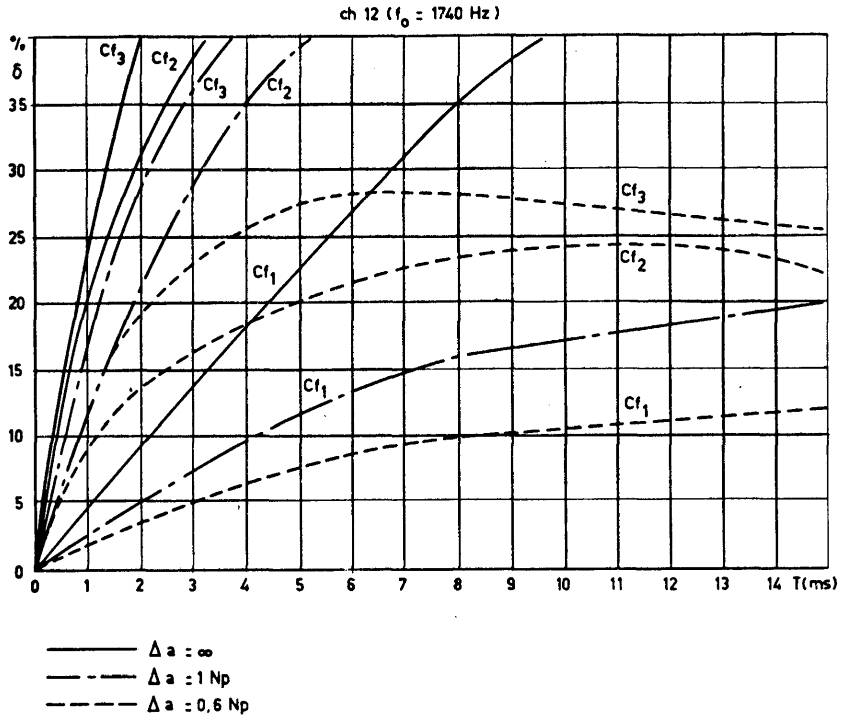


FIGURE 3

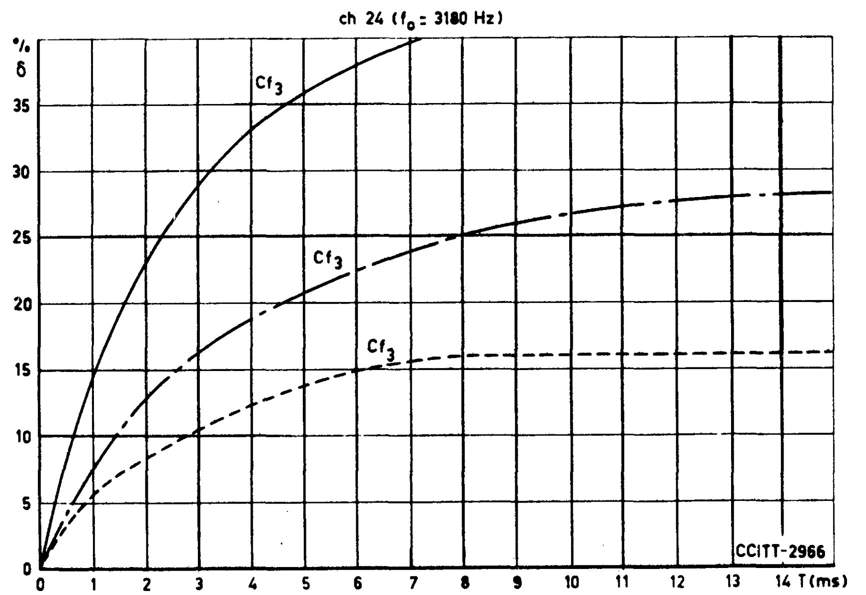


FIGURE 4

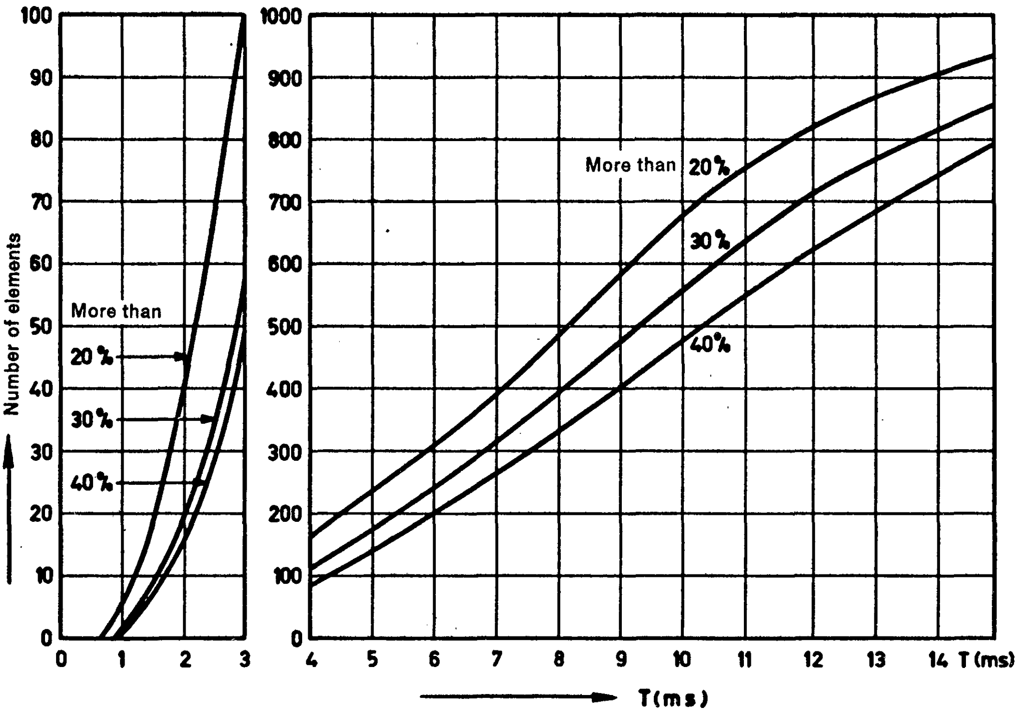


FIGURE 5

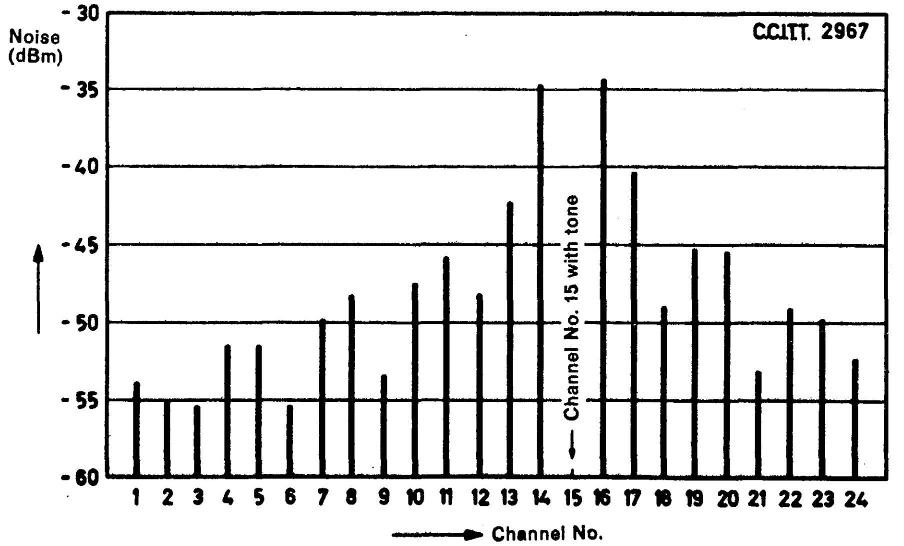


FIGURE 6

3.2 *On FM carrier telegraph system*

Figure 8 shows induced noise power for variations in level by channel No. 12 with permanent tone, measured on the other 30 channels.

Measurements were made under the same conditions as 3.1.

Figure 9 shows induced noise powers for variations in level by 23 channels with permanent tone, measured on channel No. 15.

The data given above explain two limiting factors in telegraph distortion. The primary factor is the variation in level itself to change the length of the element. The secondary factor is the noise caused by other tones, transmitted over the same line, for abrupt changes in level.

The influence of the primary factor on telegraph distortion will vary with the time when the variation occurs. In other words, the part of the element on which the variation occurs is important. On the other hand, the distortion being influenced by the characteristics of the equipment (mainly time constant of restitution circuit including relay), the mechanism inducing the distortion is complicated.

The secondary factor is easily explained as a transient phenomenon originated by an abrupt variation in level.

The noise is given by the next formula:

$$g(\omega) = \frac{T \cdot \Delta E}{2\pi} \left(\frac{\sin \omega \frac{T}{2}}{w \frac{T}{2}} \right)$$

where T is duration of variation in level, and ΔE is amplitude of variation.

The noise spectrum is continuous, and affects other channels. These effects are explained by Figures 6 and 8.

The phase of tones, which are emitted by all channels, is random, so that the total voltage of tones on a line fluctuates continuously. If abrupt variation in level occurs when the voltage is at maximum, the induced noise rises to the maximum.

According to the experiments, the variation in level produced the maximum noise when its duration was between 2 ms and 6 ms (shown in Figures 7 and 8). As the duration increased over 6 ms, the noise power voltage became constant.

Noise is supposed to be produced at both transient points (declivity and acclivity) of the variation, and its duration is determined by the characteristics of the line and equipment.

When the duration of the variation is between 2 ms and 6 ms, maximum noise voltage is produced by superposition of both noises, one being produced at the beginning and the other at the end of the variation.

So far as the influence of variations on distortion are concerned, the FM system is less sensitive than the AM system. In the case of the AM system, a variation of 0.5 ms (where Δa is infinitive) caused a letter error.

According to the experiment on the N.T.T. AM system, variations (where Δa is infinitive) of 0.5 ms, 1 ms, and 4 ms have caused a letter error rate of 5%, 9% and 24%, respectively. This experiment was carried out according to the N.T.T. test text (see contribution to Question 18/IX from N.T.T.) under similar conditions to Ca_3, making 1000 variations in level. N.T.T. hopes that the data given above should be seriously considered in making recommendations on variations in level.

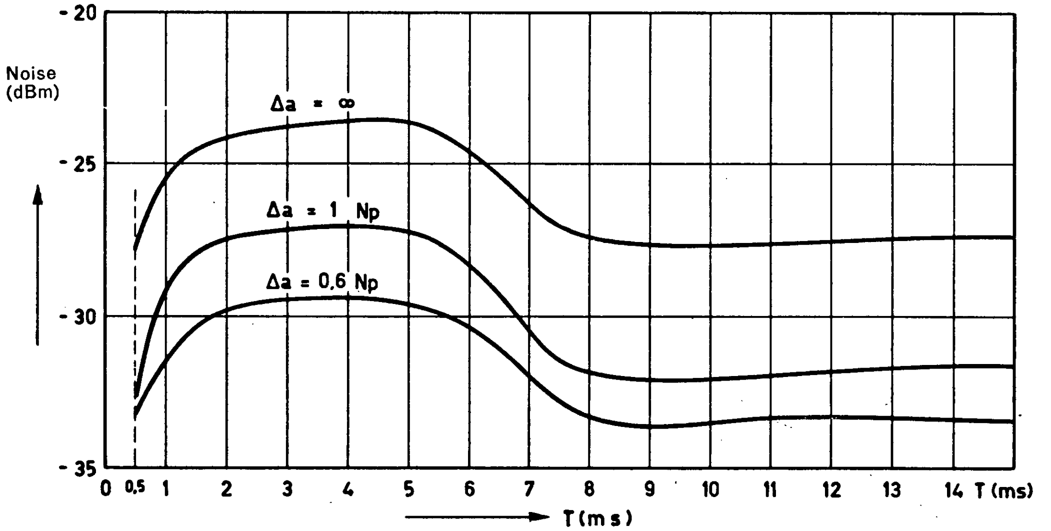


FIGURE 7

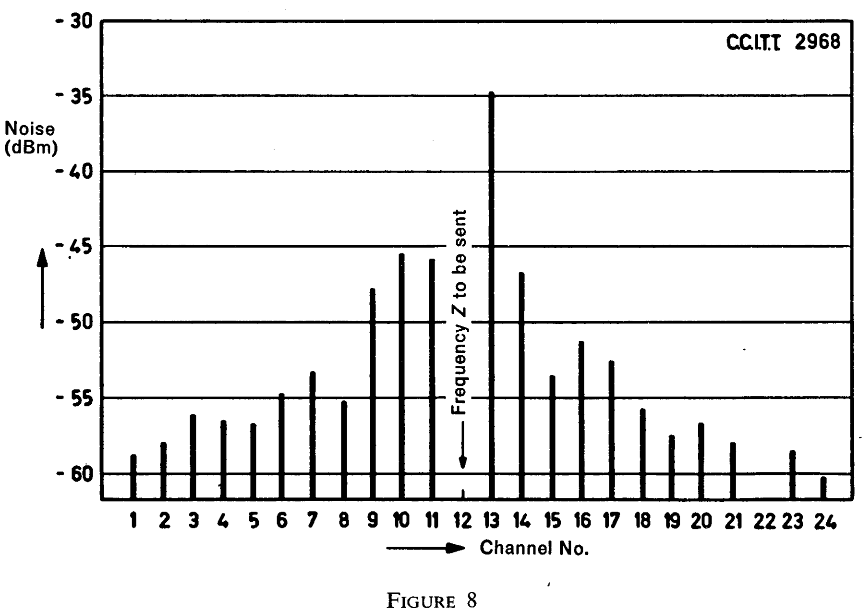


FIGURE 8

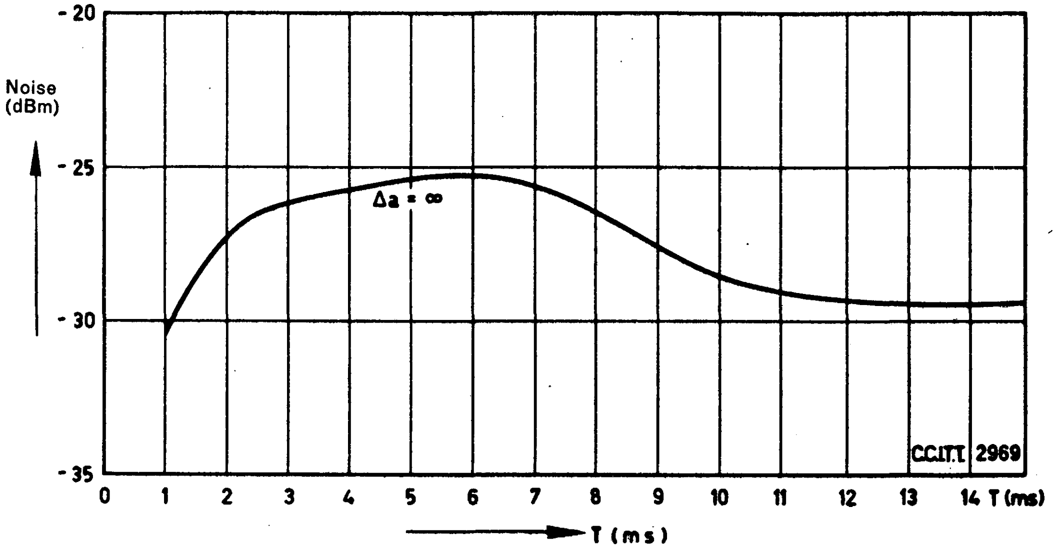


FIGURE 9

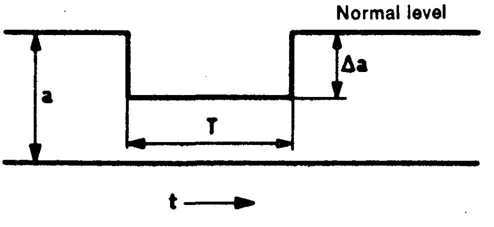


FIGURE 10

Supplement No. 5

FEDERAL REPUBLIC OF GERMANY *(Contribution COM IX—No. 13—October 1965)*

EFFECT ON TELEGRAPH DISTORTION OF SUDDEN CHANGE OF LEVEL

The German Administration submits the result of measurements carried out by Siemens & Halske and Standard Elektrik Lorenz AG in their voice-frequency telegraph systems.

C.C.I.T.T. first provides for 1:1 symmetrical signals without distortion to be used as test signals; later on they were changed to 2:2 signals in order to be able to carry out these measurements also with start-stop measuring equipment. All this time, however, both firms had already obtained results of measurements carried out with 1:1 signals. For this reason the studies were completed using 1:1 signals. However, the results measured for both types of test signals will probably show only negligible differences as in the case of a VFT system it may be assumed that the signal will about reach the steady state even in the case of 1:1 signals.

As far as it is possible to compare the results obtained by the two firms, they come more or less within the same order of magnitude. Both firms concurrently reached the conclusion that frequency-modulated VFT systems are less affected by sudden level variations than amplitude-modulated VFT systems. By thorough studies on the influence of neighbouring channels Standard Elektrik Lorenz AG obtained the surprising result that in the case of FMVFT channels the distortion does not steadily increase with the increasing duration T_U of the level decrease, but that the distortion fluctuates periodically.

Result of the measurements carried out by Siemens & Halske AG

In accordance with the measuring programme designed to supply comparable results as to the effect of sudden level variations on frequency-modulated and amplitude-modulated voice-frequency telegraphy, measurements were carried out using AMVFT 120 and FM 120 systems according to C.C.I.T.T. Recommendations R.31 and R.35 respectively. Some of the parameters of the measurements are supplemented by the following explanations:

1. *Frequency of the level variations*

In order to be able to record many level variations during a relatively short period of measurement, the number of variations per time-unit was selected higher than usual in normal circuits. The time spacing between the level variations was approximately 200 ms which ensured that one variation could occur in each character. Furthermore, care was taken not to synchronize the level variations with the test signals. Each point of measurement in the attached curves gives the maximum value of the individual distortion of signal elements measured in the course of approximately 1000 level variations.

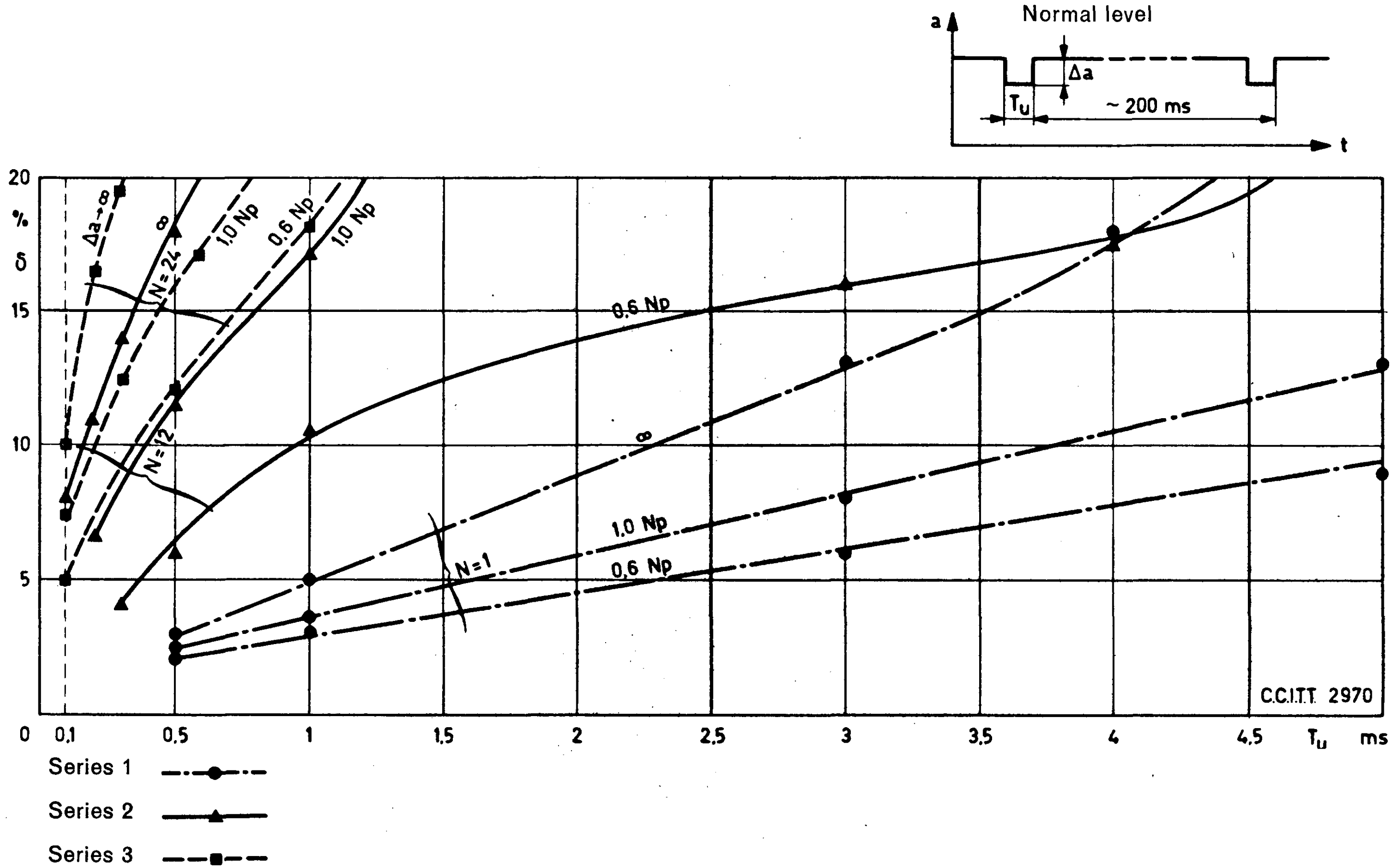


FIGURE 1 — **Individual distortion δ as a function of the duration T_U of sudden variation in level, variation in level Δa as a parameter**

Measured with 1/1 reversals at 50 bauds, in channel No. 12 of an AM voice-frequency telegraph system. Number of variations in level for each measured point is 1000.

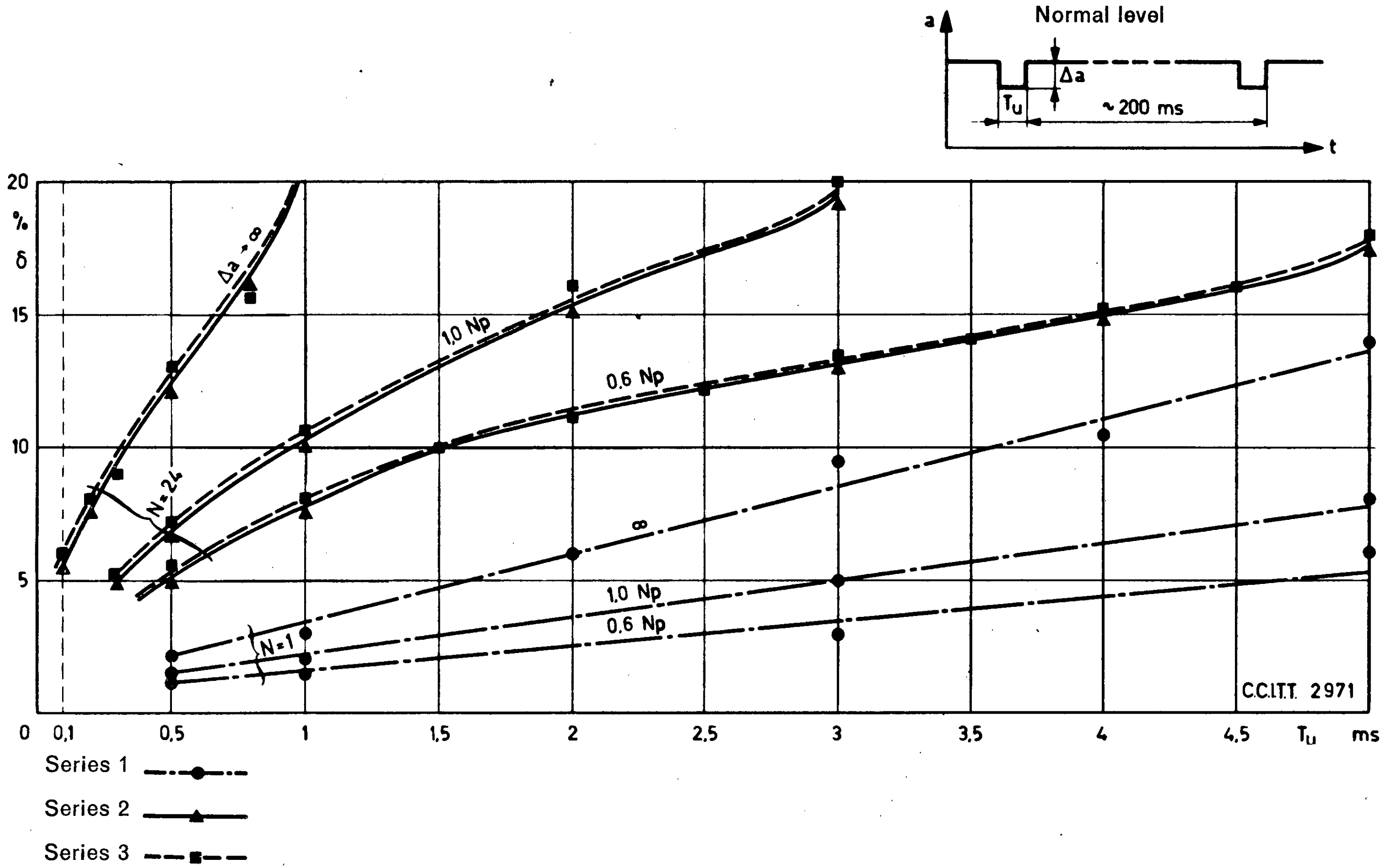


FIGURE 2 — **Individual distortion δ as a function of the duration T_U of sudden variation in level, variation in level Δa as a parameter**

Measured with 1/1 reversals at 50 bauds in channel No. 13 of an FM voice-frequency telegraph system. Number of variations in level for each measured point is 1000.

2. *Accuracy of measurements*

For the distortion measurements a telegraph distortion analyser was used. The distortion values were recorded in 1% steps. Taking into account the basic distortion of approximately 1% of VFT systems and of the measuring equipment, distortion measurements were accurate to within ± 2%.

The measured results are compiled in Figures 1 and 2. According to the operating conditions of the VFT channels these groups of curves were divided into three series of measurement. Series No. 1: measurements carried out on a single channel without any neighbouring channels; series No. 2: measurements carried out with alternating conditions in the neighbouring channels similar to like traffic, and series No. 3: measurements carried out with the most unfavourable conditions in the neighbouring channels.

The result is that the average influence of the level variations on the telegraph distortion is in the case of FMVFT systems only about half that of the influence in the case of AMVFT systems. As expected, the distortion is independent of the mean frequency of the channel if only one channel is in service (series No. 1). A comparison of series 2 and 3 shows that, contrary to the AMVFT systems, the degree of the telegraph distortion noticeable in FMVFT systems depends on the operating conditions of the neighbouring channels only to a very small degree.

Uniformly, the curves in Figures 1 and 2 were discontinued at a 20% distortion as individu l distortions exceeding 20% may bring about character errors because of the sensitivity threshold of the AMVFT system. In order to be quite sure to avoid character errors in the case of short level interruptions ($\Delta a \rightarrow \infty$), the duration of the interruption must not exceed 0.1 ms in the case of an AMVFT system whereas in the case of an FMVFT system 0.5 ms may be tolerated.

Result of the measurements carried out by Standard Elektrik Lorenz AG

1. *Object*

The tests were carried through in order to investigate the behaviour of VFT channels when sudden level variations occur in the channels. In addition these tests were to investigate the behaviour as a function of the following possible parameters:

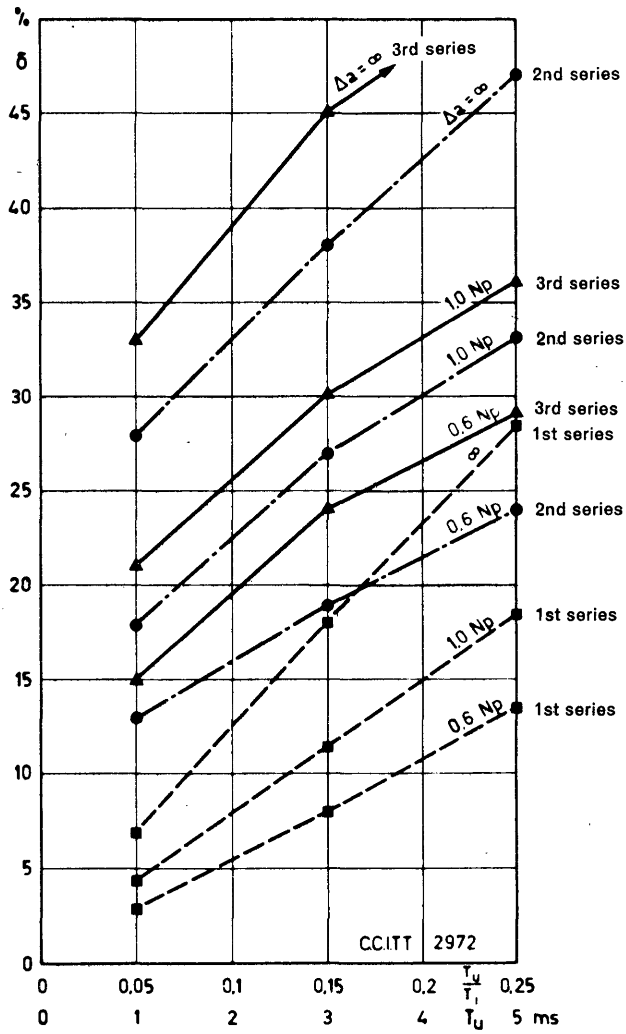
A. Signals in the test channel: e.g. reversals 1:1, 2:2

B. System-dependent parameters

1. Type of modulation: AM FM

2. Arrangement of channel frequencies, or bandwidth of channels: e.g. FM 240, FM 480

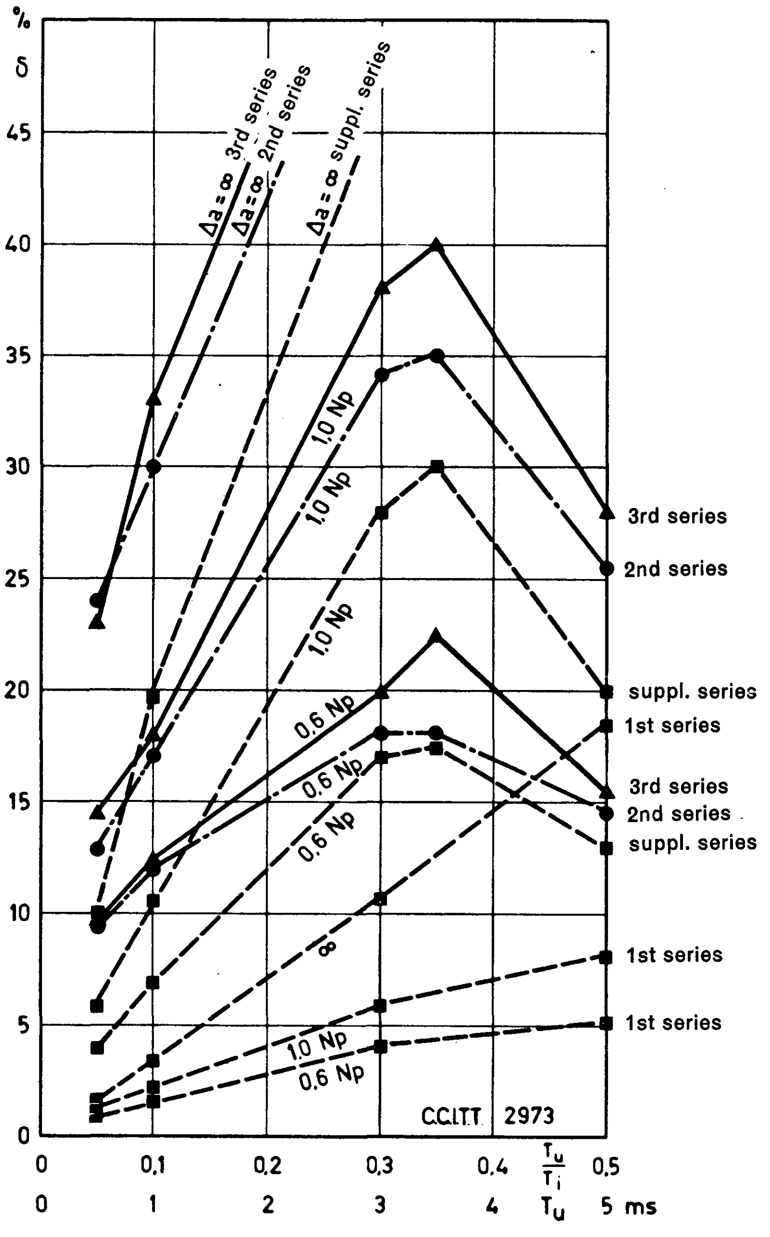
3. Filters connected in parallel: Filters in neighbouring channels connected and disconnected



Parameter: level variation Δa
Signals: 1:1 50 bauds

Voice-frequency telegraph system: AM 120 (Rec. R.31)
Channel under test: No. 12

FIGURE 1 — **Individual distortion δ as a function of the duration T_U of the sudden level variation**



Parameter: level variation Δa
Signals: 1:1 100 bauds
Voice-frequency telegraph system: FM 240 (Rec. R.37)
Channel under test: No. 6
Supplementary series: 2 neighbouring channels with frequency arrangement according to 3rd series

FIGURE 2 — **Individual distortion δ as a function of the duration T_U of the sudden level variation**

4. Operating conditions of the neighbouring channels: Permanent tone in the case of FMVFT, start-or-stop frequency; tone on or tone off in the case of AMVFT

5. Frequency allocation of the neighbouring channels

C. Parameters of the level variation

1. Duration T_U of the level variation, in the following called variation duration

2. Value Δa of the level variation

3. Moment of variation referred to the significant instants, in the following called variation phase

4. Moment of variation referred to the phase of the carrier voltage

2. *Methods of measurement*

The level variation was generated in the circuit by connecting and disconnecting a parallel resistance to the shunt resistor of a T-pad. This was achieved by a telegraph relay contact. The alteration of the line impedance caused by the connection in parallel was rendered ineffective for the VFT filters by means of a sufficiently large attenuation at both sides of the pad. The level variations were repeated periodically:

The repetition frequency was $f_p = \frac{1}{8\, T_i}$, T_i being the duration of the 1:1 element.

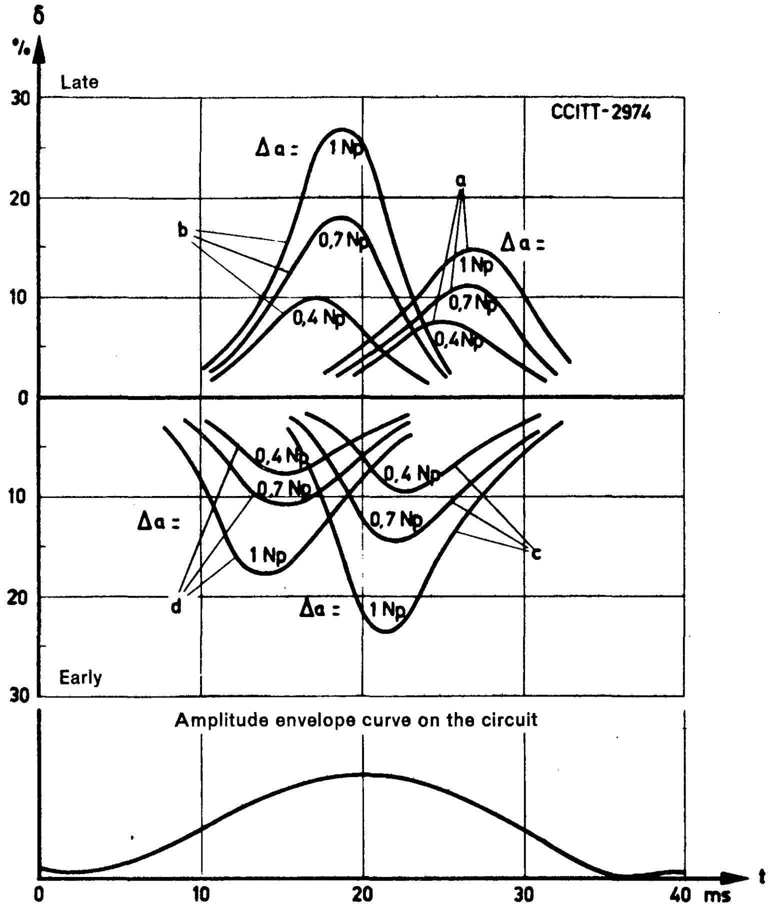
It was made sure that the transient had completely finished in the selective links of the VFT channel after eight times the duration of the unit element. The level variation was adjustable in steps to $a = 0.4$; 0.6; 0.7; 1.0; 1.5 and ∞. The variation duration T_U could be varied continually. Furthermore the variation phase could be continually varied (see Figures 3 to 5).

When the test channel was examined without any neighbouring channels, the variation phase was systematically adjusted in such a way that maximum telegraph distortion values were obtained. This most unfavourable phase depends on the variation duration T_U. Also in the presence of neighbouring channels the maximum distortions occur in the neighbourhood of this most critical variation phase as adjusted for the single channel (see Figures 6 and 7). For this most unfavourable variation phase the maximum distortions in the presence of neighbouring channels were determined by extending the observations over a sufficiently long period; though still lengthy, this statistical measurement was facilitated in so far as the influence of the variation phase was eliminated. All measurements were carried out with adjusted test channel, nominal modulation rate, nominal receiving level, and 1:1 signals. When signals other than 1:1 signals are used, basically different characteristics result which, however, were not further investigated.

3. *Result of the measurements*

In order to have a better check, the measurements required were carried out with different test channels of the same system.

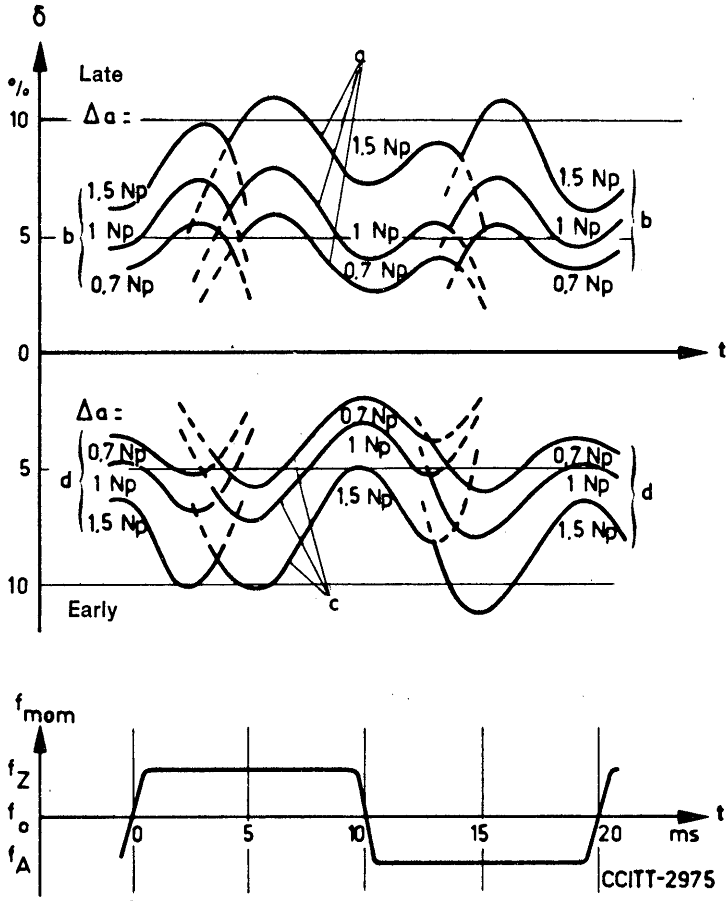
It was found that the measured results were independent of the mean frequency of the channel, a result which corresponds to the fact that the carrier phase of the test channel also has no influence on the distortions.



Parameter: level variation Δa
Signals: 1:1 50 bauds
Voice-frequency telegraph system: AM 120 (Rec. R.31).
Channel under test: No. 23
No neighbouring channels

Curves	Significant instant	Level variation
a	Z ⟶ A	decrease
b	A ⟶ Z	decrease
c	Z ⟶ A	increase
d	A ⟶ Z	increase

FIGURE 3 — **Individual distortion δ as a function of the phase of the sudden level variation with reference to the significant instants of the telegraphic modulation**

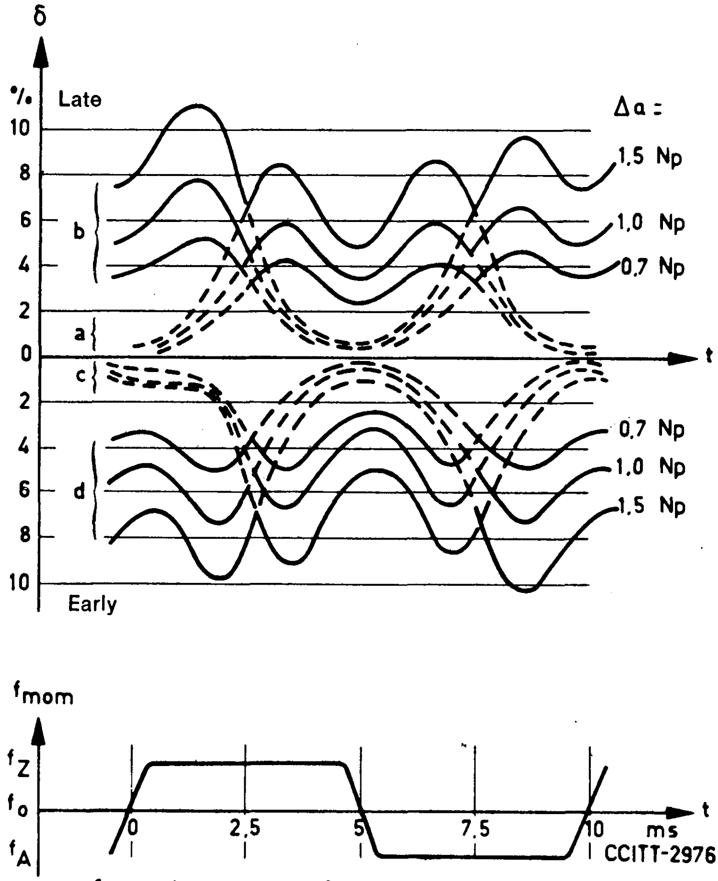


f_{mom} = instantaneous frequency on the circuit

Parameter: level variation Δa
Signals: 1:1 100 bauds
Voice-frequency telegraph system: FM 240 (Rec. R.37)
Channel under test: No. 12
No neighbouring channels

Curves	Significant instant	Level variation
a	Z ⟶ A	decrease
b	A ⟶ Z	
c	Z ⟶ A	increase
d	A ⟶ Z	

FIGURE 4 — **Individual distortion δ as a function of the phase of the sudden level variation with reference to the significant instants of the telegraphic modulation**

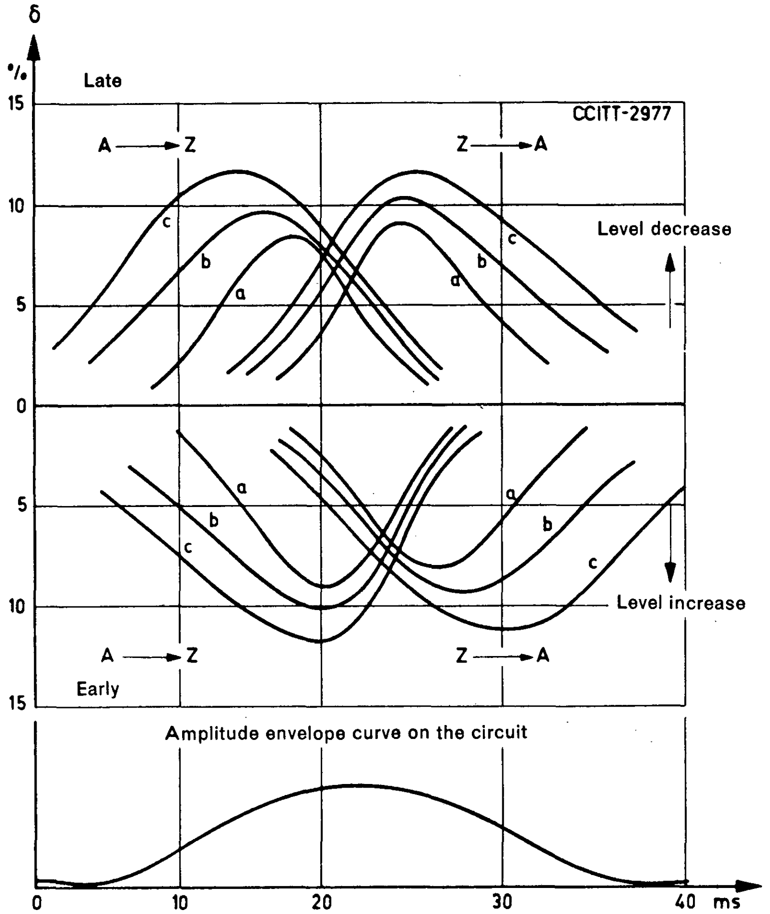


f_{mom} = instantaneous frequency on the circuit

Parameter: level variation Δa
Signals: 1:1 200 bauds
Voice-frequency telegraph system: FM 480 (Rec. R.38 A)
Channel under test: No. 4

Curves	Significant instant	Level variation
a	Z ⟶ A	decrease
b	A ⟶ Z	
c	Z ⟶ A	increase
d	A ⟶ Z	

FIGURE 5 — **Individual distortion δ as a function of the phase of the sudden level variation with reference to the significant instants of the telegraphic modulation**

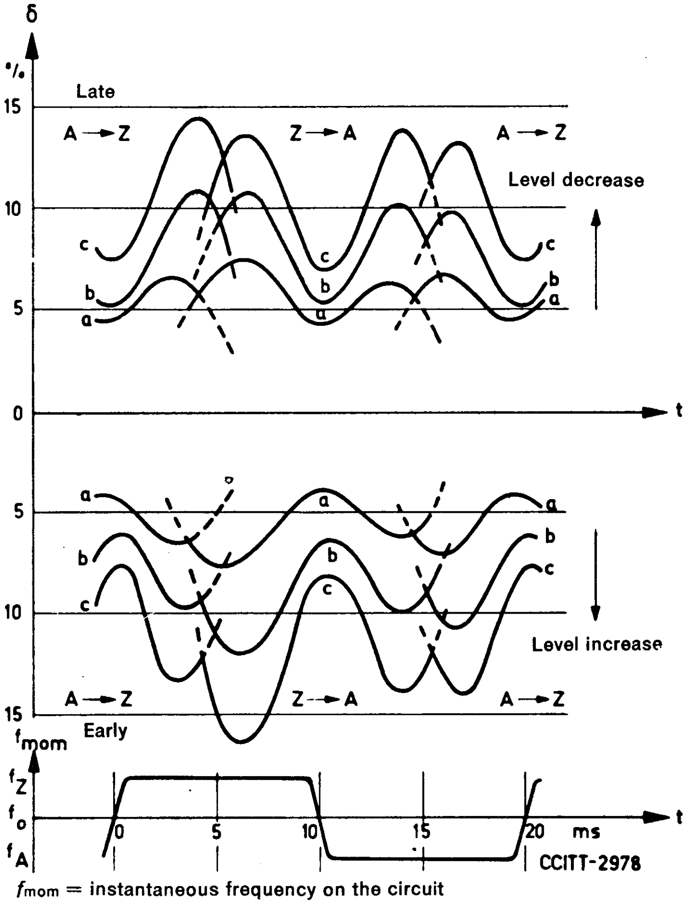


Signals: 1:1 50 bauds
Voice-frequency telegraph system: AM 120 (Rec. R.31)

Channel under test: No. 22
Level variation Δa: 0.4 Np

Curves	Neighbouring channels
a	
b	21
c	21+23

FIGURE 6 — **Individual distortion δ as a function of the phase of the sudden level variation with reference to the significant instants of the telegraphic modulation**



Signals: 1:1 100 bauds
Voice-frequency telegraph system: FM 240 (Rec. R.37)

Channel under test: No. 4
Level variation Δa: 1.0 Np

Curves	Neighbouring channels
a	
b	$\overleftarrow{5}$
c	$\overrightarrow{3}+\overleftarrow{5}$

FIGURE 7 — **Individual distortion δ as a function of the sudden level variation with reference to the significant instants of the telegraphic modulation**

In several test channels distortions were measured to spread $\pm 15\%$ from the mean value. This is a consequence of the inaccuracy of measurement and the VFT channel tolerances. In addition it was found that the (passive) filters of the neighbouring channels connected in parallel with the test channel has no influence on the behaviour of the test channel in the case of sudden level variations.

3.1 *The measuring programme desired by the C.C.I.T.T.*

The parameter values desired by the C.C.I.T.T. for tests on sudden level variations were as follows:

Value of variation: $a = 0.6; 1.0; \infty$ Np

Duration of variation: $T_U = 1; 3; 5$ ms

Condition of the neighbouring channels: all channels of the system connected in parallel

Series No. 1: neighbouring channels not in service

Series No. 2 and No. 3: part of the neighbouring channels with permanent tone (AMVFT systems), all neighbouring channels with permanent tone (FMVFT systems)

The results of the measurements have been plotted:

in Figure 1 for AM 120 channels

in Figure 2 for FM 240 channels

For the FM 120 system these points were not plotted because the behaviour of this system may be derived from the behaviour of the FM 240 system as will be shown later on.

Comparison between AMVFT system and FMVFT system in the measured range T_U:

In order to be able to compare the behaviour of the AMVFT and FMVFT channels in the case of sudden level variations, the duration of variation T_U has to be related to the bandwidth B, i.e. T_U has to be normalized to the channel transient time τ. For the purpose of simplicity T_U was normalized to the approximately proportional 1:1 unit element T_i and T_U/T_i was plotted as a second abscissa scale in Figures 1 and 2.

This comparison shows that when the test channel is operated without neighbouring channels (series No. 1) and the value of T_U/T_i remains unaltered the following equation applies for the distortions:

$$\frac{\delta \text{AM}}{\delta \text{FM}} \approx 3$$

When it is operated with neighbouring channels (e.g. series No. 3) the result is correspondingly:

$$\frac{\delta \text{AM}}{\delta \text{FM}} \approx 1.6$$

When subtracting the measured results of series No. 1 from those of series No. 3, it is found that the influence of the interrupted neighbouring channels by itself is about the same for AMVFT and FMVFT systems.

3.2 *Additional tests*

More detailed measurements were primarily carried out for the FMVFT systems as their behaviour is less known.

3.2.1 *Dependence of the distortions on the variation phase*

For these measurements the duration of the variation was selected big enough to allow for the transient initiated by the first level variation in the test channel to be entirely completed by the moment the transient starts in the opposite direction. This clearly shows the influence of the two sudden variations on the positive and negative sides of the double-circuit signal at the receiver output.

The result of these measurements is shown

in Figure 3 for AM 120 channels

in Figure 4 for FM 240 channels

in Figure 5 for FM 480 channels

The direction in which the zero-axis crossing of the double-current signal is displaced, is reversed according to whether the level is increased or decreased. Depending on the variation phase it is the positive or the negative side of the signal which is displaced more.

In the AMVFT system there is one maximum distortion for each direction of level variation and for each side of the signal; in the case of the FMVFT systems there are two. For the different FMVFT systems the maximum distortion values are about the same, for the AMVFT system they are about 2.5 times as high as those of the FMVFT systems.

Figures 6 and 7 give the results of the relevant measurements carried out on AM 120 and FM 240 channels respectively with one or two neighbouring channels being in service. They show that the most unfavourable variation phases (for maximum distortions) differ only slightly whether the test channels are operated with or without neighbouring channels.

3.2.2. *Dependence of the distortions on the variation duration in the case of FMVFT systems*

When thoroughly investigating the measured results given in Figure 2 for FM 240 channels it is striking that the distortions increase as a function of T_U if the test channel is operated without any neighbouring channels, and that on the other hand it has a maximum at $T_U \approx 3.5$ ms (except for $\Delta a = \infty$) if there are any neighbouring channels being operated at that time. For this reason the dependence of the distortions on the variation duration of T_U was further investigated for $\Delta a =$ 0.6 Np and was represented in Figure 8:

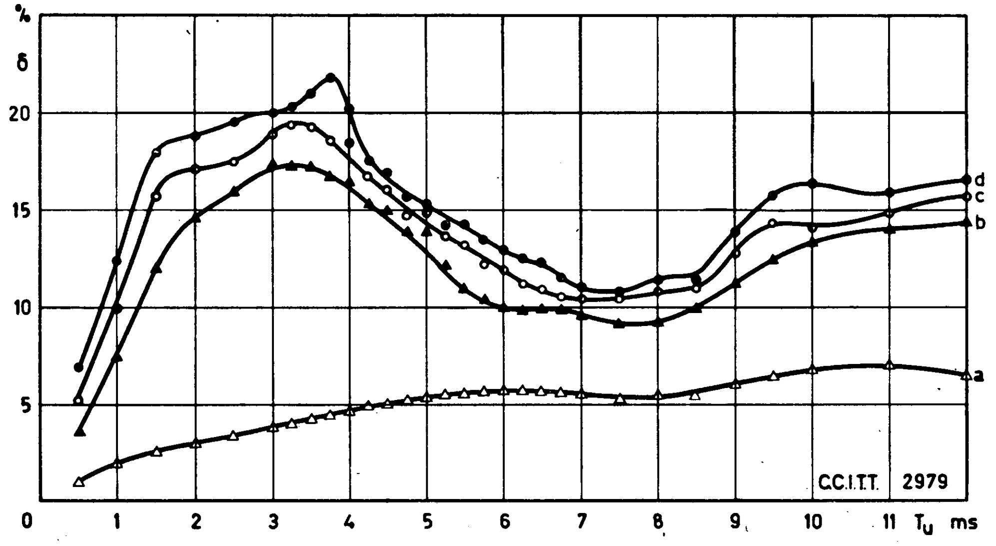
a) for the test channel without the influence of any neighbouring channel (curve a)

b) with the two immediately adjacent channels each of them operated with that characteristic frequency which is nearer to the channel under test (curve b)

c) with 4 neighbouring channels, the two adjacent channels on each side and operated with those characteristic frequencies which are nearer to the channel under test (curve c)

d) with all 11 neighbouring channels according to series 3 (curve d)

Curve a shows a monotone increase of the distortions with a weakly marked minimum at $T_U = 8.5 \ldots 8$ ms. For two adjacent channels (curve b) the distortions reach a marked (first) maximum at $T_U \approx 3.5$ ms after an initial linear increase. A minimum follows approximately at the same point as in curve a, then the curve rises again. A periodical repetition of this fluctuation with a period of $T \approx 10$ ms may be expected for a larger variation duration T_U.

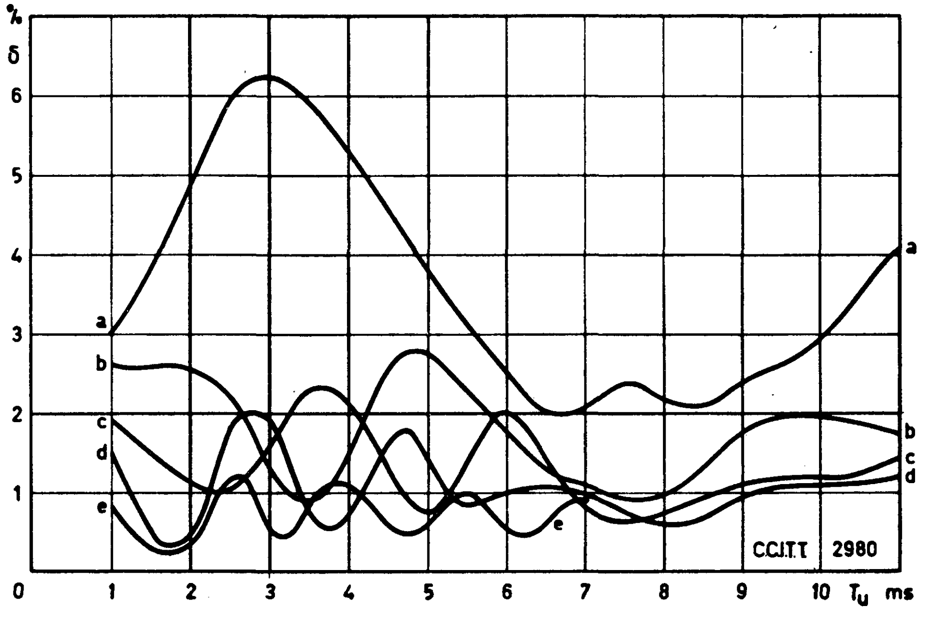


Signals: 1:1 100 bauds
Voice-frequency telegraph system: FM 240 (Rec. R.37)

Channel under test: No. 6
Level variation Δa: 0.6 Np

Curves	Neighbouring channels
a	
b	$\overrightarrow{5}+\overleftarrow{7}$
c	$\overrightarrow{4}+\overrightarrow{5}+\overleftarrow{7}+\overleftarrow{8}$
d	$\overrightarrow{1}+\overrightarrow{2}+\overrightarrow{3}+\overrightarrow{4}+\overrightarrow{5}+\overleftarrow{7}+\overleftarrow{8}+\overleftarrow{9}+\overleftarrow{10}+\overleftarrow{11}+\overleftarrow{12}$

FIGURE 8 — **Individual distortion δ as a function of the duration T_u of the sudden level variation**



Signals: 1:1 100 bauds
Voice-frequency telegraph system: FM 240 (Rec. R.37)

Channel under test: No. 6
Level variation Δa: 0.6 Np

Curve	Neighbouring channels	Distance (Hz)
a	$\overleftarrow{7}$	180
b	$\overrightarrow{7}$	300
c	$\overleftarrow{8}$	420
d	$\overrightarrow{8}$	540
e	$\overleftarrow{9}$	660

FIGURE 9 — **Individual distortion δ as a function of the duration T_u of the sudden level variation**

A similar structure is shown by curves c and d representing additional more distant neighbouring channels being connected in parallel. However, smaller distortion variations with smaller periods seem to be superimposed. This means that from all the neighbouring channels the two adjacent ones have the biggest influence on the distortions.

The influence of the individual neighbouring channels was investigated in detail. For this purpose only the frequency of a single neighbouring channel was applied to the circuit at a time. Thus the distance of these channel frequencies from the midband frequency of the test channel was:

$f = 180\ \text{Hz} + n \cdot 120\ \text{Hz}$ (for FM 240 channels)

$= \underbrace{180 \quad 300}$	$\underbrace{420 \quad 540}$	660 Hz
1st upper neighbouring channel	2nd upper neighbouring channel	3rd neighbouring channel
$f_Z \quad f_A$	$f_Z \quad f_A$	f_Z

For each measurement only the distortion values resulting for the test channel itself were subtracted from the total distortions. The result is given in Figure 9. It represents the sole influence of the individual frequencies of the neighbouring channels. It was found that it is of no importance which is the midband frequency of the test channel and whether the frequencies are below or above the test channel; the only important factor is their distance from the midband of the test channel.

As shown in Figure 9 the distortions caused by sudden level variations of a neighbouring frequency periodically fluctuate with the variation duration. The more distant the frequencies are from the test channel, the smaller are the periods and amplitudes of these fluctuations. The dominant factor is the distortion caused by the nearest neighbouring frequency.

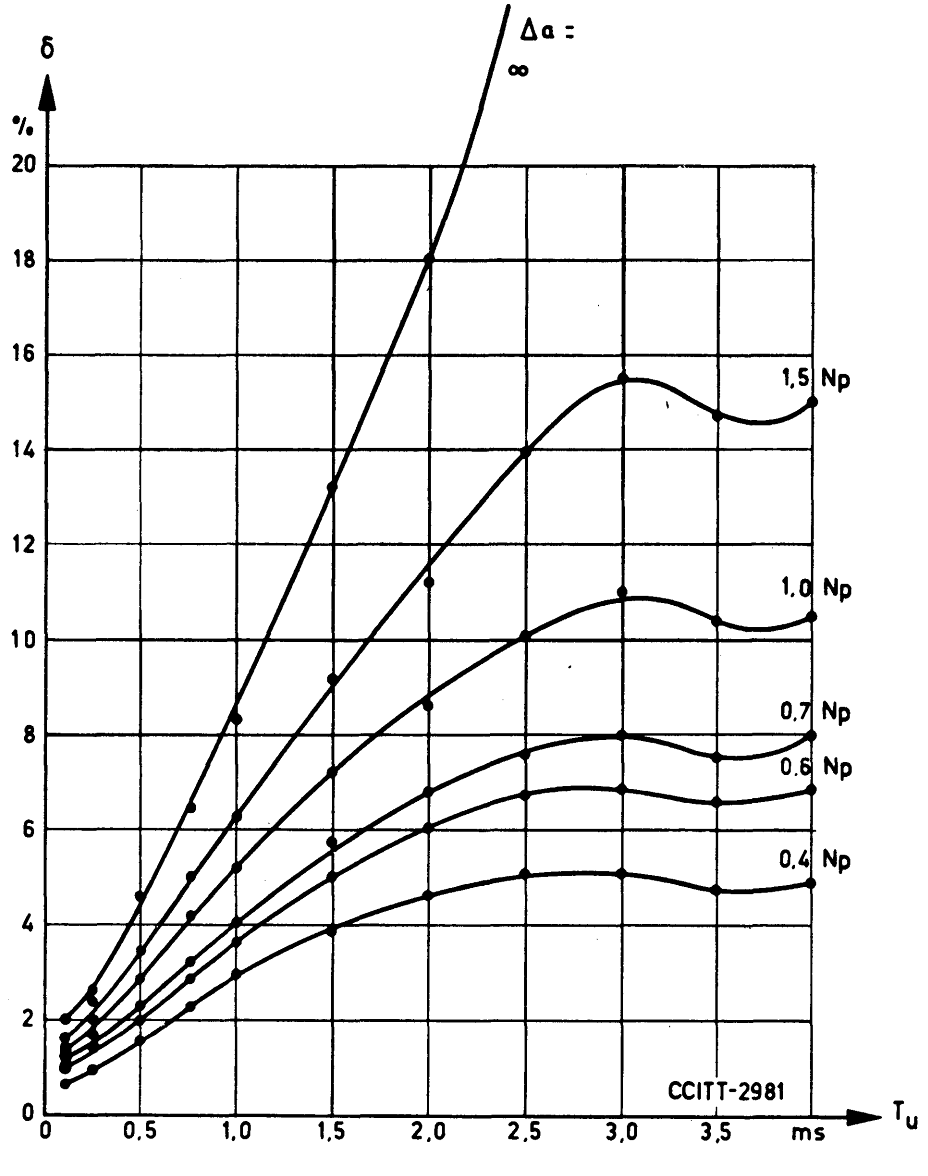
This result explains the shapes of curves c and d in Figure 8; they may also be achieved by superimposing the shares of the individual neighbouring frequencies according to Figure 9. A comparison of curves a and b in Figure 9 shows that at least in the case of the immediately adjacent channels the characteristic frequency which is nearer to the test channel is more critical than the more distant one. However, the ratio of the distortions is not constant for the two frequencies but depends on the variation duration.

3.2.3 *Comparison of different FM VFT systems*

Figures 10 to 12 illustrate for the FM 480 system the result of measurements similar to those given in Figure 8 for FM 240, only with a bigger duration T_U, but for different values Δa of the level variation. The measured curves show the same shape independently of the number of neighbouring channels in service.

It is striking that in the FM 480 system the maximum and minimum values of distortion appear in the individual curves at half the variation duration of the relevant curves in the FM 240 system.

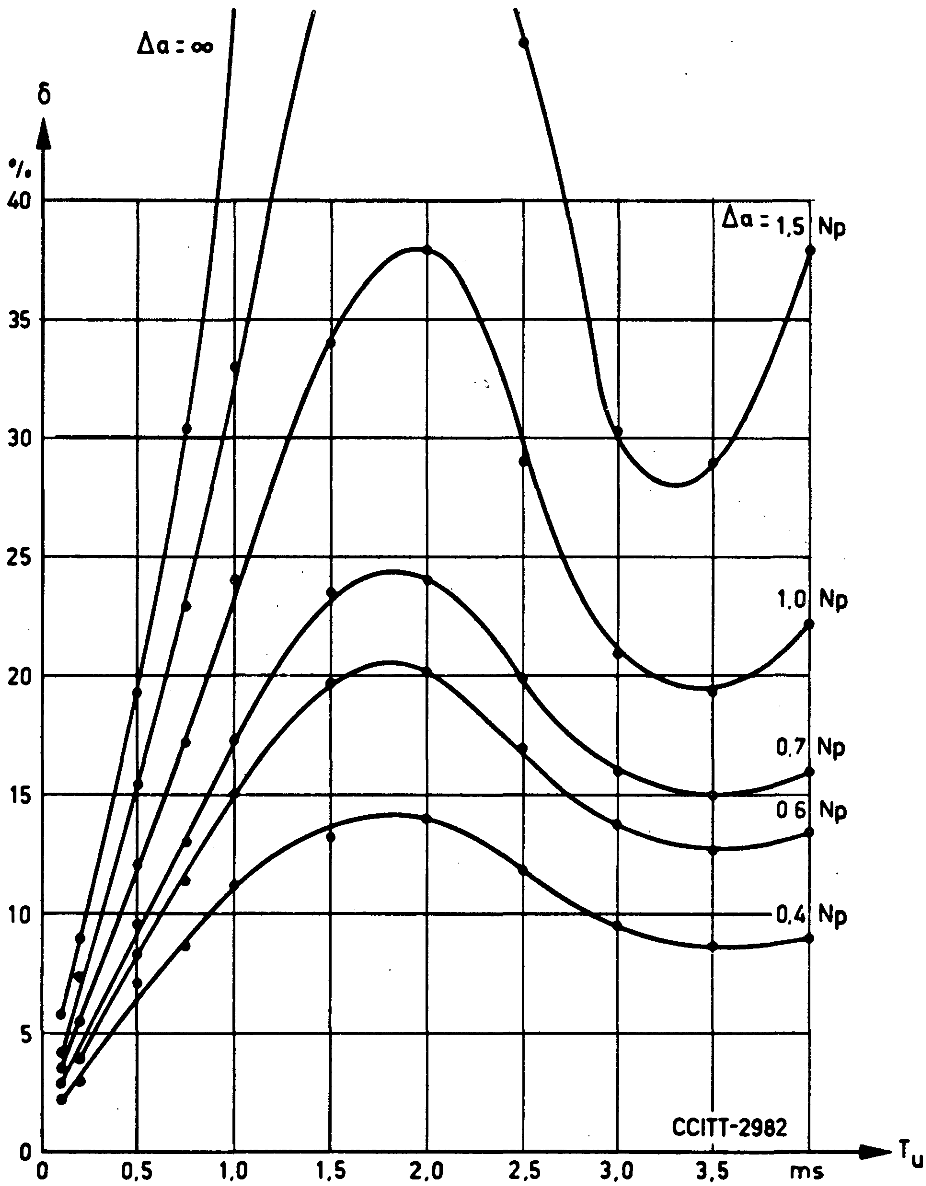
By normalizing the variation duration T_U to the 1:1 basic element $T_i = \frac{1}{v_0}$ (v_0 = nominal modulation rate), a direct comparison of the behaviour of FM 240 and FM 480 channels becomes feasible. To be quite exact T_U should be normalized to the transient period $\tau = \frac{1}{B}$ (B = bandwidth) of the VFT channel in question; for simplification the basic element was chosen as normalizing unit. No mistake results if in the VFT systems to be compared $\tau \sim T_i$ and $B \sim v_0$.



Signals: 1:1 200 bauds
Parameter: level variation Δa
Voice-frequency telegraph system: FM 480 (Rec. R.38 A)

Channel under test: No. 4
No neighbouring channels

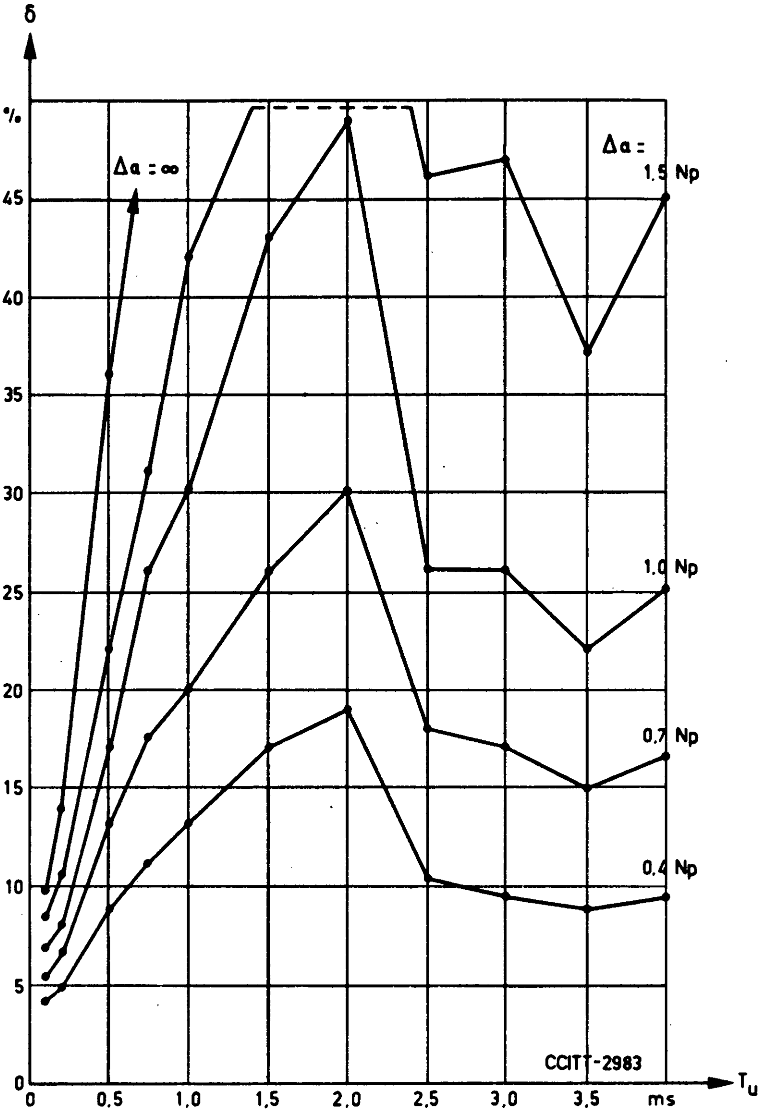
FIGURE 10 — **Individual distortion δ as a function of the duration T_u of the sudden level variation**



Parameter: level variation Δa
Signals: 1:1 200 bauds
Voice-frequency telegraph system: FM 480 (Rec. R.38 A)

Channel under test: No. 4
Neighbouring channels: $\overrightarrow{3}+\overleftarrow{5}$

FIGURE 11 — **Individual distortion δ as a function of the duration T_u of the sudden level variation**

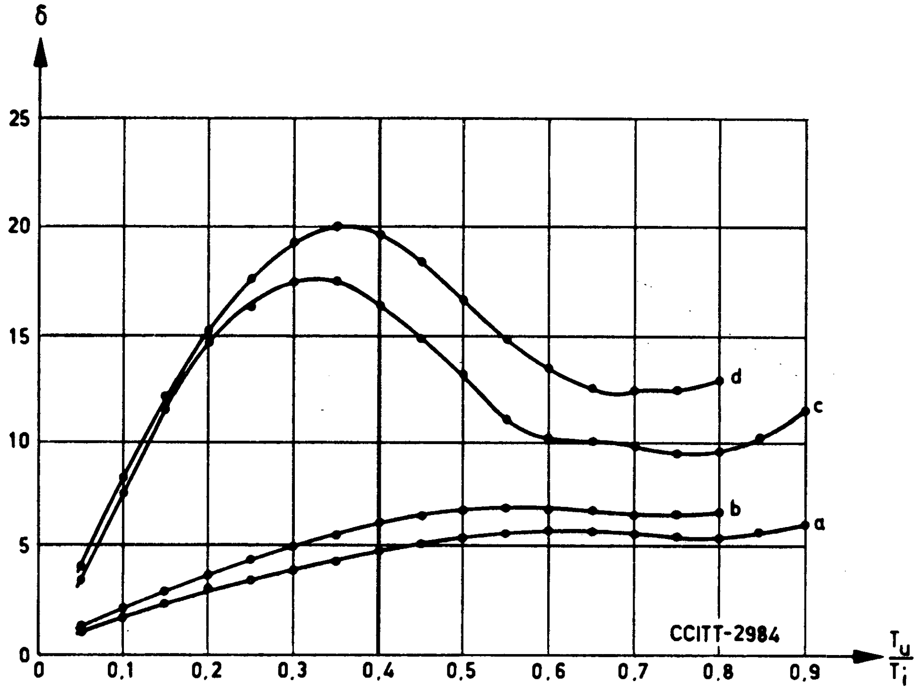


Parameter: level variation Δa
Signals: 1:1 200 bauds
Voice-frequency telegraph system: FM 480 (Rec. R.38 A)

Channel under test: No. 4
Neighbouring channels: $\overrightarrow{2}+\overrightarrow{3}+\overleftarrow{5}+\overleftarrow{6}$

FIGURE 12 — **Individual distortion δ as a function of the duration T_u of the sudden level variation**

The curves showing these comparisons are given in Figure 13. They indicate the same shape as a function of the normalized variation duration. Bigger distortions were found in the FM 480 channel, due on the one hand to manufacturing tolerances and on the other hand to the fact that the ratio of the bandwidths of the FM 480 and FM 240 channels under test is not exactly 2:1.



Level variation: 0.6 Np

Voice-frequency telegraph system:	FM 240 (Rec. R.37)	FM 480 (Rec. R.38 A)
Signals 1:1	100 bauds	200 bauds
Unit interval T_i	10 ms	5 ms
Without neighbouring channels	curve a	curve b
With two neighbouring channels	curve c	curve d

FIGURE 13 — **Individual distortion δ as a function of the normalized duration T_u/T_i of the sudden level variation**

3.2.4 *Dependence of the distortions on value Δa of the sudden level variation in the case of FMVFT systems*

In Figures 14 and 15 the distortions are plotted as a function of value Δa of the level variation for FM 480 channels. For small values of T_U they show a monotone increase with Δa. They remain finite even when they fall below the sensitivity threshold of the VFT receiver, i.e. for $\Delta a > 2.7$ Np (represented by the points $\Delta a = \infty$). This means that the VFT receiver suppresses line interruptions if these are short enough. Without any neighbouring channels the time limit is about

$$\frac{T_U}{T_i} = 0.25 \ldots 0.3$$

($T_U = 2.5 \ldots 3$ ms for FM 480).

For operation with 2 or more neighbouring channels it is below $\frac{T_U}{T_i} = 0.1$. For bigger durations of complete interruptions the distortion as a function of T_U shows a quick and monotone increase to 100%. Beside this the curves reflect the dependence of the distortions on the variation duration as illustrated in Figures 10 to 12.

4. *Conclusion*

This is to give a short summary of the most important results of the tests.
Dependence of the distortions on the parameters given in paragraph 1.

A. Kind of test signal: affects the effects of the level variation.

B. 1. Type of modulation: AMVFT systems are more sensitive to sudden level variations than FMVFT systems.

2. Bandwidth of the channels: is fundamentally without influence on the maximum distortions as long as the relation between transient period and basic element τ/T_i remains constant. When the bandwidth is doubled, the same distortion values are measured for half the variation duration T_U.

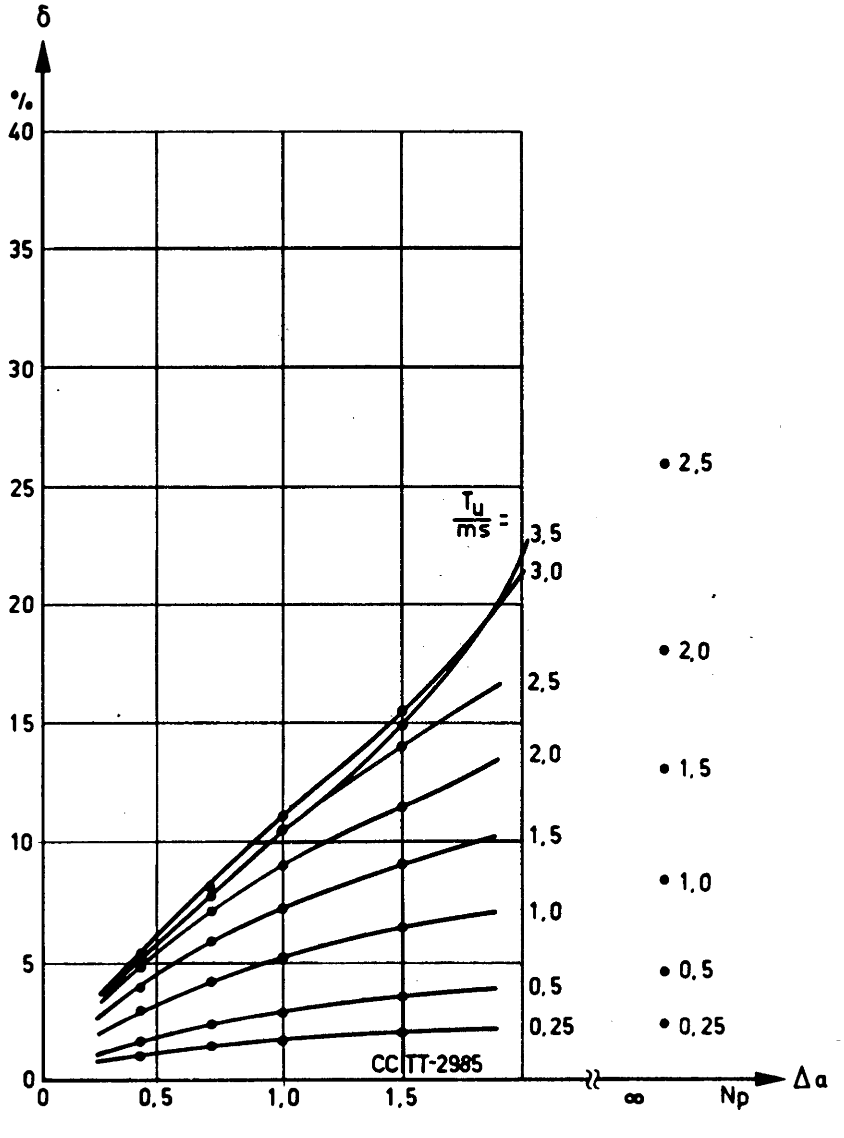
3. Neighbouring filters connected in parallel: Do not affect the behaviour of the VFT channel.

4. Operating conditions of the neighbouring channels: See 5.

5. Frequency allocation of the neighbouring channels: The absolute frequency of the neighbouring channel has no influence. The only important factor is the distance of the neighbouring frequency from the mean frequency of the test channel. The more this distance increases, the smaller the influence of the neighbouring frequency becomes.

C. 1. Variation duration T_U:

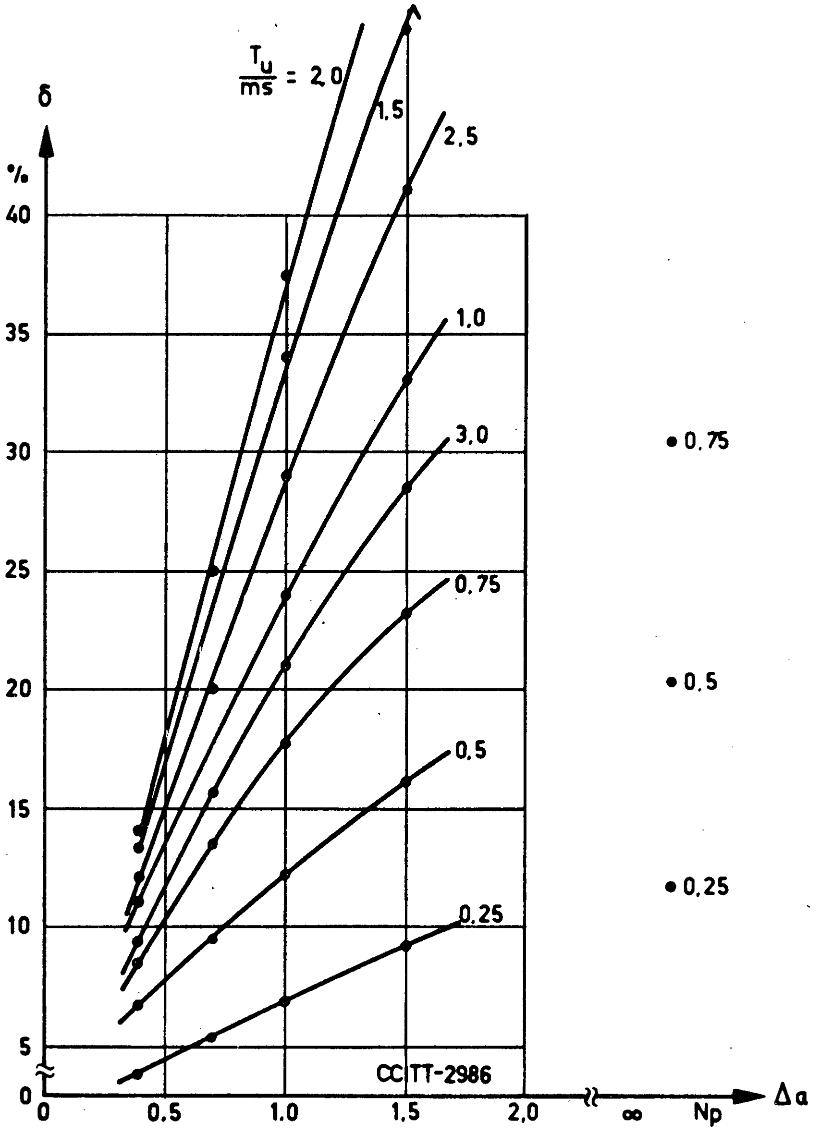
a) Test channel without neighbouring channels:
Essentially the distortions show a monotone increase as a function of T_U in the measured range.



Parameter: duration T_u
Signals: 1:1 200 bauds
Voice-frequency telegraph system: FM 480 (Rec. R.38 A).

Channel under test: No. 4
No neighbouring channels

FIGURE 14 — **Individual distortion δ as a function of the variation Δa of the sudden level variation**



Parameter: duration T_u
Signals: 1:1 200 bauds
Voice-frequency telegraph system: FM 480 (Rec. R.38 A)

Channel under test: No. 4
Neighbouring channels: $\overrightarrow{3}+\overleftarrow{5}$

FIGURE 15 — **Individual distortion δ as a function of the variation Δa of the sudden level variation**

b) Test channel with neighbouring channels in FMVFT systems:
For a rather small variation duration linear increase of the distortions, for bigger values of T_U periodical fluctuations of the distortions the period and the fluctuation amplitudes being determined by the nearest neighbouring channels.

2. Value Δa of level variation:

The distortions show a monotone increase as a function of Δa. Limit value of the distortions when the level falls below the sensitivity threshold of the VFT receiver ($\Delta a \rightarrow \infty$)
for small values of T_U: finite
for bigger values of T_U: 100%
i.e., erroneous signals occur.

3. Variation phase:

The degree of the distortions depends on the phase of the variation referred to the significant instant. Marked maximum distortions occur as a function of the variation phase.

4. Beginning of the variation referred to the phase of the carrier voltage in the test channel: Without influence on the distortions, i.e. the results are independent of the absolute frequency of the test channel.

Finally we want to remark that, as shown by the results of the measurements, it is not possible to cover the maximum distortions caused by sudden level variations for all VFT systems in general, especially in the presence of neighbouring channels, by using the values proposed by the C.C.I.T.T. in document COM IX-No. 51 for the variation duration, i.e. $T_U = 1; 2; 3$ ms.

Supplement No. 6

FRANCE *(Contribution COM IX—No. 40—May 1967)*

EFFECT ON TELEGRAPH DISTORTION OF SUDDEN CHANGES OF LEVEL

I. *Introduction*

The French Administration herewith submits the results of measurements carried out on voice-frequency telegraph channels with 100-baud and 200-baud frequency modulation, the purpose of which was to show the effect on telegraph distortion of sudden changes of level.

The measurement conditions were those recommended by the C.C.I.T.T. The channels concerned were placed in an ordinary telegraph rack; the input and output of the channel coupler were connected by a quadripole with 600 ohms impedance in which the attenuation was varied.

The changes in level considered were: $\Delta a = 0.25-0.4-0.7-1$ Np$-\infty$. The duration T of these variations was: $0.2-0.25-0.5-0.7-1-3-5$ ms. The frequency of occurrence was eight times more than the duration of a modulating element. The variations were not, of course, synchronized with transitions in the modulation transmitted.

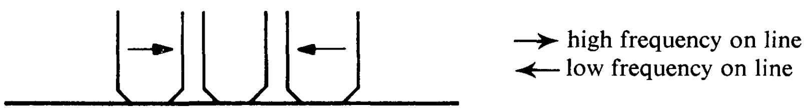
Bias distortion was eliminated and the maximum isochronous distortion observed on 2/2 signals was noted in respect of 1000 to 1500 sudden changes in level.

II. *100-baud channels*

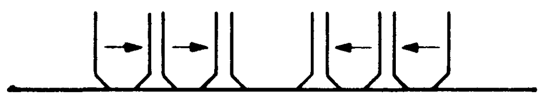
The measurements were made on Nos. 4, 5 and 6, 100-baud channels. Several series were carried out to assess the influence of neighbouring channels on distortion.

1st series: the channel measured was alone in the rack.

2nd series: the channel measured was placed in a group of 100-baud voice-frequency channels.



3rd series: the 100-baud channel was placed in a 50-baud channels group

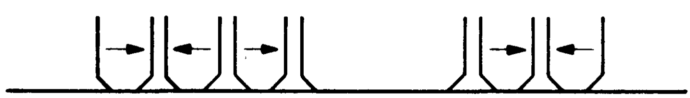


III. *200-baud channels*

The 200-baud channels tested were Nos. 3 and 4. Two series of measurements were made.

1st series: the test channel was alone in the rack.

2nd series: the channel was placed in a 50-baud channels group.

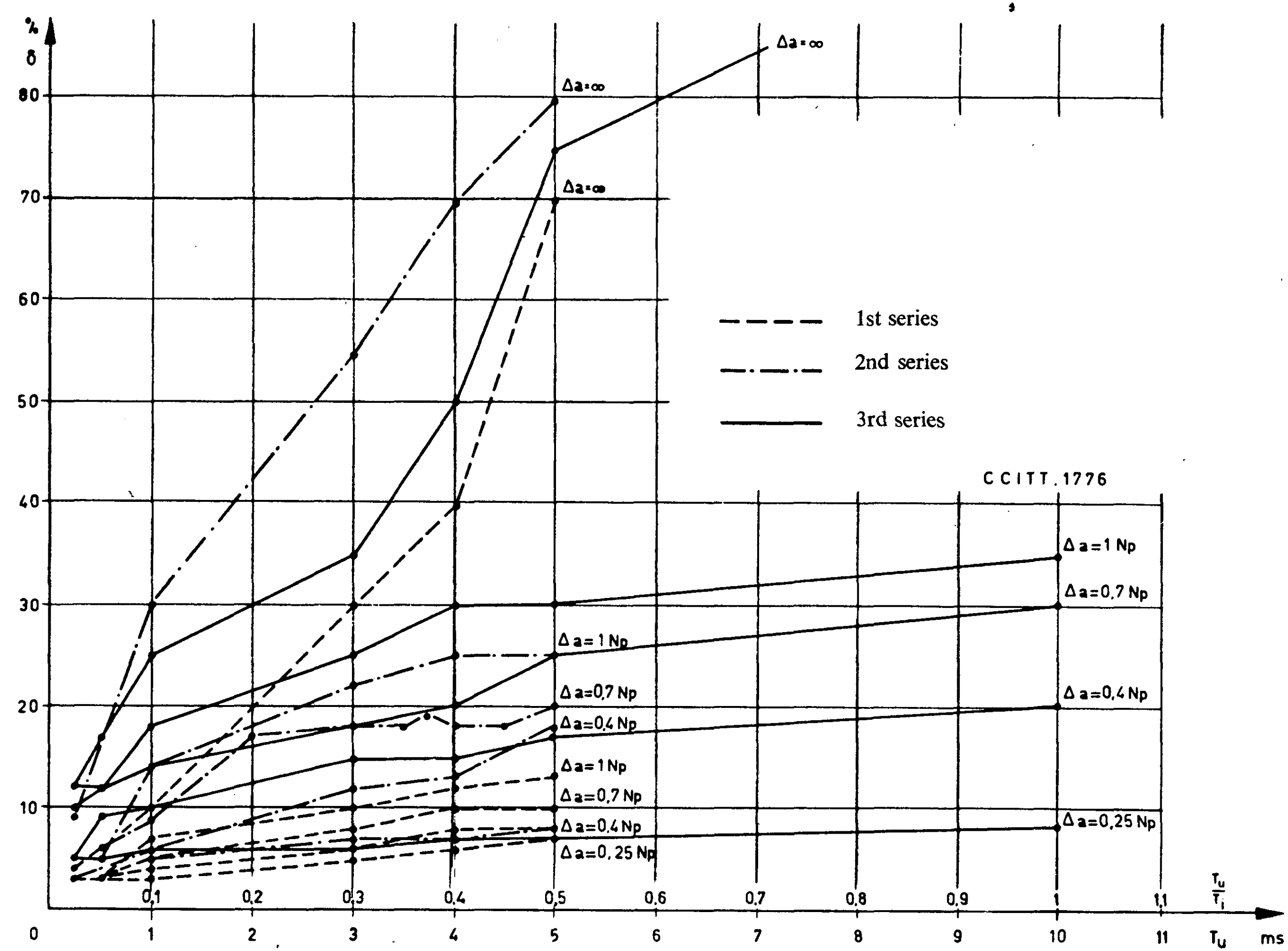


IV. *Conclusion*

These tests thus confirm previous observations, i.e.:

— distortion is hardly influenced by the number of channels but is greatly affected by the condition of neighbouring channels. It increases with the proximity of the frequencies transmitted on these neighbouring channels to the centre frequency of the test channel.

— distortion is a monotone function of the amplitude of the variation in level. It is not possible, however, to conclude from these tests that distortion fluctuates periodically as a function of the duration of the variation in level. In these measurements distortion occurs as a monotone function of the duration of the variation.



Isochronous distortion according to the duration of the level variation

FIGURE 1 — **VF telegraph system with FM 100-baud channel No. 5**

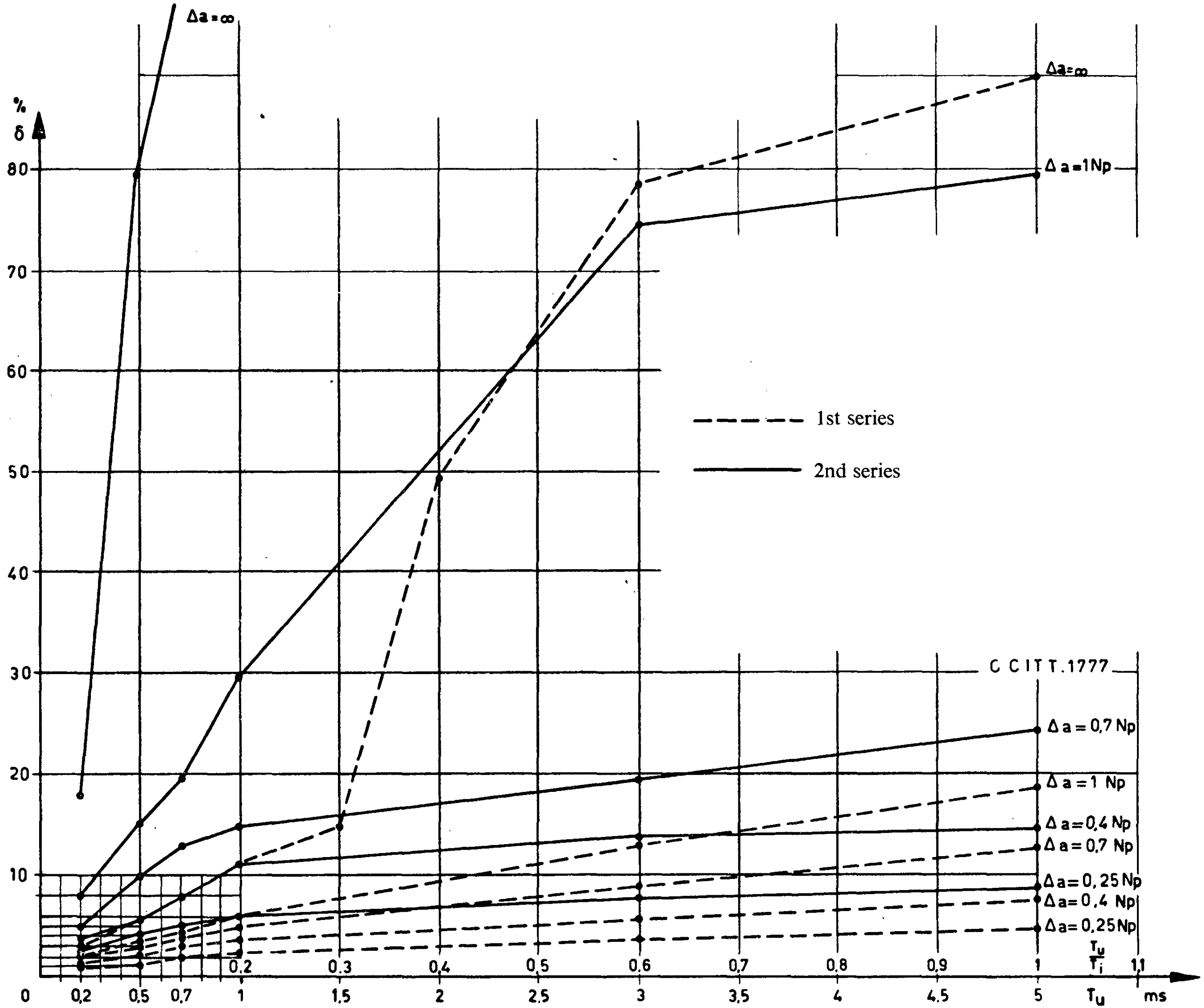


FIGURE 2 — **VF telegraph system FM 200-baud channel No. 4**

Supplement No. 7

TELE-SIGNAL CORPORATION (U.S.A.) *(Contribution COM IX—No. 50—March 1968)*

COMBINED OPERATION OF A 1200-2400-BAUD DATA TRANSMISSION CHANNEL AND SEVERAL 50-75-BAUD TELEGRAPH CHANNELS IN A SINGLE VOICE-BAND

1. For economical reasons it is desirable to combine on leased cable circuits a number of telegraph channels along with a 1200-2400-baud data channel.

2. The standardized 600-1200-baud modem according to Recommendation V.23 may be combined with a number of lower-speed frequency-modulated telegraph channels specified under Recommendations R.35 and R.36.

3. A preferred method of operation is to allocate five 50-75-baud channels (1-5) below and five 50-75-baud channels (18-22) above the spectrum occupied by the 600-1200-baud modem centred on 1700 Hz as shown in Figure 1 b.

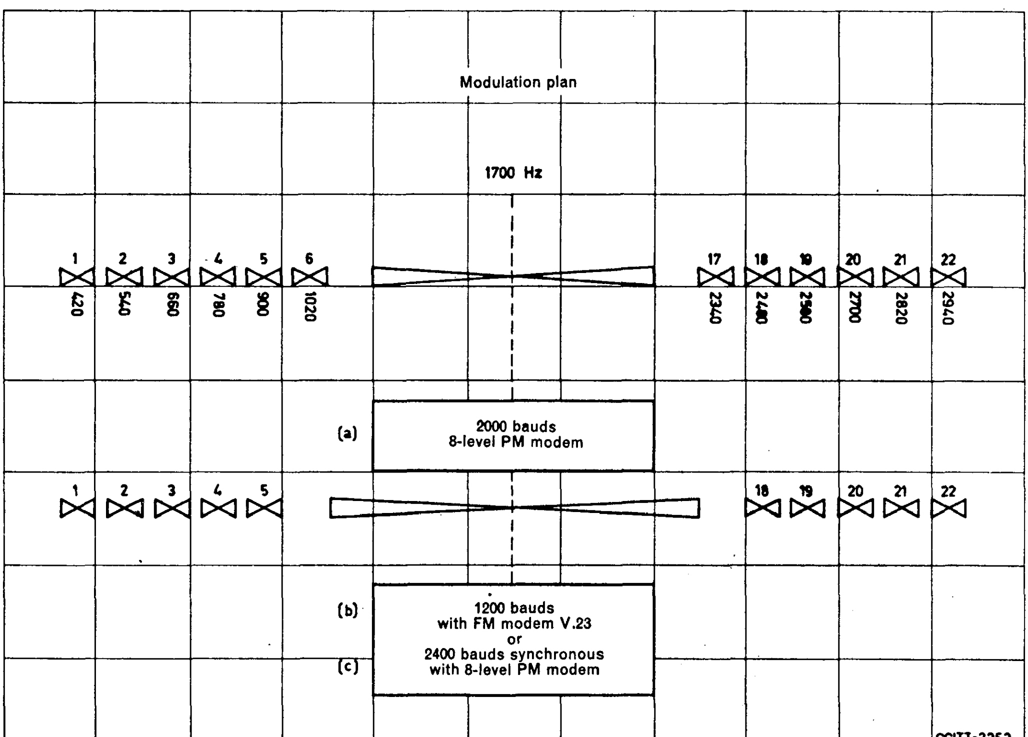


FIGURE 1 — **Combined operation of FMVFT 50-75 bauds and 1200, 2000 or 2400 bauds on one voice-channel**

Assuming the bandpass filters for the 600-1200-baud modem are made with adequate attenuation characteristics, there will be little interference between the channels.

This has been proved by thorough testing and also by practical operation on long-haul cable circuits.

4. Improvements in bandpass filter production allow the nominal 50-baud channels to be operated at 75 bauds with only a negligible increase of distortion of about 2%.

5. By using multi-level phase modulation, speeds higher than 1200 bauds are possible in the available spectrum centred on 1700 Hz.

For example (Figure 1 a), with eight-phase modulation it is possible to operate synchronously at 2000 bauds along with twelve 50-75b-aud channels on the same voice-channel. Synchronous operation at 2400 bauds is possible along with ten 50-75-baud channels. Such systems have been tested with satisfactory results (Figure 1 c).

Supplement No. 8

STUDY GROUP VIII

REPORT ON SYNCHRONOUS TELEGRAPHY OVER STANDARDIZED TELEGRAPH CHANNELS

General survey

The basic problems connected with the transmission of start-stop signals by synchronous telegraphy are well known, i.e.:

— the start and stop units of the start-stop signal are not sent over the channel operated by the synchronous method, which means a gain in efficiency on such a channel;

— the elimination of the start and stop units no longer enables a distinction to be made between signals formed by the permanent " start " condition or the permanent " stop " condition from the signals corresponding to combinations No. 29 and No. 32; hence provision must be made to enable more signals to be transmitted than those of alphabet No. 2.

The problem raised also requires that the normal voice-frequency telegraph channels be used in order to obtain synchronous channels by means of time-division multiplexing.

The Study Group had before it two systems based on different principles, i.e.:

— one system presented by France, which describes a five-unit synchronous system in which the supplementary possibilities are offered by the use of three-condition modulation (a combination of frequency-shift modulation and amplitude modulation). This system can be applied to each individual voice-frequency telegraph channel;

— one system presented by the United Kingdom which describes a synchronous system in which the supplementary possibilities are obtained by six-unit synchronous transmission. This system is applicable to groups of six voice-frequency telegraph channels.

Channel grouping

Should time-division of voice-frequency telegraph channels be envisaged either simultaneously for a group of six VF channels or for one VF channel at a time according to requirements

a) from the operating point of view; in particular, should the six voice-frequency telegraph channels be adjacent ?

b) from the point of view of maintenance and reliability of working ?

The system allowing channels to be dealt with one by one is obviously more flexible.
As regards the system applying to groups of six channels, it should be noted:

— that less than six channels can obviously be equipped in one group;

— that the six voice-frequency channels should preferably be adjacent, at least for ease of operation. This is not an imperative rule, the precautions being taken to ensure that deviations in propagation times with respect to the mean group delay are less than $\pm$ 3 milliseconds.

If there is a change in the telephone-type circuit carrying the voice-frequency telegraph system, a readjustment problem may arise for the system applying to six-channel groups according to the new propagation time on each telegraph channel.

Telegraph distortion

The question of the modulation rate on the synchronous channel has been raised; with the regenerative possibilities of synchronous devices, a modulation rate of more than 50 bauds on a normal voice-frequency telegraph channel designed for 50 bauds is admissible, and both systems use modulation rates of more than 50 bauds.

The study bears in particular on the use of transmission channels whose characteristics are as close as possible to those set out in Recommendation R.35.

It appears that rates of about 120 bauds would be possible with two-condition modulation. The question has not yet been considered with regard to three-condition modulation.

Error rate and transmission performance

For calls set up by synchronous cable systems, the quality laid down by Recommendation F.10 for land-line and submarine cable circuits is to be aimed at.

This should, in principle, follow Recommendation S.12 (conditions which must be satisfied by synchronous systems operating in connection with start-stop teleprinter systems).

However, to allow for the feeding of one synchronous system by another, the incoming speed of the signals in the first system should not exceed the clearance speed of the second system. It is also of interest to increase precision on the beginning of the " start " units so as to increase the duration in which the absence of synchronizing signals can be tolerated.

For synchronous cable systems, it is therefore proposed that the mean interval between the beginnings of successive start elements should be $145^5/_6$ milliseconds with a tolerance of $\pm 1/10^6$.

As far as Recommendation S.3 is concerned, item 4 cannot be observed. However, transmitters with a 7-unit cycle are rapidly being replaced and need not be further considered.

Where it is required to receive signals from a teleprinter or automatic transmitter which uses a 7-unit cycle (i.e. transmits characters at a rate of 428 characters per minute) for retransmission through the synchronous system (which transmits characters at a rate of 411 characters per minute), it will be necessary to insert suitable storage to reconcile the different speeds.

Automatic phasing

Automatic phasing should be recommended.

Transmission of type C signalling through a synchronous system

Type C signalling (see Recommendation U.11) has been designed with the view to use it through a synchronous system; therefore no special steps need be taken in the case of use of type C signalling through such a system.

Transmission of type A and B telex signalling through a synchronous system

Cycle

At the output of the multiplex channel, the duration of the start-stop cycle will be $145^5/_6$ milliseconds.

Call

It is advisable for the call signal to be sent as quickly as possible, so as to cut down the number of collisions which are possible when the channels are used as both-way trunks between telex exchanges.

In this connection, interlacing by elements is more favourable than interlacing by characters, as the delay introduced per character may reach 346 milliseconds in the most unfavourable case.

Call-confirmation signal

It is also advisable for the call-confirmation signal to be transmitted as quickly as possible, so as to be able to identify a case of collision immediately.

The transmission of this signal over the synchronous system may be subject to a maximum delay of 346 milliseconds when interlacing is by characters.

For type B signalling, after passage through a synchronous system, the upper tolerance limit would be raised from 35 to 50 milliseconds.

Proceed-to-select signal

Recommendation U.1 should be amended to read as follows, taking into account the requirements of synchronous systems as well as of switching in general:

For type A signalling, the sending duration of the " stop " polarity, from the beginning of the call-confirmation signal until the moment when the proceed-to-select signal begins to be sent, should be at least 150 milliseconds.

For type B signalling, the time interval between the end of the call-confirmation signal pulse and the moment when the proceed-to-select signal begins to be sent, during which the " start " polarity is sent, should be at least 100 milliseconds.

For type B signalling, after passage through a synchronous system, the upper tolerance limit would be raised from 35 to 50 milliseconds, as for the call-confirmation signal.

Busy signal

For type B signalling, after passage through a synchronous system, the " stop " polarity pulse will have a duration of between 145 and 292 milliseconds for the 6-unit system and between 145 and 317.5 milliseconds for the 5-unit system. This assumes that the signal entering the synchronous system is in conformity with Recommendation U.1.

Moreover, with the lower limit on the duration tolerance of the " stop " polarity (200 ms $-$ 30% $=$ 140 ms), a signal shortened in this way would run the risk of being restituted with a much shorter duration ($25^5/_6$ milliseconds) when interlacing by characters is used. Therefore, administrations are asked to make measurements of the actual lower tolerance of the " stop " polarity of busy signal generated within their networks to ascertain whether it would be possible to accept decrease of the lower tolerance of 200 milliseconds of " stop " polarity specified in Tables Ia and Ib of Recommendation U.1. A figure of 165 milliseconds is proposed for consideration.

If several synchronous systems (or signal regenerators) are placed in tandem, the duration of the " stop " element of the busy signal at the output of this group of systems should not exceed 440 milliseconds; a longer duration of the " stop " pulse could lead to metering errors.

Similarly, if the " start " polarity element of the busy signal is sent with the lower tolerance limit (duration 1050 milliseconds) the duration may, after retransmission, be further shortened by 10% (Recommendation U.5) and fall below the 1000 milliseconds tolerance limit for the clearing signal. However, it appears that the difficulties which may result are rather rare.

Dial pulses

After retransmission by the synchronous system, the tolerances applicable to dial pulses would be as follows:

Speed: $\pm 3\%$ of the mean speed of input measured for the digit " 0 " (nominally 9 to 11 pulses per second).

Ratio: the duration of " stop " polarity pulses should not be less than 33 ms; the duration of " start " polarity pulses should not be less than 45 ms.

Under certain circumstances, the retransmitted signals may include pulses of the " stop " polarity having durations of up to 73 ms, and pulses of the " start " polarity having durations of up to 98 ms. Where this is so, and the incoming switching equipment cannot accept pulses with these characteristics, a pulse regenerator should be inserted between the output of the multiplex circuit and the input of the switching equipment.

Synchronous system operated over VF telegraph channels in tandem

The question of transfer from one VF telegraph channel to another without regeneration at the transfer point was examined. The Study Group thinks that regeneration at the transfer point is to be recommended.

Multiplexing arrangements

For 6-unit synchronous systems, the Study Group proposes that signals should be used and interleaved (interleaving by elements) in accordance with the proposals made by the United Kingdom, as amended.

For 5-unit synchronous systems, the Study Group proposes that signals should be used and interlaced (interlacing by characters) in accordance with the proposals made by the French Administration.

The essential characteristics proposed for these systems are given in Appendices 1 and 2 below.

APPENDIX 1

A six-unit synchronous time-division multiplex system for use over voice-frequency telegraph channels spaced at 120 Hz

1. *Method of channel interleaving*

The interleaving of channels element by element facilitates the rapid transmission of calling and call-confirmation signals. (The delay in transmission of these signals can then be reduced to the minimum by having the start-stop to synchronous conversion unit switched out until the call is established and by transferring the signal condition direct to the multiplex distributor.)

Therefore, " element interleaving " should be used.

2. *Inversion of polarity of signals in one channel*

It is desirable to have no polarity inversion on any channel of the multiplex system. This is because the failure of the voice-frequency telegraph channel, which should produce continuous A polarity at the output (Recommendation R.35, paragraphs 10 and 12), will then automatically produce the telex call clearing conditions at the channel output of the multiplex. However, it is desirable that on that multiplex system which controls the timing of a multiplex group of six multiplex systems to have polarity inversion of multiplex channel B in order to produce reliable synchronization in the event of adopting a higher modulation rate at a later date to permit three-channel time division. This does not affect the situation because multiplex channel B, being permanently subdivided, will not carry telex.

Therefore, it should be recommended that all multiplex channels should have the same polarity of modulation except in the case of multiplex systems carrying the special phasing signal in which case the polarity of channel B should be inverted (the phasing signal should be carried by sub-channel B 4).

3. *Six-unit code*

The signals sent over the synchronous path when continuous stop polarity or continuous start polarity is received are the same regardless of whether the start-stop to synchronous conversion unit is in circuit or not. This prevents false signals from being sent out when the conversion is switched in or out (during the setting-up and disconnection of a telex call) in order to facilitate the rapid transmission of telex switching signals.

4. *Transposition in the order of transmission of the elements*

It is necessary to provide transposition in the order of transmission of the elements to distinguish between the two (or three) channels. (Otherwise, a phase error of one element can cause channel A signals to be intelligible in channel B before phase is corrected.) Although it might be slightly more expensive to provide further transpositions to distinguish sub-channels, it is worth giving the highest degree of protection against cross-connection of sub-channels, even though the probability of signals of one sub-channel becoming intelligible in another is very small and failure of the automatic phasing apparatus might be extremely rare.

Note. — For the six-unit multiplex system that has been adopted, see Recommendation R.44.

APPENDIX 2

Three-condition five-unit synchronous time-division multiplex system for use over frequency-shift voice-frequency telegraph channel

1. *Basic channel used*

A frequency-shift modulation voice-frequency telegraph channel, in accordance with Recommendation R.35 of the C.C.I.T.T.

2. *The channels obtained*

With every basic channel the following can be formed at will:

— two ordinary rhythmic channels offering transmission of up to 400 characters per minute with a 50-baud teleprinter, either by manual keying or the use of an automatic transmitter;

— instead of one ordinary rhythmic channel, two half-speed sub-channels offering transmission of up to 200 characters a minute by use of a 50-baud automatic transmitter, with an effective emission during one cycle in two;

— instead of one half-speed sub-channel, two quarter-speed sub-channels offering transmission of up to 100 characters a minute by use of an automatic transmitter by the same procedure (one effective emission every fourth cycle).

3. *Signals which can be transmitted*

The 32 combinations of international alphabet No. 2 and the permanent start and stop polarities can be transmitted by each intermittent channel.

Every ordinary rhythmic channel can, in addition, transmit telex signalling of types A or B. A variant of the wiring diagram enables the system to be adapted to either kind of signalling.

A supplementary device should be provided to allow every ordinary synchronous channel adapted to type B signalling to transmit dial pulses.

4. *Code*

a) The 32 combinations of the international alphabet No. 2 are transmitted by two-condition isochronous modulation as combinations of five code units.

b) The permanent start and stop polarities are transmitted by three-condition isochronous modulation in the form of combinations of five code units, in which transmission of the fourth unit is characterized by a third significant condition in the voice-frequency telegraph channel [1].

c) In every combination transmitted by three-condition modulation:

— the first, second and fifth units characterize the intermittent channel in which the combination is transmitted;

— the third unit characterizes the permanent polarity to be transmitted;

— the fourth unit is of the third significant condition.

d) Telex type A or B signalling signals are transmitted as alphabetical combinations or as permanent polarities.

5. *Composition of synchronous modulation for transmission*

The elements which correspond to successive characters are placed side by side; the five elements of one character are transmitted successively and then immediately followed by the five elements of the following character and so on.

6. *Synchronization*

The receiving equipment is automatically synchronized on all transitions of the isochronous modulation transmitted by the basic channel; the correction rate is $\pm$ 1/32 (some 3%) of the duration of one unit for each transition.

7. *Phasing and re-phasing*

The receiving equipment is automatically brought into phase with the transmitter, by the three-condition combinations received. In these combinations, the third unit characterizes the permanent polarity to be retransmitted. Appearance of the third significant condition during the fourth unit being used to show this permanent polarity, the other three (the first, the second and the fifth) are used to designate the intermittent channel in which this polarity is to be applied.

When the receiving equipment detects the third significant condition in the basic channel, it should ordinarily be in the phase corresponding to reception of the fourth code unit of the channel designated by units 1, 2 and 5 of the combination. But if, on the other hand, the equipment is not in this phase, it can at once shift itself to the correct one. However, this shift will take place only after a phase-shift has been observed in four successive three-condition combinations; this is a protection against accidental interruptions in the basic voice-frequency channel.

[1] This third significant condition may be the attenuation of 30 dB of the frequency or the transmission of the centre frequency F_0.

When the isochronous device is equipped to provide low-speed sub-channels, there is no need for the phasing and re-phasing to be done on all the sub-channels. It uses but one of these sub-channels, one of the slowest, so as to do away with any possibility of ambiguity in orientation.

8. *Alternation of signals and constitution of intermittent channels*

During each cycle, which lasts $145^5/_6$ ms, the basic channel is distributed into two sectors, A and B. Each sector can be divided to provide four sub-channels, at the most, so that these cycles are numbered in the order in which they follow one another: 1, 2, 3, 4, 1, 2 ... etc. Hence the signals follow in the order: A1, B1, A2, B2, A3, B3, A4, B4, A1, B1 ... etc.

Cycle 1		Cycle 2		Cycle 3		Cycle 4		
x		x		x		x		...
A1	B1	A2	B2	A3	B3	A4	B4	

With half-speed sub-channels, the elementary sub-channels have to be combined as shown in the following table, for either Sector A or Sector B, as desired:

Fraction of operating speed	Combination of elementary sub-channels
(1) quarter (2) quarter (3) half	No. 1 No. 3 Nos. 2 and 4
(1) half (2) half	Nos. 1 and 3 Nos. 2 and 4

In each sector, sub-channel 1 is used for automatic maintenance of the phase when operated at a quarter of the speed. This function is performed by sub-channels 1 and 3 when the sector affords half-speed channels only.

9. *Action taken against mixing of intermittent channels*

We have to avoid reception of signals, in clear, transmitted by an intermittent channel, by another intermittent channel, as a result of de-phasing.

To this end, the coding of signals is systematically modified as a function of the channel to which they belong. This change is made in the polarity of the units and in their position within the signal, in accordance with the following table, in which digits show the units and the sign " X " thereafter means that the polarity of the corresponding units is reversed.

	Sector A					Sector B				
Cycle 1	1	2	3	4	5	1X	2X	3X	4X	5
Cycle 2	1	4X	3	2	5X	1X	4	3X	2X	5X
Cycle 3	1	5X	3	4	2X	1X	5	3X	4X	2X
Cycle 4	4	2X	3	1	5X	4X	2	3X	1X	5X

The third unit, which characterizes a permanent condition of polarity throughout the cycle of each sub-channel, can neither be transposed nor reversed during the sequence of cycles belonging to Sector A or B.

The ordinary rhythmic channels and half-speed sub-channels take the coding attributed to the component cycle with the lowest number.

Thus, for example:

— for channel A, at the ordinary rhythm, all signals are formed by the sequence 1, 2, 3, 4, 5, hence, without polarity inversion or transposition;

— for the half-speed sub-channel formed by B2 and B4, all signals are coded in accordance with the sequence 1X, 4, 3X, 2X, 5X.

10. *Transmission of telex signalling* (see Recommendation U.1)

a) Type A: these signals are transmitted as follows:

— passage to stop polarity: transmission of combinations corresponding to the permanent stop polarity;

— proceed-to-select signal: transmission of the alphabetical character V (combination No. 22);

— call-connected signal: transmission of a single combination corresponding to the permanent start polarity;

— passage to the start polarity: transmission of one or more combinations, corresponding to the permanent start polarity.

b) Type B (except for dial signals): these signals are transmitted as follows (variant b in the following table):

— passage to stop polarity: transmission of a combination No. 32, followed by combinations corresponding to the permanent stop polarity;

— call-confirmation signal and proceed-to-select signal: transmission of a combination No. 32, possibly followed by a combination corresponding to the permanent stop polarity;

— busy signal: transmission of a combination No. 32, normally followed by one or two combinations corresponding to the permanent stop polarity.

— passage to the start polarity: transmission of combinations corresponding to the permanent start polarity.

c) dial signals: these are sent by means of the above-mentioned supplementary device connected to the appropriate channel when the forward channel transmits no start polarity longer than 130 ms and the backward channel transmits a permanent start polarity. This equipment provides samples of the incoming dial signals and the appropriate polarities are sent in groups of five to the other end, which puts them into shape again (calibration at 55 ms of break pulses).

11. *Isochronous modulation rate*

Recommendation S.12 provides for an interval of $145^5/_6$ ms between the beginnings of successive start units with a tolerance of $\pm$ 1 in 10^6. Therefore the isochronous modulation rate on the basic channel is $68^4/_7$ bauds.

12. *Characteristics of the receiving and retransmitting parts of the system*

The receiving and retransmission parts of the system meet the exigencies set forth in Recommendation S.12.

	Signal duration before multiplex equipment (C.C.I.T.T. standards)		Duration of signal restituted by multiplex equipment	Signal restitution delay		Comments
	Minimum	Maximum		Min.	Max.	
Alphabetical character generally exceptionally	150−0.75% $145^5/_6$−10-4	150+ 0.75% $145^5/_6$+ 10-4	$145^5/_6$	211	357	
Passage to start polarity				80	226	variant (a)
				200	346	variant (b)
Passage to start polarity				211	357	
Proceed-to-select signal, type A – start polarity	32	48	40	211	357	
Call-connected signal			$145^5/_6$	211	357	variant (a)
– start polarity	139	161	$265^5/_6$	211	357	variant (b)
Call-confirmation signal and proceed-to-select, type B – stop polarity	17.5[a]	35	$145^5/_6$ or $291^2/_3$	80	226	variant (a)
			$25^5/_6$ or $171^2/_3$	200	346	variant (b)
Busy signal, type B – stop polarity	165	260	$145^5/_6$ or $291^2/_3$ or $437\frac{1}{2}$	80	226	variant (a)
			$25^5/_6$ or $171^2/_3$ or $317\frac{1}{2}$ [b]	200	346	variant (b)
Teleprinter characters	150−0.75%	150+ 0.75%	$145^5/_6$	211	357	
Start polarity				211	357	
Dial signals – interval between pulses	90	110	87.5 or 117			
– negative pulse (break)	49.2	72	52 (adjustable)	231	261	
– positive pulse	31	50	35.5 or 65			
– interval between pulse trains	600		$586^2/_3$ at least			

[a] The multiplex equipment may not retransmit this signal when it lasts less than 17.6 ms.

[b] The restitution of this signal may last $25^5/_6$ ms only in unfavourable circumstances, if the signal received lasts less than 161 ms.

Supplement No. 9

AUSTRALIA *(Extracts from Contribution GM/TGX—No. 6—September 1966)*

PRINCIPLES NECESSARY TO ESTABLISH THE AUTOMATIC INTERCONTINENTAL TRANSIT TELEX NETWORK

. . . .

2. *Establishing limits for the setting-up time of intercontinental calls and the tandem connection of intercontinental exchanges*

As these two issues are obviously related it would be logical to consider them together. In regard to the assessment of a reasonable value for the setting-up time of intercontinental transit calls, a number of aspects should be considered, the more important being:

i) the ratio of ineffective to effective intercontinental trunk time;

ii) the ratio of ineffective to effective circuit time in the network of the originating subscriber and in the international system connecting this network to the intercontinental network; and

iii) the inconvenience caused to the calling subscriber wishing to initiate short messages.

Consideration of the setting-up time of international telex calls by Study Group X has led to the following definition and set of objectives to be included in Recommendation U.1:

" Setting-up time is defined as follows:

Period of time from the initiation of the call on the international circuit until the initiation of the return of either the call connect signal or a service signal indicating that the call has been unsuccessful, provided the selection signals have been transmitted at the maximum speed. For new networks the objectives are as follows:

— an average of 8 seconds,

— a maximum of 15 seconds with a probability of 1% exceeding this value."

In view of this progress, it would appear appropriate to propose a similar definition for the setting-up of an intercontinental telex call and to analyse conditions which may determine suitable objectives. By the addition of a short qualifying phrase to the expression " international circuit " contained in the above definition, the following definition is obtained for the setting-up time of an intercontinental telex call.

" Period of time from the initiation of the call on the international circuit leading to the first intercontinental transit exchange until the initiation of the return of either the call connect signal or a service signal indicating that the call has been unsuccessful, provided the selection signals have been transmitted at the maximum speed."

This definition includes the following increments of time in addition to those covered by the definition quoted from Recommendation U.1:

i) a period of time necessary to gain access to the first intercontinental exchange, and

ii) a further period of time to extend the call through two or more intercontinental exchanges.

Assuming the majority of administrations elect to interconnect with the intercontinental system in accordance with Table II of Recommendation U.11, then the estimated access time would be approximately four seconds. Also, using Recommendation U.11, the average connection time through a single intercontinental exchange may be calculated as $2^1/_4$ seconds. An acceptable method therefore remains to be found to determine the limit of the number of intercontinental exchanges that may be connected in tandem.

To rationalize the approach to this problem, the following factors should be considered:

i) limitations, if any, imposed by transmission arrangements;

ii) the need to achieve maximum overall economy by the most efficient use of the long and costly intercontinental circuits; and

iii) the effect of increasing the value for the permissible setting-up time of intercontinental calls on the operational efficiency of the intercontinental telex network.

With regard to point i), because only teleprinter characters are employed for signalling purposes within the intercontinental network, tandem connecting intercontinental circuits presents no problem, provided that agreement can be reached on the siting of adequate regenerative devices. Therefore, there appears to be no reason at this stage to restrict the number of intercontinental transit centres connected in tandem because of transmission limitations.

Similarly on the grounds of maximum overall economy (point ii) there is a need to exploit the capacity of the intercontinental telex network. A ready means of achieving this objective would be to provide high usage circuit groups from which traffic overflows to final routes dimensioned for a low loss probability. In view of these factors, there are good reasons why the limit on the permissible number of intercontinental telex exchanges connected in tandem should not be too restrictive.

From the foregoing, it is apparent that to achieve the desired economic balance, careful consideration must be given to the unpaid circuit time that accrues primarily during the setting-up time of the call. Because most existing telex networks do not comply with the setting-up time objectives for international calls now included in Recommendation U.1, two values of unpaid intercontinental circuit time and average setting-up time must be considered for each of a number of different configurations of the intercontinental connection.

Thus in Table I below, column A in each case refers to calls terminating in new networks (average setting-up time for an international call being 8 seconds) while column B reflects the conditions prevailing for calls terminating in existing networks. As it is anticipated that many existing networks will not have direct connection to the new intercontinental network, the establishment of

TABLE I

Comparison of the average setting-up times for intercontinental telex calls involving extension through multiple intercontinental transit exchanges

Number of intercontinental exchanges connected in tandem	Average value of unpaid intercontinental circuit time (seconds)		Average setting-up time (seconds)	
	A	B	A	B
2	13	21	19	27
3	15	23	21	30
4	18	26	24	32
5	20	28	26	35
6	23	31	29	37
7	25	33	31	40

Note 1 — The times shown are approximate only and have been rounded off to the nearest second.

Note 2 — The average value of unpaid intercontinental circuit time applies to the first intercontinental circuit involved in the connection.

intercontinental calls to these networks will involve connection through existing international facilities. The setting-up time in column B, therefore, includes an amount of 16-17 seconds to cater for all conditions to obtain connection to a subscriber in an average existing network. By considering different numbers of intercontinental exchanges connected in tandem, the following approximate results are obtained for the unpaid intercontinental circuit time.

3. *Operational efficiency of the intercontinental transit network*

If we express the unpaid intercontinental circuit time (i.e. the average for all links involved in the connection) as a percentage of the paid time for a successful call, this value may be described as the loss in operational efficiency of the intercontinental network. From Table II below, it is then possible to see how the magnitude of this loss in efficiency will vary with the length of a successful call and with the number of intercontinental exchanges connected in tandem, in the light of present conditions prevailing in terminal networks.

TABLE II

Variation in the loss of operational efficiency of the intercontinental network for successful calls

Duration of intercontinental telex call (paid minutes)	Percentage (%) Loss in operational efficiency for connections extended through different numbers of intercontinental exchanges					
	2 exchanges	3 exchanges	4 exchanges	5 exchanges	6 exchanges	7 exchanges
1	35	37	39	42	44	45
2	18	19	20	21	22	23
3	12	13	13	14	15	15
4	9	10	10	11	11	12

From Table II a number of conclusions can be reached:

a) because of the magnitude of the setting-up time of calls in existing terminal networks, the loss in efficiency reflected into the intercontinental system becomes large as the duration of the successful call is reduced;

b) the increase in the loss of efficiency which can be attributed directly to transit switching activities in the intercontinental network does not become large unless the duration of the successful call is very short.

Experience gained so far with automatic telex calls over long intercontinental circuits indicates that the average duration of calls is at present between 3 and 4 minutes and is still declining. It is important to note, however, that approximately 50% of these calls are already less than 2 minutes in duration. Therefore, it appears prudent to restrict the number of intercontinental exchanges which may be connected in tandem for any particular call.

From the viewpoint of the originating subscriber, it is most important to ensure that a rapid service is possible using intercontinental facilities. Within the limits of the intercontinental connections considered here, it is quite probable that one minute may elapse from the time a subscriber originates a call until the required answer-back is received.

4. *Provision of flexibility in regard to overflow routing*

As previously stated, because the circuits employed in the intercontinental telex network will be long and costly, it is important that the most efficient exploitation may be obtained, thereby permitting maximum overall economy. One of the most obvious methods available to achieve this objective is to establish direct groups of circuits between appropriate transit centres in different continents. These direct circuit groups, however, would be under-dimensioned to carry the available peak busy hour traffic offered. In peak periods, therefore, a substantial fraction of the traffic offered would be permitted to overflow on to other transit-switched (final-route) circuits which are provided on a low-loss probability basis.

As the above method of routing can involve the choice of an alternative route at more than one intercontinental transit exchange for each call, adequate discrimination would be required in each exchange to ensure that retrogressive routings are not made.

Acceptance of this routing principle would:

i) significantly reduce the total number of intercontinental circuits required;

ii) improve the operational efficiency of the intercontinental network as a whole; and

iii) contribute to reducing the setting-up time of intercontinental calls.

Supplement No. 10

UNITED KINGDOM *(Extracts from Contribution GM/EFF—September 1966)*

USE OF THE EFFICIENCY FACTOR IN AUTOMATIC SWITCHING

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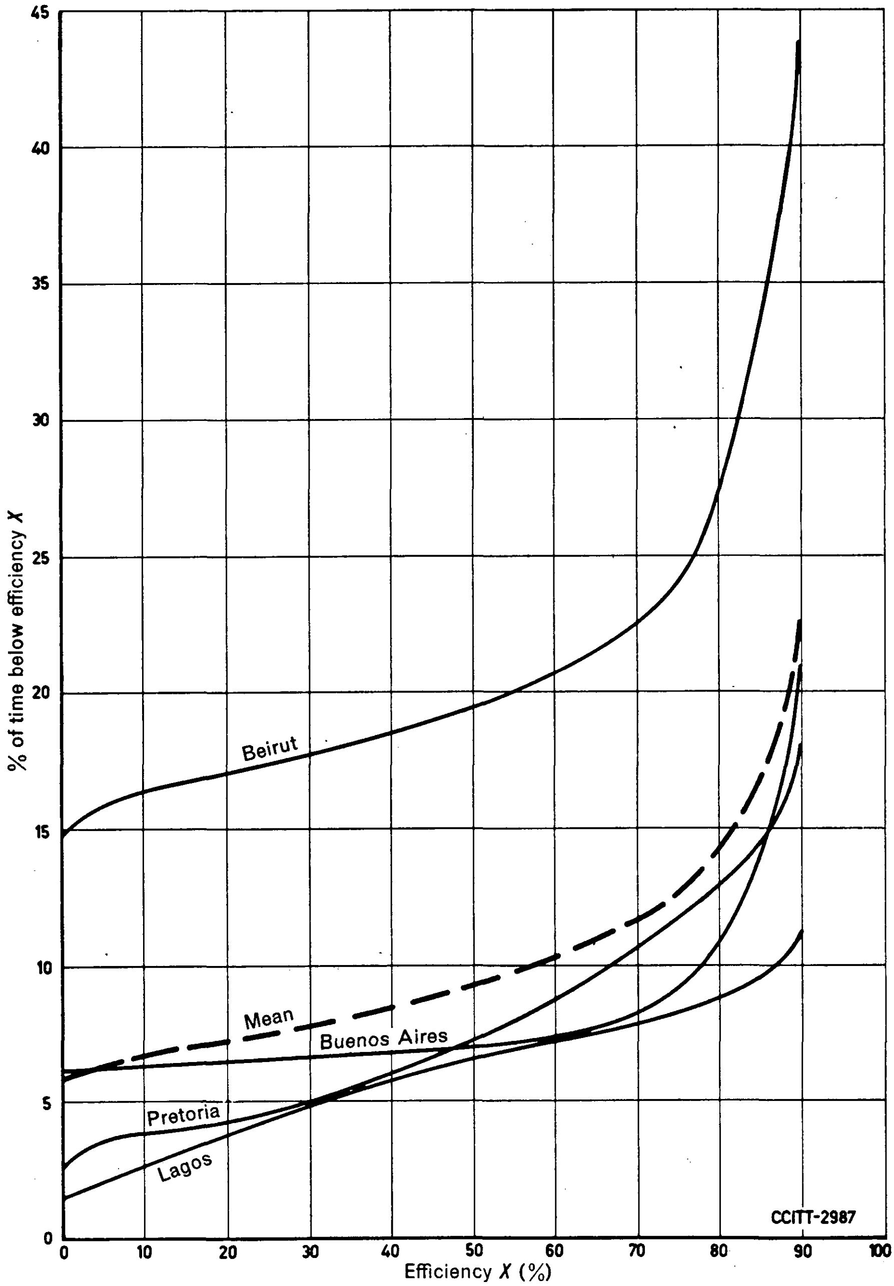
2. *Method used for measuring the circuit efficiency*

A recording has been made on five-unit tape of the incidence of the character release pulses returned from the ARQ equipment for each of four circuits. Observations were made on each circuit for five consecutive weekdays throughout the normal United Kingdom working period of 8 hours per day. The circuits chosen for an initial study were on routes over which calls transit switched in London are likely to be extended. These comprised a route to the Middle East, one to South Africa, one to West Africa and one to South America.

The tapes have been analysed by computer to provide the following information:

2.1 Continuous measurement of the level of efficiency. This was obtained from the incidence of character release pulses integrated over the preceding 12-, 20-, 30-, 60-, 180- and 360-second periods. These integrating periods broadly cover the range suggested for the study in earlier contributions to both the C.C.I.T.T. and C.C.I.R.

2.2 For each integration period a record of the number of occasions on which the efficiency level fell below 90%, 80%, 70%, etc. to 0% and also the percentage of the overall recording time spent below these levels.



London—Beirut
London—Buenos Aires
London—Lagos
London—Pretoria
Integration period = 60 seconds

FIGURE 1 — **Percentage below efficiency *X* for four routes**

2.3 As an alternative indication of efficiency, a record of the number of characters in a storage device associated with the radio equipment would have reached 200, 400, 1000, 2000 and 4000, if characters were received continuously at 400 per minute and cleared over the radio circuit when conditions permitted at 411 per minute.

3. *Degradation of the grade of service*

The extent to which the grade of service is reduced due to busying circuits out is indicated in Figures 1 and 2 which give the percentage of time spent below the various efficiency levels.

Figure 1 shows, for comparison, the results for the individual circuits tested using a single integration period of 60 seconds. It will be seen that, in all cases, the percentage of time spent below a given level of efficiency falls rapidly to a figure between 90% and 70% and then tends to level out, thus confirming the figure of 80% adopted by the C.C.I.T.T. for further study as being realistic and indicating that once the efficiency falls significantly it tends to continue rapidly to zero.

Figure 2 gives an average curve for all four routes and shows that, from the point of view of busying the circuit, variation of the integration period has little effect at the efficiency levels suggested in earlier contributions as being suitable either for charging purposes or for technical reasons.

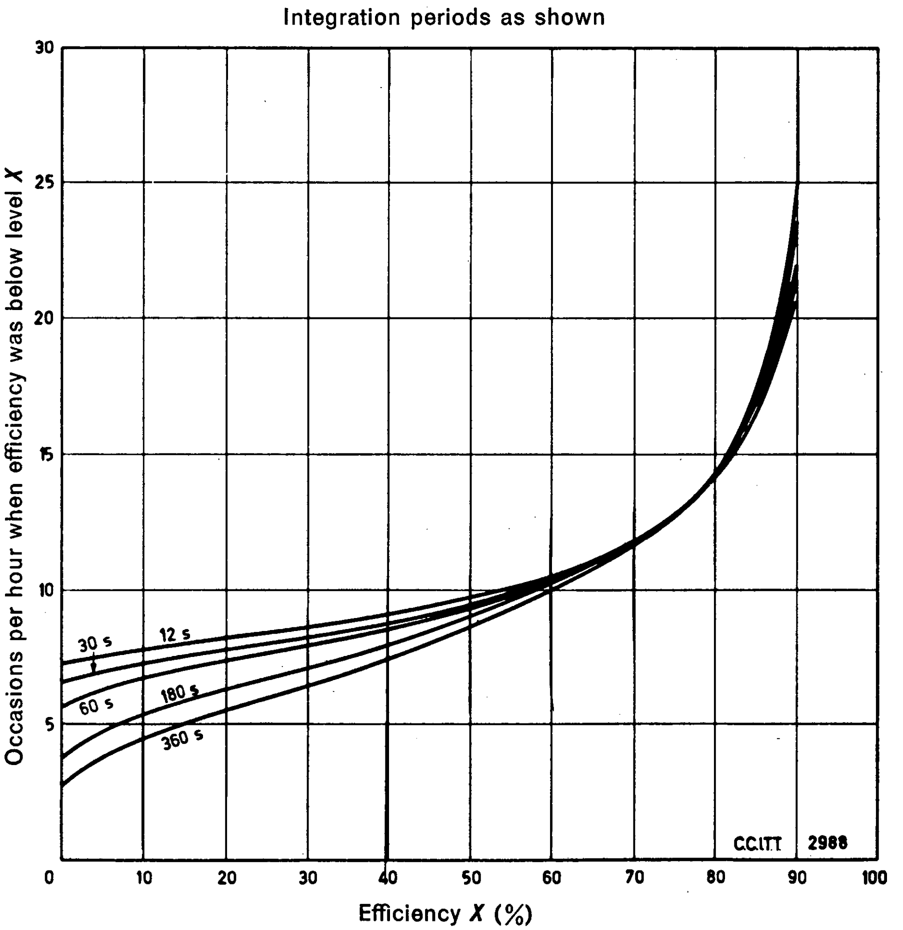


FIGURE 2 — **Percentage time below efficiency *X* as an average for all four routes**

4. *Loss of traffic capacity*

From a commercial viewpoint, because of the tendency for the efficiency to deteriorate rapidly below a critical level, the loss of circuit capacity, if the circuit is taken out of service below any given efficiency, is not as great as might be expected. Average curves for all routes are shown in Figure 3. It will be seen that even the longest integrating period results in a comparatively small loss of capacity.

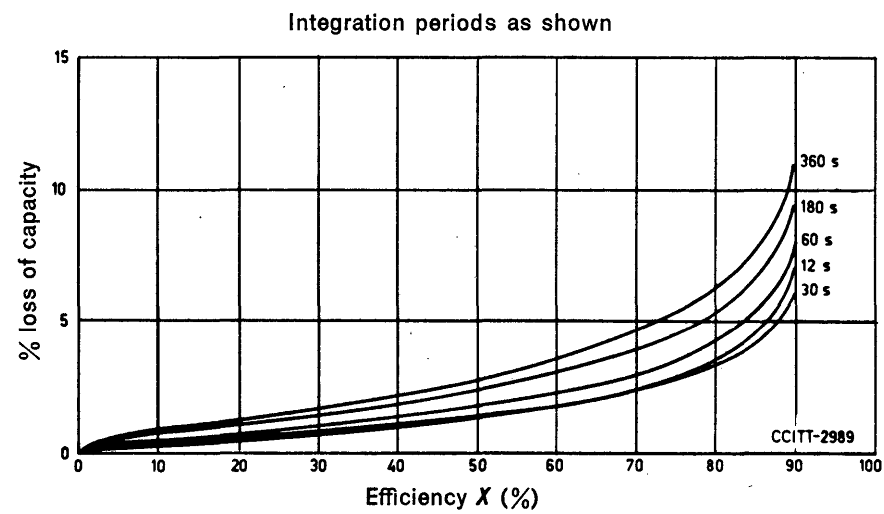


FIGURE 3 — **Loss of capacity if circuit removed from service at efficiency X as an average for all four routes**

5. *The incidence of connections being forcibly released*

The number of occasions per hour when the efficiency fell below the various levels under consideration is shown in Figure 4 as an average for all four routes. It will be seen that the integrating period now has considerable significance and that, with the two shortest periods and 80% efficiency, the number of occasions that calls are forcibly released is approximately 15 per hour. This is of the same order as the number of calls that could be expected to be carried by a circuit under fully automatic conditions. Even with the 360-second integrating period, approximately 1 call in 15 would be released at an efficiency level of 80%.

Some improvement in the incidence of forcibly released connections can be obtained by relating the integrating period to the duration of the call. One practical method of doing this would be to release the connection when the number of characters in the storage device reached a predetermined figure, although such a method would tend to penalize the longer calls. The number of occasions per hour when the number of characters in store exceeded various figures are shown in Figure 5 for each of the four circuits.

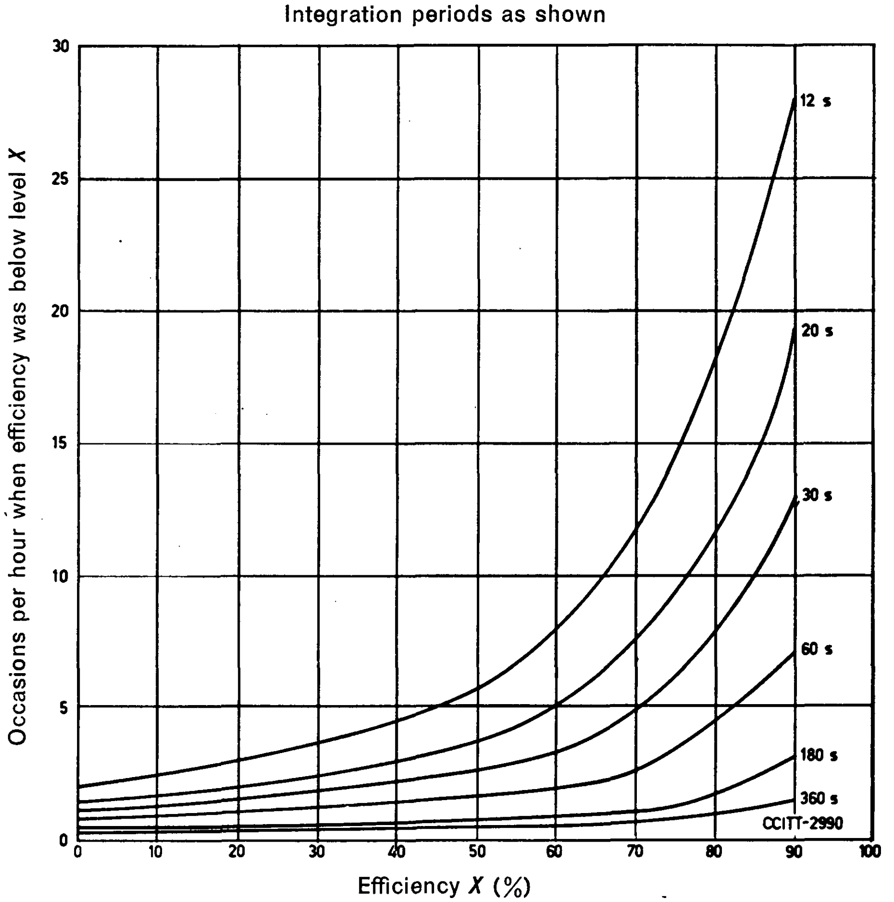
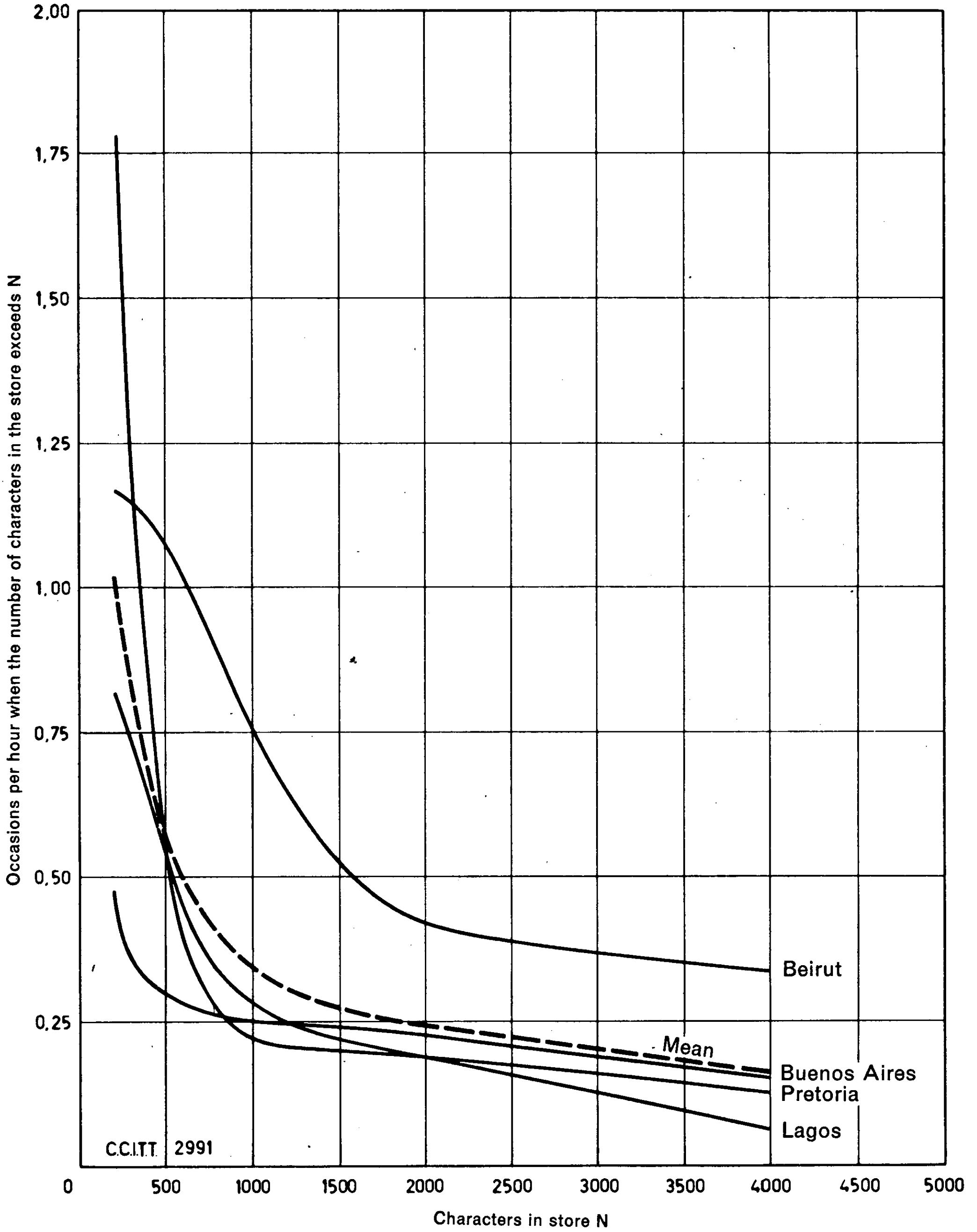


FIGURE 4 — **Occasions per hour when efficiency was below level X as an average for all four routes**



London—Beirut
London—Buenos Aires
London—Lagos
London—Pretoria

FIGURE 5 — **Occasions per hour when the number of characters in the store exceeds *N* for four routes**
Integration periods as shown

Supplement No. 11

NETHERLANDS *(Contribution COM X—No. 20—March 1967)*

THE " FLEX " SYSTEM FOR ARQ CHANNELS

1. HF radio circuits are frequently used to link telex networks. The transmission of information passed over such circuits is protected to a sufficient degree by means of duplex ARQ circuits, the main characteristics of which are laid down in Recommendation 342-1 of the C.C.I.R.

The traffic delays occurring in ARQ circuits during periods of conditions unfavourable to radio reception are, due to cycling, of variable duration and therefore interfere disagreeably with the automatic telex procedure.

2. The existing practice of charging only during the non-cycling time cannot be maintained for automatic telex procedure over radio links. There, charging has to be based on the time during which the circuit is established. To safeguard a subscriber against unreasonable charges the following procedure may appear to be sound:

the telex circuit will be cleared when the efficiency of the ARQ channel drops below a predetermined value. This will be detected immediately, if the channel efficiency is guarded continuously. To pass his information, the subscriber is enabled to establish a new circuit over another ARQ channel of sufficient efficiency.

Two or more ARQ channels to the same destination are therefore needed. If these ARQ channels are available, they should be distributed over at least two different HF radio paths to give the best results. In such an arrangement, the probability of finding all the ARQ circuits inefficient at the same time is far lower than for one circuit alone.

3. Though large parts of a telex circuit are duplex, it is to be observed that telex operation is basically simplex. The ARQ part of the circuit has the disposal of a " go " path and a " return " path, for which a radiotelegraph channel is busied in each direction. Depending on the direction into which information is transmitted in simplex operation, each of the radiotelegraph channels will function alternately as a go or as a return path. The return path is needed to close the ARQ loop, but no information is passed over it. Considering that, on an average, for half the time that a telex circuit is established the radiotelegraph channel serves a go path in each direction, it may be stated that only 50% of the channel capacity is utilized. This is the more so if the average is taken over a group of channels as in a multi-channel system.

4. Moreover, during a telex connection, idle-time signals are transmitted over the go path when the active subscriber is not actually transmitting (stop intervals). This again reduces the utilization of channel capacity, with the result that, on the average, the channel is utilized for even less than 50% of its capacity.

5. If, for the destination considered, several ARQ circuits are available, a subscriber can be offered a circuit that is substantially free from cycling, if a method of re-routing his traffic is applied, each time the busied ARQ circuit becomes inefficient. This method not only offers better service to the subscriber than that of paragraph 2, but also appears better to increase the capacity utilization of the radiotelegraph channels, discussed in paragraph 3. Then, an ARQ loop will no longer serve one pair of subscribers as the go path in one direction and the return path in the other

direction, but each direction of the ARQ loop becomes a go path for a separate pair of subscribers, of whom the active subscriber occupies that go path as long as his traffic can be transmitted over it. Also, during intervals of time in which a large amount of traffic is offered, traffic that is held up can, with this system, be transmitted over other channels that are not fully occupied, so that the idle periods on those channels will be filled up by the overload traffic.

6. The method, described in paragraph 5, which involves improvement in the utilization of capacity, has been called the " flex " system. Its main features are given in the Annex.

ANNEX

1. The " flex " system is a method that deals with the automatic connection and disconnection of telex circuits to and from ARQ channels, which makes it possible:

1.1 to re-route telex circuits from ARQ channels in which the efficiency has dropped below a predetermined value to ARQ channels that are efficient;

1.2 to disconnect an ARQ channel from a telex circuit during the idle intervals in the traffic flow, so that the ARQ channel becomes available for another telex circuit;

1.3 to allot each of both paths of an ARQ channel to different telex circuits;

1.4 to effect forced clearing of a telex circuit if none of the functions described in paragraphs 1.1, 1.2 or 1.3 can be performed.

2. An ARQ channel is connected to the telex network at both ends via a telex adaptor panel, which panel will, for the sake of convenience, be referred to as TP. This TP complies with C.C.I.T.T. Recommendation U.20.

A number (N) of TP terminals and a number (M) of ARQ terminals are interconnected by the automatic switching device of the flex system (N and M need not necessarily be equal). This arrangement replaces the permanent connection between a TP and a specific ARQ channel via a patching board in conventional ARQ circuits.

3. If no telex circuit is established, all the TP in the flex system are disconnected from the ARQ channels, and all non-cycling ARQ channels transmit " signal β ".

4. At the interface to the flex system, each TP has a sending and a receiving terminal. The sending terminal of a TP is automatically connected to the front end of an efficient ARQ channel when, from the landline circuit:

— a call criterion is received by the TP,
— traffic is brought into the storage device of the TP,
— a clearing criterion is received by the TP.

5. The front end of an ARQ channel can be seized only if:

— the ARQ channel is efficient,
— the ARQ channel is not cycling,
— the front end has not yet been allotted to another TP.

6. Each TP is extended by an address generator which, as soon as the TP sending terminal is connected to the front end of an ARQ channel, transmits the address signal over this connection. The address signal is specific for each individual TP, and consists of a 5-unit signal, transmitted thrice in succession. The remote ARQ receiver recognizes a signal as an address, when at least two out of three signals are identical, and this group has been preceded by at least two consecutive " signals β ". One wrongly interpreted signal in the three signals of the address (which is then a transposition) can do no harm to the signalling.

It is considered that for an efficient ARQ channel the probability of receiving two transposed signals in a group of three, without a fault being detected, is extremely low.

7. At its receiving end, the ARQ channel finds the needed TP receiving end terminal by means of the appropriate address signal via the flex system.

8. An established circuit can serve to pass:

— a call,

— traffic,

— a clearing signal.

8.1 To pass a call over the ARQ channel, only the address is transmitted. The reception of only the address at an ARQ receiving terminal puts the required TP receiving end to the " called " position.

8.2 Traffic signals transferred over an ARQ channel immediately follow the address signal. The TP receiving terminal is disconnected from an ARQ go path as soon as the traffic flow is interrupted by pause signals (on the ARQ path at least two consecutive " signals β ").

8.3 To pass a clearing signal over an ARQ channel, the address signal is immediately followed by seven " signals α ". On receipt of two consecutive " signals α " the TP receiving end accepts the clearing condition after which it is disconnected from the ARQ receiver by the flex system.

9. The flex system disconnects a TP sending end from an ARQ front end when:

— during traffic, the traffic flow is interrupted because the TP storage is empty, and moreover three consecutive " signals β " have been successfully transmitted over the ARQ path,

— no traffic is yet available after a call signal has been passed, and after again three consecutive "signals β" have been transferred over the ARQ path,

— at reception of a clearing signal seven consecutive " signals α " and three consecutive " signals β " have been passed over the ARQ channel,

— the efficiency of the ARQ channel drops below the predetermined value.

The disconnecting of the TP sending end from an ARQ channel under the fourth of the above conditions might cause the loss of three characters stored in the ARQ storage. Nevertheless the disconnecting and re-routing of a TP-user can be performed without loss of characters, due to the presence of the system cycle and an externally added dummy cycling storage.

10. A peculiar situation arises when a TP-user has a telex circuit at his disposal but fails to re-establish an ARQ connection because all efficient ARQ channels are engaged. In such a case one of these channels is *temporarily* disconnected from the transmitting TP busying it, and is allotted to the first-mentioned TP, only to enable it to transmit a forced clearing signal over the ARQ route. The ARQ channel is returned to its previous user as soon as the clearing has been effected.

The clearing signal is also sent to the subscriber who was using the TP that cleared the connection over the ARQ route.

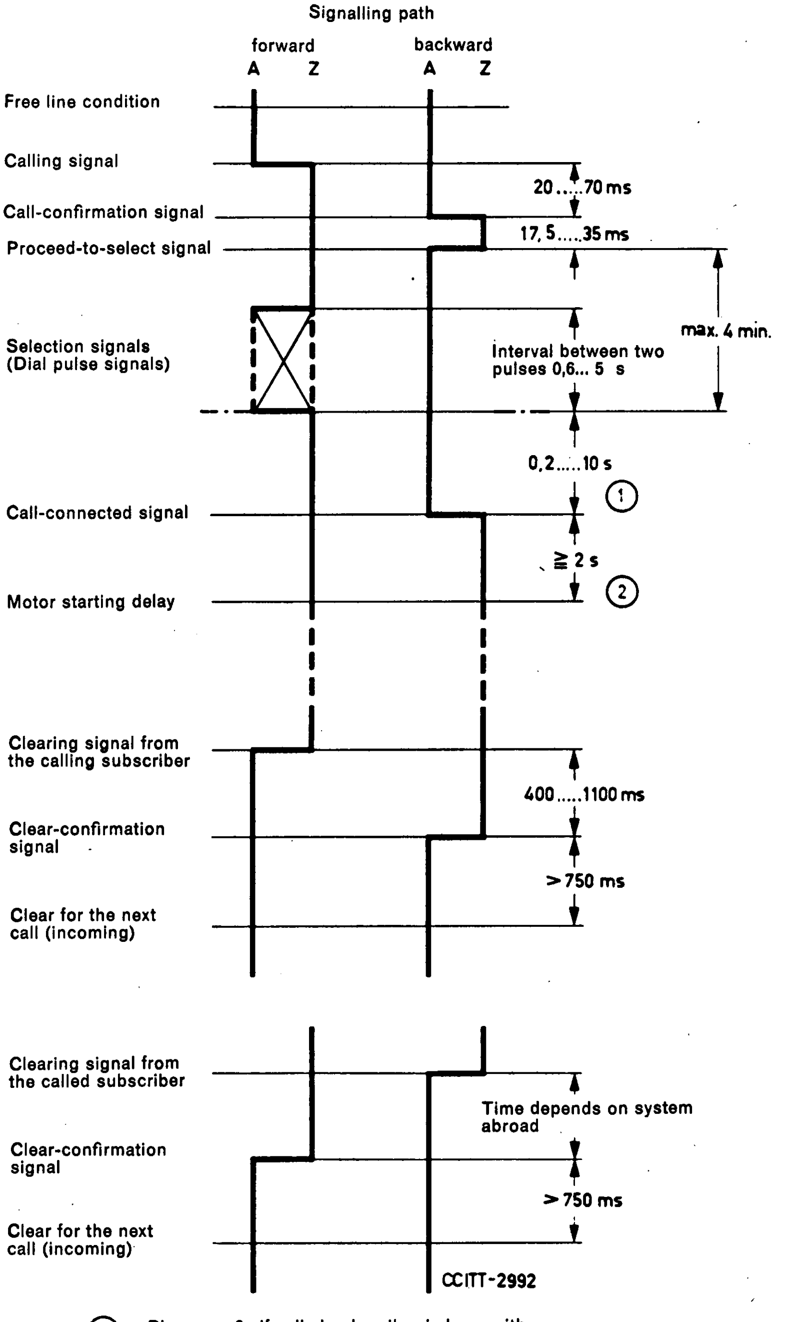
Supplement No. 12

FEDERAL REPUBLIC OF GERMANY *(Contribution COM X—No. 2—October 1967)*

APPLICATION OF RECOMMENDATION U.4: STANDARDIZATION OF SIGNALLING IN THE TELEX AND GENTEX SERVICES

In the *Blue Book*, Volume VII, Recommendation U.4, administrations are invited to supply to the C.C.I.T.T. time sequence diagrams of the signals transmitted in their telex and gentex networks.

The time sequence diagrams of the German telex and gentex networks are shown on the following pages.

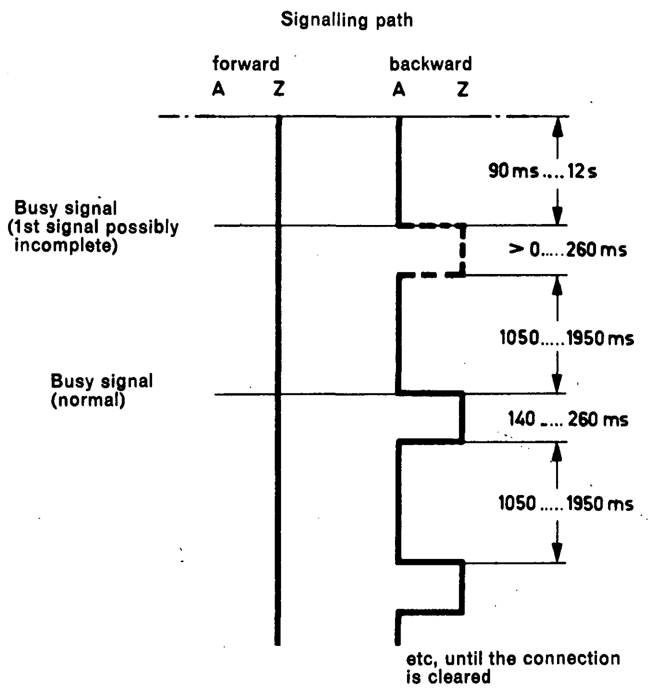


1 Plus max. 3s if called subscriber is busy with local operations.

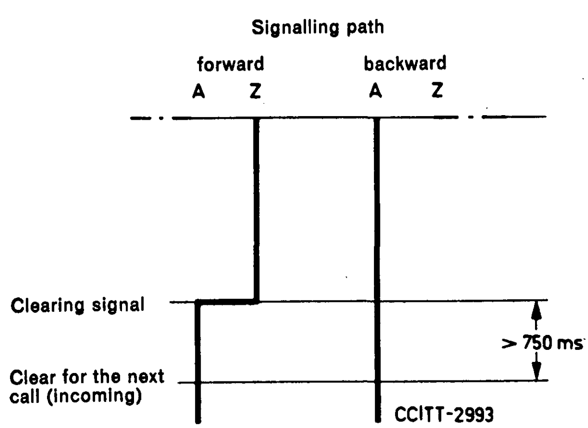
2 If called subscriber was busy with local operations, this time may be omitted

The called subscriber is free

Signalling diagram for telex and gentex traffic to the Federal Republic of Germany



The called subscriber is busy, no circuits



Called number is spare or not accessible

Signalling diagram for telex and gentex traffic to the Federal Republic of Germany

Supplement No. 13

EAST GERMANY (Source external to the Union) *(Contribution COM X—No. 4—January 1966)*

APPLICATION OF RECOMMENDATION U.4: TELEX SIGNALLING DIAGRAM

The Posts and Telecommunication Administration of the German Democratic Republic maintains an international telex service with a large number of European and extra-European countries.

Experience acquired with the international telex service and with the opening of new connections reveals that it would be useful for the C.C.I.T.T. to be informed of the telex signalling diagram used in the German Democratic Republic.

Hence, with reference to Recommendation U.4, we have pleasure in sending you the signalling diagram of the telex system used in the German Democratic Republic.

Signalling for automatic telex traffic to the GDR

All times without taking account of the propagation time

Notes:

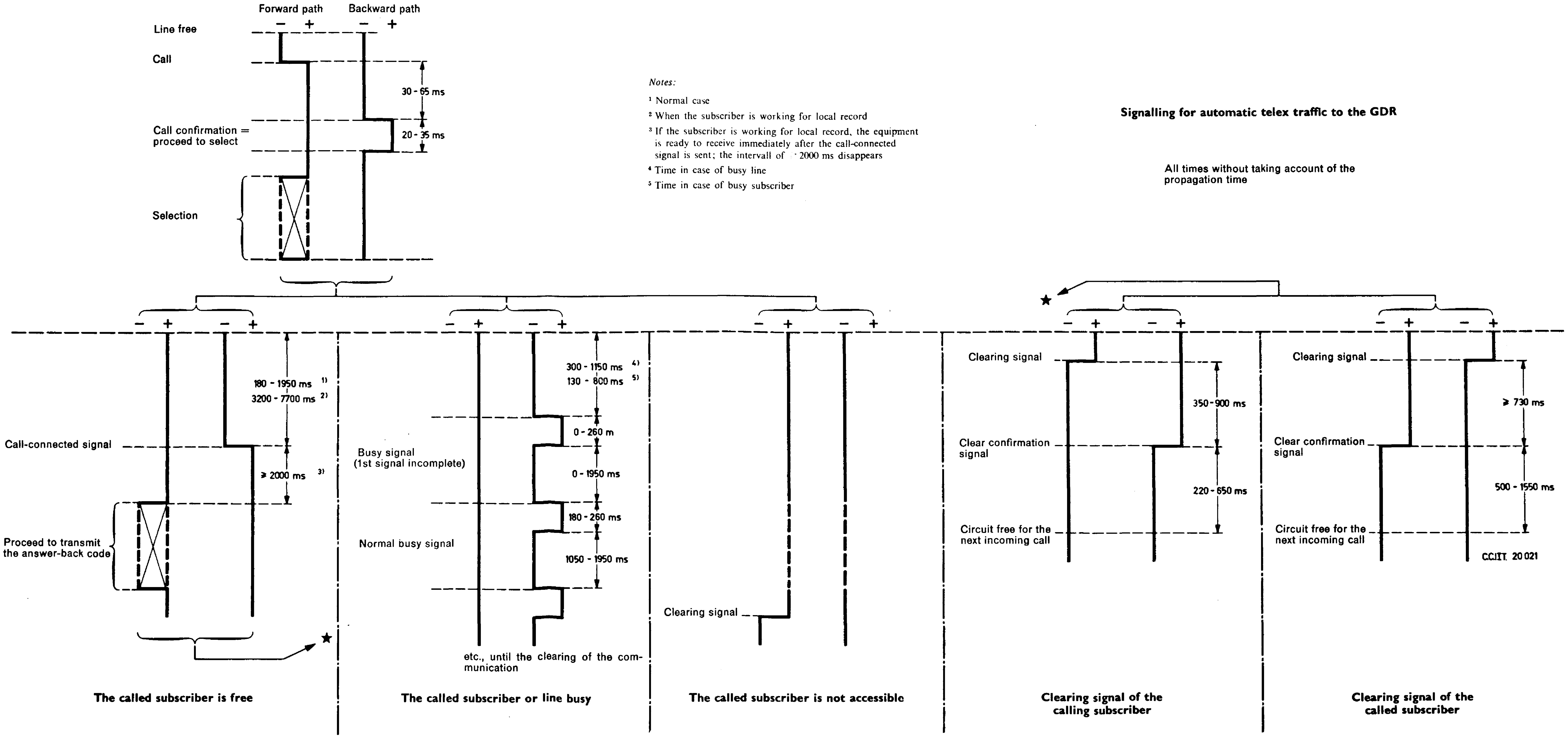
1 Normal case

2 When the subscriber is working for local record

3 If the subscriber is working for local record, the equipment is ready to receive immediately after the call-connected signal is sent; the intervall of ≥ 2000 ms disappears

4 Time in case of busy line

5 Time in case of busy subscriber



Supplement No. 14

FRANCE *(Contribution GM/SYN—No. 5—March 1966)*

SYNCHRONOUS SYSTEM OF TIME-SUBDIVISION OF A TELEPHONE CHANNEL TO PRODUCE A LARGE NUMBER OF TELEGRAPH CHANNELS

The French Administration undertook the study of a synchronous telegraph system based on the principle of direct time-subdivision of a channel with telephone characteristics which is used alternately for the transmission of signals corresponding to several telegraph channels using the five-unit start-stop code and for the normal modulation rate of 50 bauds.

The object of the present contribution is to define the most important problems presented by a system of this kind, to describe the solutions which were adopted for the system now in use and to indicate which characteristics should be standardized if such systems are employed on an international scale.

The system described here has been given the code name ASTARTE (Appareillage synchrone de télégraphie à répartition temporelle électronique—electronic synchronous time-division telegraph equipment).

1. *Composition of telegraph modulation to be transmitted over the synchronous channel*

This type of modulation may take one of two forms: either the signals corresponding to the characters to be transmitted consecutively over the different channels are placed side by side, so that the units representing a given character are always together, or the character transmitted over the different channels may overlap, so that the units representing a given character are separated by units of other characters coming from the other channels.

The advantage of the latter procedure is that in some cases certain signals, such as the switching signals, can be identified more rapidly since, by means of the code, they are recognizable from the first few units of the complete character.

On the other hand, this method requires more complex and more costly equipment, mainly because data must be transferred from the start-stop receivers to the synchronous transmitter element by element instead of character by character; the storage units in the start-stop receivers and the transfer pulse distributing mechanism also are more complicated.

The advantage mentioned above was not considered decisive. For reasons of simplicity and economy, therefore, the procedure, whereby characters relating to the different channels are placed side by side without overlapping, was adopted.

2. *Type of transmission of signals corresponding to the permanent polarities*

There are two ways of adding the two additional signals corresponding to permanent start and stop polarities to the 32 signals provided in international alphabet No. 2: either 3-condition modulation may be used or a 6th code element per character can be introduced.

The French Administration preferred the former alternative for time-subdivision systems on ordinary telegraph channels, since it allows a modulation rate of only 67 bauds to be transmitted over the synchronous section; this is easily done on normal VF telegraph channels without alteration or any special adjustment. The introduction of a 6th code element per character, on the other hand, demands a modulation rate higher than 80 bauds, which is impossible to transmit over such channels without special precaution.

This disadvantage disappears when, as in the present case, the bandwidth is large enough to transmit a high modulation rate and the practical advantage of using simply 2-condition modulation becomes all-important. The solution adopted for the present system therefore consisted in adding a 6th code element per character. It was also possible in this way to settle the problem of automatic phasing and rephasing expeditiously, as we shall see below.

3. *Number of multiplex telegraph channels*

Assuming that each character is transmitted over the synchronous channel with 6-unit lengths, if the duration of a complete cycle were exactly 150 ms, the number of unit lengths in 150 ms would be equal to 6 N where N is the number of multiplex channels, and hence the modulation rate on the start-stop section, expressed in bauds, would be $\frac{1000}{150} \times 6\ N = 40\ N$, or the number of channels multiplied by 40.

In practice, it is essential to transmit over the synchronous channel a modulation rate slightly higher than this theoretical minimum in order to prevent any characters being lost because the synchronous channel is delayed in relation to the start-stop channels to be multiplexed.

To determine the number of normal start-stop channels which can be multiplexed, we must thus ascertain the maximum modulation rate which it is possible to transmit over the telephone circuit which is used to support the synchronous channel.

In this connection, we must bear in mind that a large group of telegraph channels such as the present system is capable of providing will be used only by very big offices handling a heavy volume of telecommunication traffic. Such offices will surely be connected by high-quality direct telephone circuits without intermediate demodulation. Study of the present system was therefore based on the features of this type of circuit.

Two types of channel were examined:

1) overland carrier telephone channels with 4-kHz spacing, and

2) submarine cable telephone channels with 3-kHz spacing.

On the assumption that these channels are used by themselves, without interconnection with supplementary circuits or intermediate demodulation, the experiments carried out showed that two-condition synchronous modulations could be transmitted on these channels without difficulty at a rate of 3700 bauds in the first case and 3000 bauds in the second.

Hence, the following standards were adopted in order to obtain numbers of channels that could easily be divided into sub-groups:

1) 90 telegraph channels in the case of telephone channels with 4-kHz spacing (which would correspond to a minimum modulation rate of 3600 bauds).

2) 60 telegraph channels in the case of telephone channels with 3-kHz spacing (which would correspond to a minimum modulation rate of 2400 bauds).

It will be noted that a system of this type gives a considerably larger number of channels as compared with the frequency-division multiplex systems used at present, even if the channels provided by the latter are themselves subdivided by bisecting devices.

4. *Modulation rate on the synchronous channel*

The base oscillator of the system supplies a signal at frequency 118.504 Hz having a stability of 7×10^{-6}. By simple reductions of this fundamental frequency, we obtain:

a) with 90-channel operation, a time base for transmission at a modulation rate of 3703 bauds, corresponding to a unit length of 270 microseconds.

b) with 60-channel operation, a time base for transmission at a modulation rate of 2469 bauds, corresponding to a unit length of 405 microseconds.

In both cases the exact duration of the cycle is 145.817 milliseconds. This means that the signals restored at the receiving end by start-stop transmitters on ordinary telegraph channels will have a stop element with a duration of 25.817 ms instead of 30 ms. If transmission is effected at automatic speed, a period of stop polarity will be introduced in the signals restored about every 35 characters.

5. *Element-by-element synchronization*

Element-by-element synchronization of the synchronous receiver with the transmitter is based on the position of the significant instants of the modulation received. If the significant instants are found to be ahead of the theoretical instants defined by the receiver's time base, the following test pulses supplied by the time base are advanced by a fraction of the unit length. If there is delay, the inverse operation is produced. In this way, the test instants are always near the centre of the information units of the modulation received, and correct reception can thus be obtained even where a slight frequency difference exists between the transmitter and receiver time bases.

It follows from this method, however, that significant instants must exist in the modulation received for synchronization between transmitter and receiver to be maintained. Long periods of either polarity should therefore be avoided, otherwise there is a risk of dephasing, and hence erroneous reception on all channels for one cycle at least.

This has been the outstanding consideration in selecting the solutions adopted for encoding signals in a synchronous channel.

6. *Encoding of signals corresponding to the permanent polarities*

The encoding system was selected with two points in view:

a) avoidance of long periods of either polarity on the synchronous channel, in order to ensure the element-by-element synchronization indicated above.

b) avoidance of long periods of balanced modulation, such as 1/1 or 2/2 reversals to maintain transmission to line of the frequency corresponding to the modulation d.c. component required for the operation of the modem.

The signals most frequently encountered in all channels will probably be those corresponding to the permanent polarities; the signal corresponding to the permanent A polarity (or α-signal), will be met on all temporarily unoccupied free line condition channels; while the signal corresponding to the permanent Z polarity (or β-signal) on all occupied, but non-operating, channels, or channels awaiting signals for transmission, such as backward channels of calls taking place in the other direction.

It was also desired to characterize these special combinations by a given polarity of one of the code elements, distinguishing them from the alphanumerical combinations.

It was a matter of indifference whether one unit, or one polarity, rather than another should be selected. For reasons of simplicity, the sixth unit was selected, so that units 1 to 5 of the alphanumerical combinations could correspond to units 1 to 5 of the same combinations in the international alphabet No. 2. Finally it was decided to characterize:

a) the alphanumerical combinations by the Z condition of the sixth unit of the code;

b) additional α and β combinations, corresponding to the permanent polarities, by the A condition of the sixth unit of the code.

All the necessary conditions (introduction of significant conditions, avoidance of reversals, a sixth space element to distinguish the α and β combinations, by two units at least) led in the end to the adoption of the following for these additional combinations:

α combination (permanent A polarity): A Z A Z Z A

β combination (permanent Z polarity): A Z Z A Z A

7. *Encoding of alphanumerical signals*

Together with signal B, the alphanumerical signals are the only ones which can be found on a channel during a call. The fact that on such a channel there is no signal to be transmitted (idle-circuit condition) means that the five-channel storage elements are kept idle, which is the same as if they were mark. If the channel is idling, this case will take the form of a transmission to line of the β signal; it will therefore be necessary, in view of the agreed composition of this signal, to reverse the polarity of units Nos. 1 and 4.

If it is decided to extend this operation to all alphanumerical signals, this may be done very easily by a simple wiring combination at the transmission end, with a reverse combination at the reception end, thus simplifying the logical part of the system.

Systematic inversion has therefore been adopted, for line transmission, of units Nos. 1 and 4 of all alphanumerical combinations. There is no particular advantage or disadvantage in this arrangement for encoding such signals, and it has been adopted simply because it helps in technical design.

Whatever the solution adopted there remains an alphanumerical combination which should take the form of a series of six-mark elements and thus shows no change of sign. In the present case, the relevant combination is No. 16 of the international alphabet No. 2 (letter P), which includes units Nos. 1 and 4 of space polarity (i.e. negative, in France).

Should combination No. 16 have to be transmitted on several successive adjacent channels, the result might be the line transmission of a comparatively large period of unbroken Z polarity with the attendant risk of loss of element by element synchronization, as explained above.

To eliminate this risk, it has been considered wiser to adopt special encoding for combination No. 16, characterized by a signal of the additional category, with the sixth element A. The following is the combination adopted:

signal corresponding to combination No. 16: $- + - - + -$

This special encoding is carried out by the synchronous transmitter, in the particular case where a channel has transmitted a character composed of six-mark elements, i.e. leaving all the storage units idle. This is exactly the same as happens when a channel is not equipped. It was very simple therefore to use the same encoding in this latter case. The places occupied in the cycle by non-equipped channels thus take the form of permanent transmission of the signal corresponding to combination No. 16, indicated above. This presents no inconvenience if there are numerous consecutive non-equipped channels, since the repeated transmission of this signal does not take the form of long periods of the same polarity or balanced modulation.

With this encoding system, it may be said that there will never at any time be found, in the modulation transmitted to line, more than nine consecutive mark elements (case of a No. 17 combination followed by a No. 9 combination), nor more than six consecutive space elements (case of an α, β or No. 16 combination, followed by a No. 4 combination).

We would mention finally a variant which was considered in order to improve the system further and which consists in superimposing a transition coding on the encoding just described at the input of the line. The effect of this arrangement is that any mark element to be transmitted is indicated by a change of the signal condition and any space element by no change of condition. Consequently, sequences of mark element are replaced by reversals 1/1 and sequences of 1/1 reversals by 2/2 reversals. This additional operation thus improves modulation on the synchronous channel to some extent as compared with the conditions described above.

8. *Phasing and rephasing at the reception*

It is clearly essential that a system such as the one discussed here is feasible only if the phasing of the receiver with the transmitter at the beginning of an emission, and rephasing in case of phase loss during emission (e.g. following a brief interruption in the line), is fully automatic and does not require human intervention.

The arrangement adopted for this system is based on the fact that the code we have described is more than adequate; of the 32 possible combinations using a sixth space element, only three are in fact used, so that certain sequences of mark and space element may never be found in the modulation normally transmitted to line. One has merely to choose one of these unit sequences and transmit it periodically in a given position in the cycle; when it is received at the other end, phasing with the transmitter can be checked and rephasing carried out automatically when necessary.

A particular sequence of 12 elements was selected for this operation and is transmitted in the cycle corresponding to two consecutive channels, which are always the same. The last two channels in the cycle were reserved for this purpose, i.e. channels Nos. 89 and 90 in 90-channel systems and Nos. 59 and 60 in 60-channel systems. These channels, of course, can no longer be used for communications so that finally 88 telegraph channels are available for use as telephone channels in a system with 4-kHz spacing and 58 in a system with 3-kHz spacing.

As shown above, it is impossible with the encoding system adopted for a sequence of more than six space elements to be transmitted. For that reason a sequence of 12 elements including nine consecutive space elements was selected for the phasing sequence. This is made up of one mark, nine spaces and two mark elements.

The automatic rephasing method is therefore the following. When the synchronous receiver registers the final 12 elements of a cycle in a different sequence from the one mentioned above, it means that a phase loss has probably occurred. The receiver than records all the element signals successively on the line in a 12-element delayed-action store, and reverts to the beginning of the cycle when it observes that a sequence corresponding to the phasing sequence is in the store. Until that moment, signals for the various channels are received and interpreted normally as if no phase loss had been detected. In this way, any accidental distortion of the phase sequence will not produce an error while, if phase loss is present, erroneous signals will be transmitted only for the length of two cycles at most.

A false phasing operation could happen only in the very unlikely case that two errors occurred together, the first of which would produce a deformed phase signal at the end of a cycle and the second a simulated phase signal in the telegraph signals in the subsequent cycle. Moreover, this false phasing operation would itself be detected and corrected in the following two cycles.

9. *High-speed telegraph channels*

An important advantage of the present system is the ease with which we can set up telegraph channels that consistently transmit five-unit signals at a modulation rate above 50 bauds.

By coupling the positions in the synchronous cycle occupied by two normal channels, data transmission capacity is increased from one to two characters per cycle. In this way it is possible to handle a 100-baud start-stop channel. Similarly, by coupling the positions occupied by four normal channels, one can handle a 200-baud start-stop channel.

A complementary study of send and receive start-stop equipments was carried out to ascertain how this coupling should be done. In principle, any two channels in the cycle can be coupled, but the operation is simpler when the combined channels can be placed at equal intervals in the synchronous cycle. In this case, we have only to multiply by the appropriate coefficient (e.g. 2 or 4) the frequency furnished by the time-bases of the start-stop receiver and transmitter used for the high-speed start-stop channel desired.

10. *Merits of an error protection device*

Study of the present system was centred mainly on line telegraph transmission with a view to providing transmission channels of a quality comparable to that of frequency-division multiplex VF telegraph channels.

Prototypes of the system based on the data mentioned above were built and perfected in the laboratories of the French Administration's Centre national d'études des télécommunications and were tested on real coaxial-cable telephone circuits. The tests showed that the solutions proposed were quite sound and that the error rate on such telegraph channels was much the same as on the usual type of VF telegraph channel.

It was therefore not considered essential to equip the system with special error protection devices. These would necessitate a special code for the synchronous channel which would increase the number of elements per character and reduce the number of channels that could be used for a given modulation rate, and the system would lose some of its value.

Nevertheless, the telegraph channels in this system may, of course, be used with appropriate error correction devices placed in each of the terminal equipments, as in the case of VF telegraph channels. The only limitation compared with the latter is that all signals transmitted must be in the form of five-unit start-stop signals, as the system is incapable of accommodating any other type.

In conclusion, we should not forget that the system provides not only for multiplexing but also for the regeneration of the signals it transmits, as signals retransmitted by start-stop transmitters at the receiving end are free from distortion. This is an important advantage compared with VF telegraph systems and an additional reason for dispensing with error correction devices, since the distortion produced by channels at the receiving end of the system does not affect that produced by channels at the sending end.