THE INTERNATIONAL TELEGRAPH AND TELEPHONE CONSULTATIVE COMMITTEE

(C.C.I.T.T.)

FIFTH PLENARY ASSEMBLY

GENEVA, 4-15 DECEMBER 1972

GREEN BOOK

VOLUME VII

TELEGRAPH TECHNIQUE

Published by

THE INTERNATIONAL TELECOMMUNICATION UNION

Geneva, 1973

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CONTENTS OF THE C.C.I.T.T. BOOKS

APPLICABLE AFTER THE FIFTH PLENARY ASSEMBLY (1972)

GREEN BOOK

Volume I — Minutes and reports of the Vth Plenary Assembly of the C.C.I.T.T.
— Resolutions and Opinions issued by the C.C.I.T.T.
— General table of Study Groups and Working Parties for the period 1973-1976.
— Summary table of Questions under study in the period 1973-1976.
— Recommendations (Series A) on the organization of the work of the C.C.I.T.T.
— Recomemndations (Series B) relating to means of expression.
— Recommendations (Series C) relatives to general telecommunication statistics

Volume II-A — Recommendations (Series D) and Questions (Study Group III) relating to the lease of circuits.
— Recommendations (Series E) and Questions (Study Group II) relating to telephone operation and tariffs.

Volume II-B — Recommendations (Series F) and Questions (Study Group I) relating to telegraph operation and tariffs.

Volume III — Recommendations (Series G, H and J) and Questions (Study Groups XV, XVI, Special Study Groups C and D) relating to line transmission.

Volume IV — Recommendations (Series M, N and O) and Questions (Study Group IV) relating to the maintenance of international lines, circuits and chains of circuits.

Volume V — Recommendations (Series P) and Questions (Study Group XII) relating to telephone transmission quality, local networks, telephone sets equipment.

Volume VI — Recommendations (Series Q) and Questions (Study Groups XI and XIII) relating to telephone signalling and switching.

Volume VII — Recommendations (Series R, S, T, U) and Questions (Study Groups VIII, IX, X, XIV) relating to telegraph technique.

Volume VIII — Recommendations (Series V and X) and Questions (Study Group VII and Special Study Group A) relating to data transmission.

Volume IX — Recommendations (Series K) and Questions (Study Group V) relating to protection against interference.
— Recommendations (Series L) and Questions (Study Group VI) relating to the protection of cable sheaths and poles.

Each volume also contains, where appropriate:

— Definitions of specific terms used in the field of this volume;
— Supplements for information and documentary purposes.

TABLE OF CONTENTS OF VOLUME VII
OF THE GREEN BOOK OF THE C.C.I.T.T.

TELEGRAPH TECHNIQUE

INTRODUCTORY NOTE

In order to simplify the wording of the Recommendations in this Volume, the expression " Administration " is used, for shortness, to indicate both a telecommunication Administration and a recognized private operating Agency.

LIST OF DEFINITIONS OF ESSENTIAL TECHNICAL TERMS IN THE FIELD OF TELEGRAPHY AND DATA TRANSMISSION APPLICABLE AFTER THE Vth PLENARY ASSEMBLY

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* = Amended definition.

** = New definition.

L.D. = *List of definitions of essential telecommunication terms (Yellow Book)*, part I.

sup. 1 = 1st supplement to part I of the *List of definitions of essential telecommunication terms.*

sup. 2 = 2nd supplement to part I of the *List of definitions of essential telecommunication terms.*

SERIES 02. GENERAL TRANSMISSION PROCESSES

No.	Terms	Definition to be found in
02.01	a) *(electric) circuit* b) ... *circuit (specific function)*	L.D.
02.02	*channel*	L.D.
** 02.021 (32.34)	*multiplex* *multichannel*	sup. 2 (51.05)
** 02.022 (32.35)	*time-division multiplex*	sup. 2 (51.06)
** 02.023 (32.36)	*frequency-division multiplex*	sup. 2 (51.07)
** 02.024 (32.361)	*frequency-derived channel*	sup. 2 (51.08)
** 02.025 (32.351)	*time-derived channel*	sup. 2 (51.09)
02.03	*(telecommunication) circuit*	L.D.
02.04	*two-wire circuit*	L.D.
02.05	a) *four-wire circuit* b) *four-wire type circuit*	L.D.
02.06	*telephone circuit*	L.D.
02.07	*telegraph circuit*	L.D.
02.08	*hypothetical reference circuit* [nominal maximum circuit]	L.D.
* 02.09	*line* 1) The portion of a circuit external to the apparatus, consisting of the conductors connecting a telegraph set or telephone set or data circuit-terminating equipment to the exchange or connecting two exchanges. 2) The group of conductors on the same overhead route or in the same cable.	
02.10	*radio link*	L.D.
02.11	*radio circuit*	L.D.
02.12	*land-line extension (to a radio-link)* *trunk circuit connected to a radio circuit* (G.B., Am)	L.D.
02.13	*transducer*	L.D.
02.14	*active transducer*	L.D.
02.15	*passive transducer*	L.D.
02.16	*linear transducer*	L.D.
02.17	*ideal transducer* (for connecting a specific source to a specified load) (G.B.)	L.D.
02.18	*instantaneous frequency*	L.D.
02.19	*natural frequency*	L.D.

No.	Terms	Definition to be found in
02.20	*pass-band*	L.D.
** 02.201	*channel passband*	sup. 2 (51.01)
02.21	*spectrum*	L.D.
02.22	*audio-frequency*	L.D.
02.23	*voice-frequency* *telephone-frequency*	L.D.
02.24	a) *sub-audio frequency* b) *sub-telephone frequency* *[sub-audio frequency]*	L.D.
02.25	a) *super-audio frequency* b) *super-telephone frequency* *[super-audio frequency]*	L.D.
02.26	*frequency translation* (of a channel or group of channels) (G.B.)	L.D.
02.27	*signal* (general sense)	L.D.
** 02.271	*basic signal*	sup. 2 (51.02)
02.28	*modulation*	L.D.
02.29	*modulation products*	L.D.
02.30	*carrier* *carrier wave* *carrier current*	L.D.
02.31	*sideband*	L.D.
02.32	*modulation frequency* *modulating frequency*	L.D.
02.33	*double modulation*	L.D.
02.34	*anode modulation*	L.D.
02.35	*over-modulation*	L.D.
02.36	*main sideband* (G.B.) *transmitted sideband* (Am)	L.D.
02.37	*vestigial sideband*	L.D.
** 02.371	*vestigial sideband transmission*	sup. 2 (51.03)
** 02.372	*asymmetric sideband transmission* *transmission with partial sideband suppression*	sup. 2 (51.04)
02.38	*demodulation*	L.D.
02.39	*detection*	L.D.
02.40	*linear detection*	L.D.
02.41	*square law detection*	L.D.
02.42	*modulation percentage* (of an amplitude-modulated wave) *modulation factor*	L.D.
02.43	*frequency swing*	L.D.
02.44	*frequency deviation*	L.D.
02.45	*modulation index*	L.D.
02.46	*deviation ratio*	L.D.
02.47	*discrimination*	L.D.
02.48	*frequency discrimination*	L.D.
02.49	*feedback*	L.D.

No.	Terms	Definition to be found in
02.50	*negative feedback*	L.D.
02.51	*pre-emphasis*	L.D.
02.52	*de-emphasis*	L.D.
02.53	*coupling*	L.D.
02.54	*coupling coefficient*	L.D.
02.55	*automatic volume range regulator*	L.D.
02.56	*automatic gain-control*	L.D.
02.57	*forward-acting regulator* (Am)	L.D.
02.58	*backward-acting regulator* (Am)	L.D.
02.59	*vogad* (Am) *No English term* (G.B.)	L.D.
02.60	*compressor* *automatic volume-contractor* (G.B.)	L.D.
02.61	*expander* (G.B.) *automatic volume-expander* (G.B.) *expandor* (Am)	L.D.
02.62	*compandor*	L.D.
02.63	*audio-frequency peak limiter*	L.D.
02.64	*singing suppressor*	L.D.
** 02.65 (32.391)	*clock*	sup. 2 (51.10)

SERIES 31. GENERAL ALPHABETIC TELEGRAPHY: CODES, ALPHABETS, SIGNALS, MODULATION

No.	Terms	Definition to be found in
** 31.01 (52.01)	*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 (52.03)	*character signal* A set of signal elements representing a character or in PCM the quantized value of a sample. *Note.* — In PCM, the term " PCM word " may be used in this sense.	
* 31.02 (52.04)	*signal element*	sup. 2
31.03	*telegraph signal element* (in alphabetic systems)	L.D.
31.04	*alphabetic signal*	L.D.
31.05	*start signal* (in a start-stop system)	L.D.
31.06	*stop signal* (in a start-stop system)	L.D.
* 31.07 (52.05)	*code (telegraph or data)*	sup. 2
** 31.071 (52.06)	*redundant code*	sup. 2
* 31.08 (52.02)	*alphabet (telegraph or data)*	sup. 2
31.10	*equal-length code*	L.D.
31.11	*five-unit code*	L.D.
* 31.12 (52.54)	*code conversion* Automatic conversion of character signals or groups of character signals in one code into corresponding signals or groups of signals in another code.	
(31.13)	*modulation*	cancelled
* 31.14 (52.07)	*telegraph modulation*	sup. 2

No.	Terms	Definition to be found in
* 31.15 (52.09)	*restitution*	sup. 2
31.16	*" semator " (no English equivalent)*	L.D.
31.17	*signal-train (" semateme " not used in English)*	L.D.
31.18	*" sémation " (no English equivalent)*	L.D.
31.19	*modulation (or restitution) element*	L.D.
* 31.20 (52.08)	*significant condition of a (telegraph) modulation*	sup. 2
(31.21)	*significant conditions of a restitution*	cancelled
* 31.22 (52.11)	*significant interval*	sup. 2
** 31.221 (52.115)	*minimum interval*	sup. 2
31.23	*theoretical duration of a significant interval (of modulation or of restitution)*	L.D.
* 31.24 (52.10)	*significant instants*	sup. 2
31.25	*restitution delay*	L.D.
** 31.251 (52.12)	*telegraph modulator*	sup. 2
** 31.252 (52.13)	*telegraph demodulator*	sup. 2
31.26 (52.116)	*unit interval* *signal element* (Am)	L.D.
31.27	*modulation rate* *[telegraph speed]*	L.D.
31.28	*baud*	L.D.
* 31.29 (52.14)	*isochronous transmission* A transmission process such that between any two significant instants there is always an integral number of unit intervals.	
** 31.291 (52.15)	*anisochronous transmission* A transmission process such that between any two significant instants in the same group [1], 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.	

[1] In data transmission this group is a block or a character; in telegraphy this group is a character.

No.	Terms	Definition to be found in
** 31.292 (52.16)	*serial transmission*	sup. 2

No.	Terms	Definition to be found in
** 31.293 (52.17)	*parallel transmission* The simultaneous transmission of code elements constituting one or more character signals.	
31.30	*start-stop modulation (or restitution)*	L.D.
31.31	*auxiliary conditions of a modulation*	L.D.
31.32	*curbed modulation*	L.D.
31.33	*earthing percentage*	L.D.
31.34	*marking percentage*	L.D.
31.35	*number of significant conditions (of a modulation or a restitution)*	L.D.
31.36	*" travail "; " repos "* Designation of the two significant conditions of a binary modulation (or restitution)	L.D.
31.37	*marking; spacing* *mark; space*	L.D.
31.38	*position A; position Z*	L.D.
31.39	*unit element*	L.D.
31.40	*code elements* *unit*	L.D.
31.41	*... sequential; coincident (signal elements)*	L.D.
31.42	*Morse code*	L.D.
31.43	*Morse dot*	L.D.
31.44	*Morse dash*	L.D.
31.45	*Morse space*	L.D.
31.46	*cable code*	L.D.
31.47	*two-condition cable code* *[double current cable code (DCCC/DC)]*	L.D.
31.48	*three-condition cable code* *cable Morse code* (Am)	L.D.

SERIES 32. TELEGRAPH CHANNELS

No.	Terms	Definition to be found in

* 32.01 (52.18)

(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 (52.19)

(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.*

No.	Terms	Definition to be found in
** 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.	
32.03	*(transmission) link*	L.D.
32.04	*(physical) extension circuit* *[tail]*	L.D.
32.05	*local line*	L.D.
32.06	*(telegraph) repeater*	L.D.
32.07	*converter*	L.D.
32.08	*code converter*	L.D.
32.09	*broadcast (telegraph) repeater*	L.D.
32.10	*conference (telegraph) repeater*	L.D.
32.11	*regenerative repeater*	L.D.
32.12	*direct-current transmission*	L.D.
32.13	*single-current transmission* *(inverse) neutral direct current system* (Am)	L.D.
32.14	*double-current transmission* *polar direct-current system* (Am)	L.D.
32.15	*open-circuit working*	L.D.
32.16	*closed-circuit working*	L.D.
32.17	*simplex (circuit)*	L.D.
32.18	*duplex (circuit)*	L.D.
32.19	*differential duplex (system)*	L.D.
32.20	*bridge duplex (system)*	L.D.
32.21	*incremental duplex*	L.D.
32.22	*opposition duplex*	L.D.
32.23	*half duplex (circuit)*	L.D.
32.24	... *diplex*	L.D.
32.25	*two-way simplex* ...	L.D.

No.	Terms	Definition to be found in
32.26	*one way (connection)* *unidirectional*	L.D.
32.27	*duplex, two-way simplex (connection)*	L.D.
32.28	*carrier telegraphy* *carrier current telegraphy*	L.D.
* 32.29 (52.20)	*amplitude modulation*	sup. 2
* 32.30 (52.21)	*frequency modulation*	sup. 2
** 32.301 (52.22)	*phase modulation*	sup. 2
** 32.302 (52.24)	*phase-inversion modulation*	sup. 2
** 32.303 (52.25)	*differential modulation*	sup. 2
** 32.304 (52.26)	*modulation with a fixed reference*	sup. 2
** 32.305 (52.27)	*modulation coherence*	sup. 2
** 32.306 (52.28 and 53.30)	*bit error rate* *element error rate* *character error rate* *block error rate*	sup. 2
* 32.31 (52.23)	*frequency shift signalling* *frequency shift keying (F.S.K.)*	sup. 2
(32.32)	*frequency-exchange signalling*	cancelled
32.33	*sub-carrier frequency modulation*	L.D.
* 32.34 (02.021)	*multiplex* *multichannel*	sup. 2 (51.05
* 32.35 (02.022)	*time-division multiplex*	sup. 2 (51.06)
** 32.351 (02.025)	*time-derived channel*	sup. 2 (51.09)
32.36	*frequency-division multiplex*	sup. 2 (51.07)
** 32.361 (02.024)	*frequency-derived channel*	sup. 2 (51.08)
32.37	*voice-frequency multichannel telegraphy*	L.D.

No.	Terms	Definition to be found in
32.38	*voice-frequency multichannel system*	L.D.
32.39	*arm* *sector*	L.D.
** 32.391 (02.65)	*clock*	sup. 2 (51.10)
32.40	*multi-tone circuit*	L.D.
32.41	*two-tone telegraph system* *two-tone keying*	L.D.
32.42	*four-tone telegraph system*	L.D.
32.43	*varioplex*	L.D.
32.44	*omnibus (telegraph) system* *way circuit* (Am)	L.D.
32.45	*echelon telegraphy* *extended telegraph circuit*	L.D.
32.46	*forked working*	L.D.
32.47	*superposed circuit* *[by-product circuit]*	L.D.
32.48	*composited circuit*	L.D.
32.49	*phantom telegraph circuit*	L.D.
32.50	*earth-return phantom circuit*	L.D.
32.51	*earth-return double phantom circuit*	L.D.
32.52	*double phantom balanced telegraph circuit*	L.D.
32.53	*sub-audio telegraphy*	L.D.
32.54	*super-audio telegraphy*	L.D.
32.55	*interband telegraphy*	L.D.
32.56	*intraband telegraphy* *[simultaneous telegraphy and telephony]*	L.D.
32.57	*speech plus simplex (equipment)* *S +S (equipment)*	L.D.
32.58	*speech plus duplex (equipment)* *S+D (equipment)*	L.D.
32.59	*static relay* *static modulator*	L.D.
32.60	*telegraph magnifier*	L.D.
32.61	*(v.f.t.) reserve circuit* *fall back circuit* (Am)	L.D.
32.62	*(engineering, traffic) speaker circuit*	L.D.

SERIES 33. QUALITY OF TELEGRAPH TRANSMISSION TELEGRAPH DISTORTION

No.	Terms	Definition to be found in
33.01	*perfect modulation (or restitution)*	L.D.
* 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 reference ideal instant shall be chosen so that the mean value of the deviations with respect to it is equal to zero.	
33.03	*incorrect modulation (or restitution)* *[defective modulation (or restitution)]*	L.D.
* 33.04 (52.61)	*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*	L.D.
33.059	*transmitter distortion*	sup. 1
33.06 (52.62)	*degree of individual distortion of a particular significant instant (of a modulation or of a restitution)*	L.D.

No.	Terms	Definition to be found in
* 33.07 (52.63)	*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 the 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.	
* 33.08	*degree of start-stop distortion* a) Ratio to the unit interval of the maximum measured difference, irrespective of sign, between the actual and theoretical intervals separating any significant instant of modulation (or of restitution) from the significant instant of the start element immediately preceding it. b) The highest absolute value of individual distortion affecting the significant instants of a start-stop modulation. The degree of distortion of a start-stop modulation (or restitution) is usually expressed as a percentage. *Note 1.* — Same as the note to definition 33.07. *Note 2.* — Distinction can be made between the degree of *late* (or positive) distortion and the degree of *early* (or negative) distortion. *Note 3.* — The theoretical intervals are related to the mean actual incoming modulation rate and not necessarily to the nominal modulation rate.	
* 33.09 (52.64)	*degree of gross start-stop distortion* Degree of distortion determined when the unit interval and the theoretical intervals assumed are exactly those appropriate to the nominal modulation rate. *Note:* As for definition 33.07.	
33.10 (52.65)	*degree of synchronous start-stop distortion (i.e. at the actual mean modulation rate)*	L.D.
33.11	*degree of distortion in service*	L.D.

No.	Terms	Definition to be found in
33.12	*degree of standardized test distortion*	L.D.
33.13 (52.66)	*degree of inherent distortion (of a channel)*	L.D.
33.14	*conventional degree of distortion*	L.D.
33.15	*characteristic distortion*	L.D.
33.16	*fortuitous distortion*	L.D.
33.17	*bias distortion* *asymmetrical distortion*	L.D.
33.18	*cyclic distortion*	L.D.
33.19	*error rate of a telegraph communication*	L.D. + sup. 1
33.191	*mutilation rate*	sup. 1
33.20	*error rate of keying*	L.D.
33.21	*error rate of a translation*	L.D.
33.22	*quality index of a channel or of a telegraph apparatus*	L.D.
33.23	*efficiency factor in time* (of a telegraph communication with automatic repetition for the correction of errors)	L.D.
33.24	*mutilation*	L.D.
33.25	*transposition*	L.D.
33.26	*controlling testing station (on a circuit)*	L.D.
33.27	*sub-control station*	L.D.
33.28	*system control station*	L.D.
33.29	*test section*	L.D.
33.30	*principal test section*	L.D.
33.31	*automatic repetition* *Verdan system*	L.D.
33.32	*precorrection*	L.D.
* 33.33 (52.30)	*error-detecting code*	sup. 2
* 33.34 (52.32)	*error-detecting and feedback system* *decision feedback system* *request repeat system* *ARQ system*	sup. 2
* 33.35 (52.33)	*error-correcting code*	sup. 2

SERIES 34. APPARATUS FOR ALPHABETIC TELEGRAPHY

No.	Terms	Definition to be found in
34.01	*translation*	L.D.
34.02	*selection*	L.D.
34.025	*local end (with its termination)*	sup. 1
* 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 (52.68)	*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.	
34.04	*effective margin*	sup. 1
34.05	*nominal margin*	sup. 1
34.06	*theoretical margin*	sup. 1
34.07 (52.67)	*margin of start-stop apparatus (or of the local end with its termination)*	sup. 1
(34.08)	*normal, or net, margin of start-stop apparatus*	cancelled
34.09	*synchronous margin*	sup. 1
** 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.	
34.10	*printing telegraphy*	L.D.
34.11	*signal-recording telegraphy*	L.D.
34.12	*synchronous system*	L.D.
34.13	*start-stop system*	L.D.
34.14	*start-stop apparatus*	L.D.
34.15	*teleprinter* *teletypewriter* (Am)	L.D.

No.	Terms	Definition to be found in
34.16	*stepped start-stop system*	L.D.
34.17	*mosaic telegraphy*	L.D.
34.18	*Hellschreiber system*	L.D.
34.19	*Wheatstone automatic system*	L.D.
34.20	*duplex apparatus*	L.D.
34.21	*quadruplex system*	L.D.
34.22	*single needle system*	L.D.
34.23	*(telegraph) transmitter*	L.D.
34.24	*local record*	L.D.
34.25	*answer-back code*	L.D.
34.26	*answer-back unit*	L.D.
34.27	*automatic transmitter*	L.D.
34.28	*automatic transmitter with controlled tape-feed mechanism*	L.D.
34.29	*tape-reader* *tape-reading head*	L.D.
34.30	*automatic numbering transmitter*	L.D.
34.31	*cable code direct printer*	L.D.
34.32	*Morse or five-unit printer*	L.D.
34.33	*perforator*	L.D.
34.34	*keyboard perforator*	L.D.
34.35	*reperforator* *[receiving perforator]*	L.D.
34.36	*printing keyboard perforator*	L.D.
34.37	*printing-reperforator* *printer perforator* (Am)	L.D.
34.38	*chadless perforation*	L.D.
34.39	*coupled reperforator and tape reader* *F.R.X.D.* (Am) = *fully automatic reperforator transmitter distributor*	L.D.
34.40	*recording* *storage*	L.D.
34.41	*automatic retransmission*	L.D.
34.42	*automatic retransmitter*	L.D.

No.	Terms	Definition to be found in
34.43	*perforated-tape retransmitter*	L.D.
34.44	*synchronous correction*	L.D.
34.45	*correcting signal*	L.D.
34.46	*correction from signals*	L.D.
34.47	*orientation*	L.D.
34.48	*orientation range*	L.D.
34.49	*motorized keyboard*	L.D.
34.50	*saw-tooth keyboard*	L.D.
34.51	*storage keyboard*	L.D.
34.52	*shift-lock keyboard*	L.D.
34.53	*(case) shift*	L.D.
34.54	*letters-case*	L.D.
34.55	*figures-case*	L.D.
34.56	*unshift-on-space*	L.D.
34.57	*telegraph electro-magnet*	L.D.
34.58	*telegraph relay*	L.D.
34.59	*side-stable relay*	L.D.
34.60	*telegraph vibrating relay*	L.D.
34.61	*(telegraph) electronic relay*	L.D.
34.62	*(telegraph) rectifier relay*	L.D.
34.63	*siphon recorder*	L.D.
34.64	*undulator*	L.D.

SERIES 35. TELEGRAPH SWITCHING

No.	Terms	Definition to be found in
35.01	*switching centre*	L.D.
35.02	*sub-centre*	L.D.
35.03	*reperforator switching*	L.D.
35.04	*(fully) automatic reperforator switching*	L.D.
35.05	*semi-automatic reperforator switching* *push-button switching* (Am)	L.D.
35.06	*(teleprinter) keyboard selection* *[permutation code switching system]*	L.D.
35.07	*switching by means of equal-length code*	L.D.
35.08	*control unit, dialling unit, signalling unit*	L.D.
35.09	*concentrator*	L.D.
35.10	*overflow* *spill-over* (Am)	L.D.
35.11	*subscriber's line* *station line*	L.D.
35.12	*trunk (telegraph) circuit* *junction*	L.D.
35.13	*free circuit condition*	L.D.
35.14	*idle circuit condition*	L.D.
35.15	*calling signal*	L.D.
35.16	*call-confirmation signal*	L.D.
35.17	*proceed-to-select signal*	L.D.
35.18	*proceed-to-transmit signal*	L.D.
35.19	*call-connected signal*	L.D.
35.20	*clearing signal*	L.D.
35.21	*gentex*	L.D.

SERIES 36. SYSTEMS OF FACSIMILE TELEGRAPHY

No.	Terms	Definition to be found in
** 36.101	*picture facsimile telegraphy* Facsimile telegraphy in which the original document is reproduced with graded tonal densities.	
** 36.102	*black and white facsimile telegraphy* Facsimile telegraphy in which the original document is reproduced so as to provide a copy with only two levels of intensity. *Note.* — The words " black " and " white " must be taken here in a very broad sense; they designate only the two significant states which are used in order to characterize the contrast between the contents of the documents to be transmitted and produced and the tone of the background.	
* 36.103 (01.09)	*phototelegraphy* Method of reception in facsimile telegraphy which is chiefly intended for the reproduction of graded tonal densities and in which a photographic process is used at the receiver.	
* 36.104	*direct recording* A method of reception in facsimile telegraphy producing visible picture elements instantly and without further processing.	
** 36.105	*drum transmitter* Apparatus in which the original document is fixed on a rotating drum and scanned helicoidally by a reading head.	
** 36.106	*flat-bed transmitter* Apparatus in which the original document is placed flat and scanned line by line.	
** 36.107	*drum receiver* Apparatus in which the recording medium is fixed on a rotating drum and scanned helicoidally by a recording head.	
** 36.108	*continuous receiver* Apparatus that records line by line on a medium which moves on by a constant length between two consecutive lines so as to record several messages in succession without the need for the operator to change the medium between two consecutive messages.	
* 36.109	*helix* A rotating part used in some continuous receivers, comprising a helicoidal rib, the intersection of which with the scanning line defines, at the given moment, the position of the scanned element on this line.	

No.	Terms	Definition to be found in
* 36.110	*writing bar (writing edge)* *chopper bar* A part used in some continuous receivers in conjunction with a helix, comprising a rectilinear rib which defines the position of the scanning line on the recording medium.	
* 36.111	*scanning spot (at transmission)* The portion of the area (of the document to be transmitted) illuminated at a given instant by the reading head in analyzing the document.	
* 36.112	*scanning spot (at reception)* The portion of the area of the recording medium, the impression of which the scanning process ensures the synthesis of the document to be obtained.. *Note 1.* — In the case of phototelegraphy, this is the part of the light-sensitive medium which is exposed at a given moment. *Note 2.* — In the case of direct recording, this is the part of the reception paper on which contact is made with the scanning device.	
* 36.113	*scanning field* The area actually explored by the scanning spot, at reception or transmission, during the transmission of a message.	
* 36.113 *bis*	*scanning line* The area explored by the scanning spot in one sweep from one side to the other of the scanning field.	
** 36.114	*scanning line period* The time interval between the scanning instants at transmission or reception of two corresponding points in two consecutive scanning lines.	
** 36.115	*scanning line frequency* The number of scanning line periods per unit of time. *Note.* — With drum apparatus the scanning line frequency is equal to the drum rotation speed (in revolutions) per unit of time.	
* 36.116	*dead sector* In drum apparatus, that portion of the drum surface the scanning time of which cannot be used for picture signal transmission.	
** 36.117	*lost time* The portion of the scanning line period which cannot be used for picture signal transmission. *Note.* — In the case of drum apparatus, this is the same as the dead sector scanning time.	
* 36.118	*scanning speed* The linear speed of the scanning spot in its movement over the original document or over the recording medium.	

No.	Terms	Definition to be found in
** 36.119	*usable scanning line length* The maximum length of the scanning line that can be achieved with a particular facsimile telegraph apparatus.	
** 36.120	*total scanning line length* The sum of the usable scanning line length and the product of the scanning speed and the lost time.	
** 36.121	*scanning pitch* The distance between the corresponding edges of two consecutive scanning lines.	
* 36.122	*scanning density* *fineness of scanning* Number of scanning pitches per unit length.	
** 36.123	*scanning shift* Relative shift of the scanning device with respect to the document during the scanning process. It is positive (negative) if the area of the message is scanned along the lines from left to right (right to left) when the scanning lines proceed from top to bottom. *Note.* — This is the same as helicoidal scanning towards the left (right) in a drum apparatus.	
** 36.124	*limited scanning* Scanning at double or another multiple of the scanning pitch normally used so as to shorten the transmission time.	
** 36.125	*factor of cooperation* The product of the total scanning line length and the scanning density.	
* 36.126	*index of cooperation* Quotient of the factor of cooperation divided by the quantity π. In the case of a drum apparatus, the index of cooperation is also equal to the product of the drum diameter and the scanning density.	
* 36.127	*drum factor* In drum apparatus, the ratio of the usable scanning length of the drum to its diameter.	
* 36.128	*reproduction ratio* The ratio of the linear dimensions of the reproduced document to the corresponding dimensions of the original document.	
** 36.129	*synchronization (in facsimile telegraphy)* The establishment of equal scanning line frequencies at the transmitter and receiver.	
** 36.130	*phasing (in facsimile telegraphy)* At the receiver, ensuring the exact coincidence of the midpoint of the scanning field, with the corresponding point at the transmitter so as to ensure the correct positioning of the picture on the recording medium.	

No.	Terms	Definition to be found in
* 36.131	*phasing signal* A signal sent to the transmitter for phasing purposes. *Note.* — Phasing is known as " phase white (black) " if the phasing signal is a black (white) signal of which a short interruption corresponding to the white (black) is sent during the lost time.	
* 36.132	*picture element* *scanned element* a) *at transmission:* The part of the area of the original document which coincides with the scanning spot at a given instant and which is of one intensity only, with no distinction of the details that may be included. b) *at reception:* The area of the finest detail that can be effectively reproduced on the recording medium.	
** 36.133	*transmission definition* An indication characterizing the finest detail of the original document that is capable of producing at the transmitter output a signal conforming to certain specifications. *Note 1.* — In the case of picture facsimile telegraphy, this signal must indicate the dimensions *and* the effective luminance of the finest detail in question. *Note 2.* — In the case of black-and-white facsimile telegraphy, assuming that the contrast of the finest detail is adequate, the transmitted signal must correspond to a nominal black. *Note 3.* — The definition is known as " longitudinal " if the dimension of the finest detail is taken in the same direction as the scanning lines, and " transverse " if its dimension is taken at right-angles to them.	
** 36.134	*reception definition* Indication characterizing the finest detail that can be recorded on the reproduction medium. *Note 1.* — In the case of picture facsimile telegraphy, the longitudinal and transverse dimensions of the finest detail in question correspond to those of the scanned element. *Note 2.* — In the case of black-and-white facsimile telegraphy, the longitudinal definition is determined by the length of the black line produced by the shortest nominal-black signal capable of actuating the receiver. The transverse definition is equal to the width of the scanning line.	
* 36.135	*nominal black (white)* Level or frequency of the signal corresponding to a pure black (white).	
** 36.136	*picture black (white)* Level or frequency of the signal corresponding to the darkest (lightest) part of the document to be transmitted.	

No.	Terms	Definition to be found in
* 36.137	*compression (expansion) of the luminance range* Deliberate or accidental change in the facsimile signals which causes the luminance range of the received picture to be narrower (wider) than that of the original.	
** 36.138	*luminance compensation* In picture facsimile telegraphy, changing of the received signals, allowing for the photometric characteristics of the reception medium, in order to reproduce the luminance range exactly.	
** 36.139	*accentuated contrast* A process whereby all the picture elements of the original document which have a luminance less than a specified intermediate value are transmitted as nominal black, and all those with a luminance greater than that value as nominal white.	
* 36.140	*aperture distortion* An effect due to the finite dimensions of the scanning spot at transmission and reception; contours are blurred and details smaller than the scanning spot are suppressed.	
** 36.141	*skew* A defect in reproduction in which lines that should be at right-angles to the scanning direction are inclined to it, owing to a difference between the scanning speeds at transmission and reception.	
* 36.142	*overlap* A defect in reproduction when the width of the scanning line is greater than the scanning pitch.	
* 36.143	*underlap* A defect in reproduction when the width of the scanning line is less than the scanning pitch.	
* 36.144	*echo effect* A defect in reproduction due to transmission phenomena, consisting in the appearance of a second outline or several other outlines displaced, in the scanning direction, from the outline of the normal picture.	
* 36.145	*tailing* A defect in reproduction whereby a sudden variation in luminance (e.g. from black to white) on the original document, is shifted irregularly, in the scanning direction, on the received document. *Note.* — In black-and-white facsimile telegraphy, this term does not apply to the reproduction of details which are smaller than the scanned element and which may in some cases be deliberately prolonged at the transmitter.	
* 36.146	*interference pattern* A defect in reproduction evident as an overlay more or less regular, of lines or density variations and generally caused by recurrent interference.	

No.	Terms	Definition to be found in
* 36.147	*longitudinal judder* Effect due to the irregular rotation of the drum or helix causing, on the reproduced picture, slight waviness or breaks in lines that are regular on the original document.	
** 36.148	*transverse judder* Effect due to irregularity of the scanning pitch resulting in concurrent overlapping and underlapping in the reproduced picture.	

SERIES 52. DEFINITIONS INVOLVING BOTH TELEGRAPHY AND DATA TRANSMISSION

No.	Terms	Definition to be found in
* 52.01 (31.01)	*character*	31.01
** 52.011	*control character* *[service character]* A character whose occurrence in a particular context initiates, modifies or stops a control operation. Such a character may be recorded for use in a subsequent action; it may have a graphic representation in some circumstances.	
52.02 (31.08)	*alphabet (telegraph or data)*	sup. 2
* 52.03 (31.012)	*character signal*	31.012
52.04 (31.02)	*signal element*	sup. 2
52.05 (31.07)	*code (telegraph or data)*	sup. 2
52.06 (31.071)	*redundant code*	sup. 2
52.07 (31.14)	*telegraph modulation*	sup. 2
52.08 (31.20)	*significant condition of a (telegraph) modulation*	sup. 2
52.09 (31.15)	*restitution*	sup. 2
52.10 (31.24)	*significant instants*	sup. 2
52.11 (31.22)	*significant interval*	sup. 2
52.115 (31.221)	*minimum interval*	sup. 2
** 52.116 (31.26)	*unit interval*	L.D.
52.12 (31.251)	*telegraph modulator*	sup. 2
52.13 (31.252)	*telegraph demodulator*	sup. 2

No.	Terms	Definition to be found in
* 52.14 (31.29)	*isochronous transmission*	31.29
* 52.15 (31.291)	*anisochronous transmission*	31.291
52.16 (31.292)	*serial transmission*	sup. 2
** 52.161	*character-serial transmission* Transmission in which successive characters follow one another in sequence. *Note.* — The elements (bits) of each character may be transmitted serially (described as serial by bit and character) or simultaneously (described as parallel by bit, serial by character).	
** 52.162	*byte-serial transmission* Transmission in which successive bytes follow one another in sequence. *Note.* — The individual bits of each byte may be transmitted serially (described as serial by bit and byte) or simultaneously (described as parallel by bit, serial by byte).	
** 52.163	*bit-order of transmission* The property of a serial transfer of data which concerns the arrangement of digits, e.g. most significant digit [1] first, least significant digit first, or any other desired order [2].	
* 52.17 (31.293)	*parallel transmission*	31.293
* 52.18 (32.01)	*(telegraph) channel* *telegraph channel* (Am)	32.01
* 52.19 (32.02)	*(telegraph) circuit* *telegraph channel* (Am)	32.02
52.20 (32.29)	*amplitude modulation*	sup. 2
52.21 (32.30)	*frequency modulation*	sup. 2
52.22 (32.301)	*phase modulation*	sup. 2
52.23 (32.31)	*frequency shift signalling* *frequency shift keying (F.S.K.)*	sup. 2
52.24 (32.302)	*phase-inversion modulation*	sup. 2

[1] This term is defined by the I.S.O. as follows:
Significant digits
Those digits of a numeral which have meaning for a certain purpose; particularly those which must be kept to preserve a specific accuracy.

[2] The terms "high order bit first" or "lower order bit first" should be deprecated.

No.	Terms	Definition to be found in
52.25 (32.303)	*differential modulation*	sup. 2
52.26 (32.304)	*modulation with a fixed reference*	sup. 2
52.27 (32.305)	*modulation coherence*	sup. 2
52.28 (32.306 and 53.30)	*bit error rate* *element error rate* *character error rate* *block error rate*	sup. 2
52.29 (53.31)	*character check*	sup. 2
** 52.291	*cyclic code* A code in which every cyclic shift of a code word is itself a code word.	
** 52.292	*parity digit* An *n*-ary digit appended to an array of *n*-ary digits to make the sum modulo *n* of all the digits always equal to 0 or to any predetermined digit. In the case of the radix 2, parity digit becomes parity bit.	
52.30 (33.33)	*error-detecting code*	sup. 2
52.31	*error-detecting system*	sup. 2
52.32 (33.34)	*error-detecting and feedback system* *decision feedback system* *request repeat system* *ARQ system*	sup. 2
** 52.321	*data signal quality detection* *[analogue error detection]* Determination that a received data signal has departed from an acceptable form, based on criteria such as amplitude of signal, signal-to-noise ratio or telegraph distortion, without involving checks of the significance or the value of the restituted digital signal.	
** 52.322	*data signal quality detector* (see 52.321)	
52.33 (33.35)	*error-correcting code*	sup. 2
52.34	*error-correcting system*	sup. 2
52.35	*residual error-rate* *undetected error-rate*	sup. 2
52.36	*track*	sup. 2

No.	Terms	Definition to be found in
** 52.37	*answer-back unit simulator* A device or programme routine, not a part of a teleprinter, but which performs the same function as the answer-back unit on receipt of a specific " who are you " signal.	
** 52.38	*centralized control signalling* The system of exchanging call control signals relating to a group of data transmission circuits by means of a transmission channel (or channels) dedicated to control signalling.	
** 52.39	*decentralized control signalling* The system of exchanging call control signals relating to a particular data transmission circuit by transmitting signals over that circuit.	
** 52.40	*call control signals* The entire set of signals necessary to establish, maintain and release a call.	
** 52.41	*selection signals* The sequence of characters which indicates all the information required to establish a call. The content of the sequence may be different in different parts of the network. *Note.* — The selection signals include the address and possibly additional network selection signals.	
** 52.42	*network selection signals* Those selection signals which indicate call control information other than the address which is required by the network for establishing a call.	
** 52.43	*address* The sequence of characters which indicates the destination of a call. These characters may have different representations in different parts of the network.	
** 52.44	*user service or facility* A user service or facility which is available on demand to users of the network.	
** 52.45	*circuit-switched connection* A connection which is established on demand between two or more DTE's giving the exclusive use of a data circuit and which is maintained until the connection is released.	
** 52.46	*packet-mode operation* *packet switching* The transmission of data by means of addressed packets whereby a transmission channel is occupied for the duration of transmission of the packet only. The channel is then available for use by packets being transferred between different data terminal equipments. *Note.* — In certain data communication networks the data may be formatted into a packet or divided and then formatted into a number of packets (either by the data terminal equipment or by equipment within the network) for transmission and multiplexing purposes.	

No.	Terms	Definition to be found in
** 52.47	*user class of service* The data signalling rate, transmission mode and code structure (if any) of the service which is provided.	
** 52.48	*closed user group* A number of users of a public switched data communication service who have the facility that they can communicate with one another but access is barred to and from all other users of the service. *Note 1.* — A special facility permitting a user in a closed user group to call any other user connected to a public switched data communication service or to any other network with which interworking is permitted, may be offered. This is termed " closed user group with outgoing access ". Access to users of this facility is restricted to other members of the closed user group. *Note 2.* — A closed user group may incorporate the direct call or abbreviated address calling facilities.	
** 52.49	*direct call* A facility which avoids the need for use of an address. The network interprets the calling signal as an instruction to establish a connection with a single destination or group of destinations previously designated by the user. *Note.* — This facility may permit faster call set-up than usual. No special priority is implied over other users of the network in establishing a connection. The designated address(es) may be changed as required by means of a suitable procedure.	
** 52.50	*abbreviated address calling* A facility which enables a user to employ an address having fewer characters than the full address when initiating a call. *Note.* — Networks may allow a user to designate up to Y abbreviated address codes. The allocation of abbreviated address codes to a destination or group of destinations may be changed as required by means of a suitable procedure.	
** 52.51	*multi-address calling* A facility which permits a user to nominate more than one address for the sending of the same data. *Note 1.* — The network may undertake this by one of two distinct forms: a) Sequentially b) Simultaneously and if both forms are provided may allow the user to opt for a preferred form. *Note 2.* — The procedure for using this facility may i) be as defined for a direct call, or	

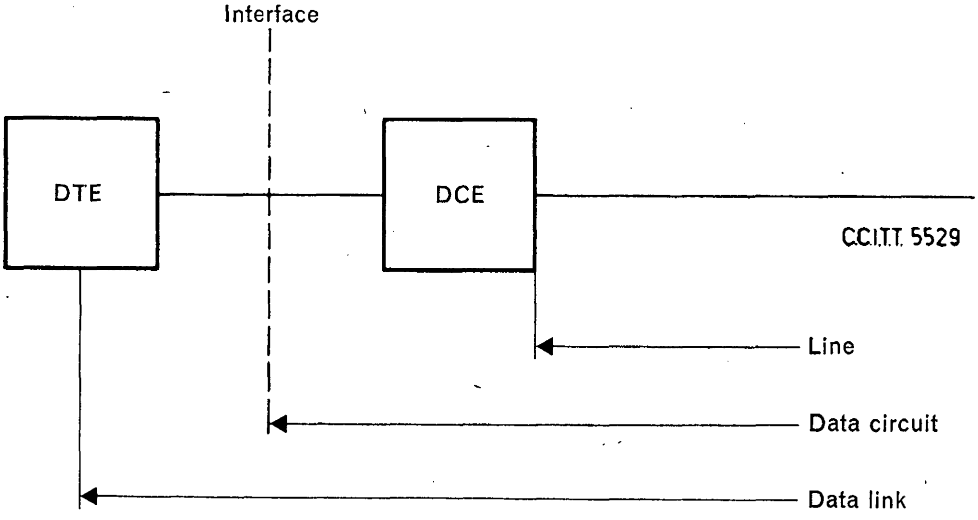
No.	Terms	Definition to be found in
	ii) use a special code or codes in the abbreviated address calling facility to designate all the required destinations, or iii) indicate the individual full or abbreviated address of each user to which data are to be transmitted. *Note 3.* — This facility may also be used in association with the delayed delivery facility.	
** 52.52	*bit sequence independence* A facility which enables the transfer of digital data in the form of a sequence of binary digits from one user to another without placing any restriction upon the sequence of the binary digits. *Note.* — This implies that an indefinitely long string of consecutive binary ones or zeros is admitted in the data signal.	
** 52.53	*delayed delivery* A facility which employs storage within the data network whereby data from a user destined for delivery to one or more addresses may be held for subsequent delivery at a later time. *Note.* — Two modes may be required 1) where the called data terminal equipment is busy when called and the network holds the data until the destination is free; 2) where the network accepts data and undertakes to deliver them at some pre-determined time.	
** 52.54 (31.12)	*code conversion*	31.12
** 52.55 (37.27)	*duplex operation* 1. In the telegram service a method of working between two telegraph sets in which the transmission of telegrams may take place simultaneously in both directions. 2. In data transmission, a method of working between two data terminal equipments in which the transmission of digital data may take place simultaneously in both directions.	
** 52.56	*interworking between networks* The means whereby a data terminal equipment connected to one public network may communicate to a data terminal equipment in another public network. *Note.* — The networks referred to may be public data networks, public telephone networks or public telex networks.	
** 52.57	*network parameter* A feature which is inherent in the design of a network.	
** 52.58	*call set-up time* The overall length of time required to establish a circuit switched call between data terminal equipments. It is the summation of: a) *call request time* = the time from the initiation of a calling signal to the delivery to the caller of a " proceed-to-select " signal.	

No.	Terms	Definition to be found in
	b) *Selection time* = the time from the delivery of the proceed-to-select signal until all the selection signals have been transmitted. c) *Post selection time* = the time from the end of the transmission of the selection signals until the delivery of the call-connected signal to the originating data terminal equipment. *Note 1.* — The selection time may be minimized by the use of the direct call or abbreviated address facility. *Note 2.* — The call set-up time for a given connection depends upon the network topology, user data rate, mode of working, grade of service, distance between users and the procedure employed (e.g. direct call).	
** 52.59	*call release time* *call clear-down time* The time from the initiation of a clearing signal by a terminal installation until the free circuit condition appears on the originating data terminal equipment.	
** 52.60	*transfer time* The time that elapses between the initial offering of a unit of the user's data to a network by a transmitting data terminal equipment and the complete delivery of that unit to a receiving data terminal equipment. *Note 1.* — A unit of data may be a bit, byte, packet, message, etc. *Note 2.* — A specific example of transfer time applied to packet mode operation may be defined as follows: packet transfer time is the time that elapses between the initial offering of a packet to the network by a transmitting data terminal equipment and the complete delivery of that packet to a receiving data terminal equipment.	
** 52.61 (33.04)	*telegraph distortion*	33.04
** 52.62 (33.06)	*degree of individual distortion of a particular significant instant*	L.D.
** 52.63 (33.07)	*degree of isochronous distortion*	33.07
** 52.64 (33.09)	*degree of gross start-stop distortion*	33.09
** 52.65 (33.10)	*degree of synchronous start-stop distortion*	L.D.
** 52.66 (33.13)	*degree of inherent distortion*	L.D.
** 52.67 (34.07)	*margin of start-stop apparatus*	sup. 1
** 52.68 (34.031)	*net margin*	34.031

SERIES 53. DEFINITIONS OF SPECIAL CONCERN IN DATA TRANSMISSION

No.	Terms	Definition to be found in
	Note. — For definitions concerning both data transmission and pulse code modulation (PCM), see Recommendation G.702 (*Green Book*, Volume IV).	
* 53.01	*binary digit* A member selected from a binary set. *Note 1.* — Bit is an abbreviation for binary digit. *Note 2.* — In the interest of clarity, it is recommended that the term " bit " shall not be used in two-condition start-stop modulation instead of " unit-element ".	
** 53.011	*byte* A group of binary digits normally operated upon as an entity.	
** 53.012	*envelope* A group of binary digits formed by a byte augmented by a number of additional bits which are required for the operation of the data network.	
** 53.013	*packet* A group of binary digits including data and call control signals which is switched as a composite whole. The data, call control signals and possibly error control information are arranged in a specified format.	
* 53.02	*digit* A member selected from a finite set. *Note 1.* — In digital transmission, a digit may be represented by a signal element, being characterized by its dynamic nature, discrete condition and discrete timing, e.g. it may be represented as a pulse of specified amplitude and duration. *Note 2.* — In equipment used in digital transmission, a digit may be represented by a stored condition being characterized by a specified physical condition, e.g. it may be represented as a binary magnetic condition of a ferrite core. *Note 3.* — The context of the use of the term should indicate the radix of notation. (The meaning of " digit " in Notes 1, 2, 3 translates into French as " élément numérique. ") *Note 4.* — In telephone subscriber numbering, any of the numbers 1, 2, 3 . . . 9 or 0 forming the elements of a telephone number (Recommendation Q.10). (This meaning of " digit " translates into French as " chiffre ".)	
** 53.021	*Hamming distance* 1. The number of digit positions in which the corresponding digits of two binary words of the same length are different.	

No.	Terms	Definition to be found in
	2. By extension, the number of digit positions in which the corresponding digits of two words of the same length in any radix are different, for example, the Hamming distance between 21415926 and 11475916 is 3.	
	Note. — In the C.C.I.T.T. context, the term " signal distance " which is synonymous for this term in data processing may cause confusion and therefore is deprecated.	
** 53.029	*information*	
	In the special context of teleprocessing, information is deemed to mean any transmission of signals via telecommunication channels. This information may take the form of data or message.	
53.03	*data signal*	sup. 2
* 53.04	*shannon* *[bit]*	
	The unit of selective information, i.e. the amount of information derived from knowledge of the occurrence of one of two equiprobable, exclusive and exhaustive events.	
* 53.05	*terminal installation for data transmission*	
	Installation comprising: the data terminal equipment (DTE), the data circuit-terminating equipment (DCE), and any intermediate equipment.	
	Note. — In some instances, the data terminal equipment may be connected directly to a data-processing machine or may be a part of it.	



No.	Terms	Definition to be found in
** 53.051	*data circuit-terminating equipment (DCE)*	
	The equipment installed at the user's premises which provides all the functions required to establish, maintain and terminate a connection, the signal conversion and coding between the data terminal equipment	

No.	Terms	Definition to be found in
	(DTE) interface and the line. It may or may not be a specific, or separate piece of, equipment. *Note.* — When the data circuit is provided in a specialized data network, a simplified form of DCE may be provided and this has been referred to as a network terminating unit.	
** 53.052	*data link* (see also 53.05) This is an ensemble of terminal installations and the interconnecting network operating in a particular mode that permits information to be exchanged between terminal installations.	
53.06	*data source*	sup. 2
53.07	*data sink*	sup. 2
53.08	*data terminal equipment*	sup. 2
53.09	*intermediate equipment*	sup. 2
53.10	*signal-conversion equipment*	sup. 2
** 53.101	*first data multiplexer* The equipment that accepts a number of streams of binary digits at the same or different standard data signalling rates and combines these on a time division basis into a single stream of binary digits signalled at a rate equivalent to that of a PCM channel time slot.	
** 53.102	*second data multiplexer* The equipment that accepts a number of streams of binary digits each signalled from first data multiplexers or signals at equal rate and combines these on a time division basis into a single stream of binary digits signalled at the digit rate of a PCM primary block.	
53.11	*modem*	sup. 2
53.12	*interface*	sup. 2
53.13	*storage register* *store* *[memory]*	sup. 2
** 53.131	*shift register* A *register* composed of *binary storage cells* in which the state of each cell is transferred to the adjacent cell in a predetermined direction by the application of a *shift* pulse applied to all stages of the register.	
53.14	*information transfer*	sup. 2
53.15	*information channel*	sup. 2
** 53.151	*information bearer channel* A channel provided for data transmission which is capable of carrying all the necessary information to permit communication including users' data synchronizing sequences, control signals, etc. It may therefore operate at a greater signalling rate than that required solely for the users' data.	

No.	Terms	Definition to be found in
53.16	*forward channel*	sup. 2
53.17	*backward channel*	sup. 2
53.18	*block*	sup. 2
53.19	*start-of-block signal* *synch* (Am)	sup. 2
53.20	*end-of-block signal*	sup. 2
53.21	*information bits*	sup. 2
53.22	*overhead bits*	sup. 2
53.23	*service bits*	sup. 2
53.24	*check bit*	sup. 2
53.25	*erroneous bit*	sup. 2
53.26	*single error*	sup. 2
53.27	*double, triple, ... error*	sup. 2
53.28	*error burst*	sup. 2
53.29	*erroneous block*	sup. 2
53.30 (32.306 and 52.28)	*bit error rate* *element error rate* *character error rate* *block error rate*	sup. 2
53.31 (52.29)	*character check*	sup. 2
53.32	*block check*	sup. 2
53.33	*loop checking* *message feedback* *information feedback*	sup. 2
53.34	*information feedback system*	sup. 2
53.35	*even parity check (odd parity check)*	sup. 2
* 53.36	*data signalling rate*	

The aggregate signalling rate in the transmission path of a data transmission system, expressed in normalized form in binary digits (bits) per second.

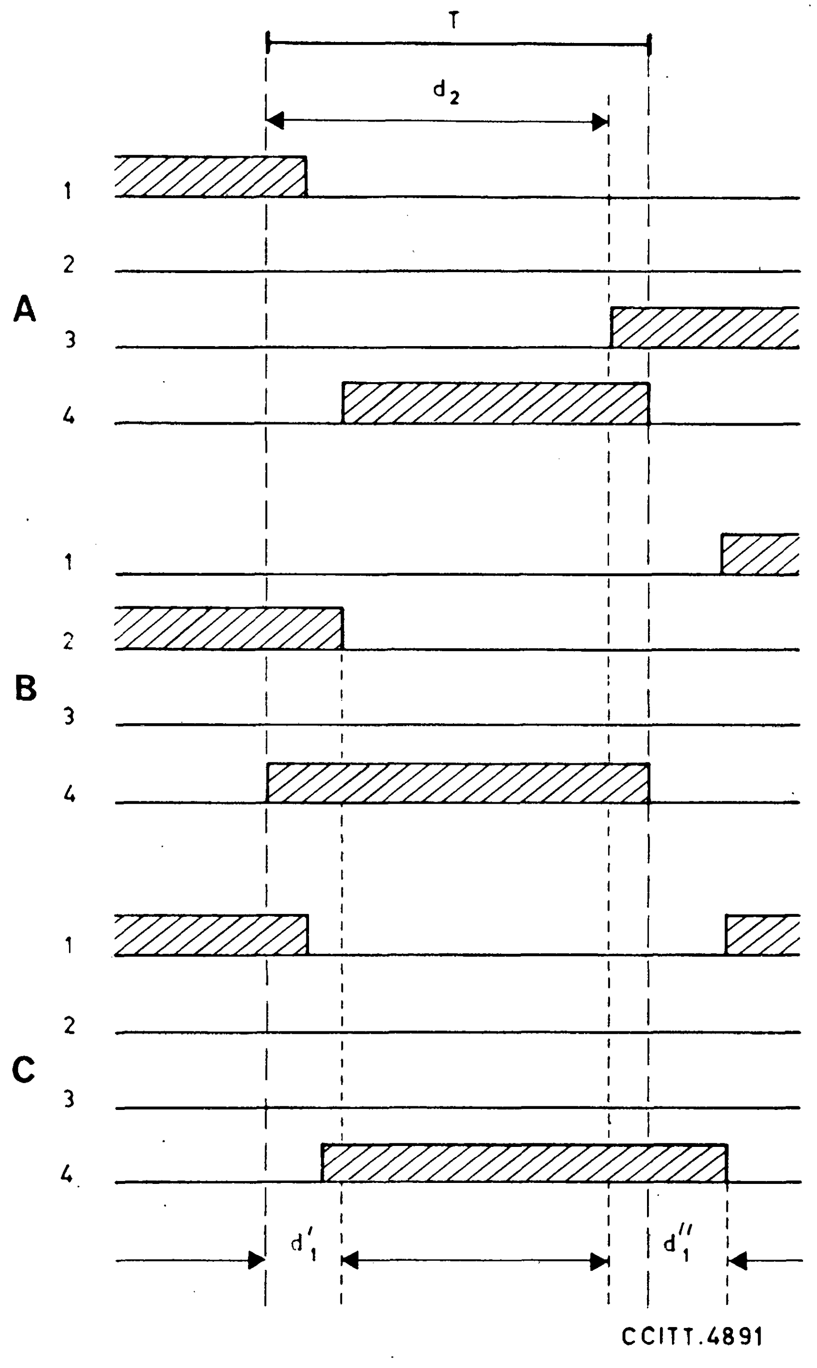
It is given by

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

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.

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 $\frac{1}{T}$;

No.	Terms	Definition to be found in
	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).	
** 53.361	*binary serial signalling rate* In the particular case of a serial two-state transmission this is expressed as the reciprocal of the unit interval measured in seconds and expressed in bits per second.	
53.37	*data transfer rate*	sup. 2
** 53.38	*minimum acceptable interval* The duration of the shortest acceptable significant interval expressed in terms of the unit interval.	
** 53.39	*degree of late anisochronous parallel distortion* Ratio to the theoretical duration of the significant interval of the maximum measured difference between the latest and the earliest coherent significant instants of a modulation (or restitution) within all parallel channels (see figure on the next page).	
** 53.40	*degree of early anisochronous parallel distortion* Ratio to the theoretical duration of the significant interval of the maximum measured difference between this theoretical duration and the duration of the interval between the earliest of all coherent significant instants of a modulation (or restitution) and the earliest of the following set of coherent significant instants (see figure on the next page).	
** 53.41	*coherent significant instant* In parallel transmission the significant instant of a modulation or restitution which normally occurs at the same instant on all channels.	
** 53.42	*inter-character rest condition* In a data system which contains no clock, the distinctive condition which exists for a time between two successive transfers of data characters.	
** 53.43	*burst isochronous* *interrupted isochronous* A transmission process which may be used where the information bearer channel rate is higher than the input data signalling rate. The binary digits being transferred are signalled at the digit rate of the information bearer channel and the transfer is interrupted at intervals in order to produce the required mean data signalling rate. The interruption is always for an integral number of digit periods. *Note.* — e.g. this has particular application where envelopes are being transmitted and received by the data circuit-terminating equipment but only the bytes contained within the envelopes are transferred between the data circuit-terminating equipment and the data terminal equipment.	



Degree of late distortion: $\delta_l = \frac{d_{1\ max}}{T}$

Degree of early distortion: $\delta_e = \frac{T - d_{2\ min}}{T} = \frac{(T - d_2)_{max}}{T}$

T = theoretical duration of the significant interval

Degree of anisochronous parallel distortion

No.	Terms	Definition to be found in
** 53.44	*code independent system* *[code insensitive system]* A system which does not depend, for its correct functioning, upon the character set or code used for transmission by the data terminal equipment.	
** 53.45	*code dependent system* *[code sensitive system]* A system which depends, for its correct functioning, upon the character set or code used for transmission by the data terminal equipment.	
** 53.46	*data switching exchange* The set of equipments installed at a single location to switch data traffic.	
** 53.47	*acoustic coupling (to telephone line)* A method of coupling a data terminal equipment or similar device to a telephone line by means of transducers which utilize sound waves to or from a telephone handset or equivalent.	

INDEX OF RECOMMENDATIONS APPLYING TO TELEGRAPH TECHNIQUE

Series R Recommendations — Telegraph channels

SUBDIVISIONS

Series S Recommendations — Alphabetical telegraph apparatus

Series T Recommendations — Apparatus and transmission for facsimile telegraphy

Series U Recommendations — Telegraph switching

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SERIES R RECOMMENDATIONS

Telegraph channels

SECTION 1

RECOMMENDATIONS CONCERNING TELEGRAPH DISTORTION

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;

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 measurements of the degrees 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 analyzers, 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 text 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 analyzer; 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 analyzer, 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 analyzer 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 last 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:

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

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:

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

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),

$\delta_{\text{irreg.}}$ = 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 δ_{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 measurements 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 -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 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 Recommendation H.22.

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.

For the new numbering of channels which has been adopted in the international service see Recommendation R.70 *bis*.

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 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 ± 0.87 dB when it operates on a constant impedance.

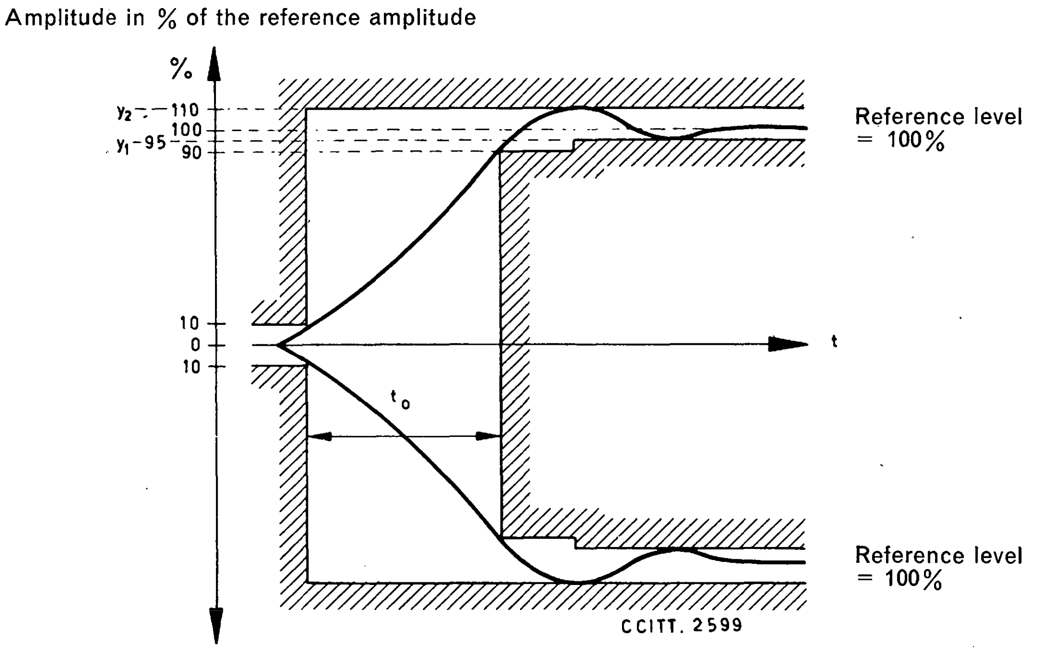


FIGURE 1/R.31. — **Diagram of tolerances to assess the signal waveform sent in amplitude-modulated voice-frequency telegraphy systems**

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 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 7c for new systems.

c) For new systems, the static relay should introduce a difference of not less than 45 dB between the two signalling conditions. (For existing systems the limit is 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 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; Administrations should equip systems which are unable to tolerate such variations with a common amplifier to enable them to at least tolerate variations of ±6 dB.

9. The permissible limit for the power of the telegraph signal 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 microwatts	decibels
12 telegraph channels or less	35	−14.5
18 telegraph channels	15	−18.3
24 telegraph channels	9	−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. 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 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 35 dB 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, Mar del Plata, 1968, and Geneva, 1972)

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.

For the new numbering of channels which has been adopted in the international service see Recommendation R.70 *bis*.

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 $\delta = 2 \frac{|F'_0 - F_l|}{F'_A - F'_Z}$ 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 over a period of 10 seconds;

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

F_l 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.

Note. — To determine the unbalance due to the modulation process by the method indicated above, it is necessary to measure the frequencies F'_A, F'_Z and F_l and to calculate the mean frequency F'_0 and the unbalance

$$\delta = 2 \frac{|F'_0 - F_l|}{F'_A - F'_Z}$$

A more rapid method for checking whether or not the unbalance is less than the limit fixed is to measure:

— the mean dynamic frequency F_l with 1: 1 signals during 10 seconds

— the mean dynamic frequency F_m with 2: 2 signals during 10 seconds

$$\delta = 2 \frac{|F'_0 - F_l|}{F'_A - F'_Z} = 4 \frac{|F'_0 - F_m|}{F'_A - F'_Z}$$

or to subtract

$$|F_l - F_m| = \frac{1}{4}(F'_A - F'_Z)\,\delta \approx \frac{1}{4}(F_A - F_Z)\,\delta \leqq 0.4 \text{ Hz}$$

The absolute value of the difference between the two frequencies measured F_l and F_m must be less than 0.4 Hz.

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. In this latter case, the absolute value of the unbalance δ due to the modulation process must be less than 3%.

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 — decibels
12 telegraph channels, or less	11.25	−19.5
18 telegraph channels	7.5	−21.25
24 telegraph channels	5.6	−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 1.7 dB in the same channel. Both of these levels must lie between +1.7 dB and −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.

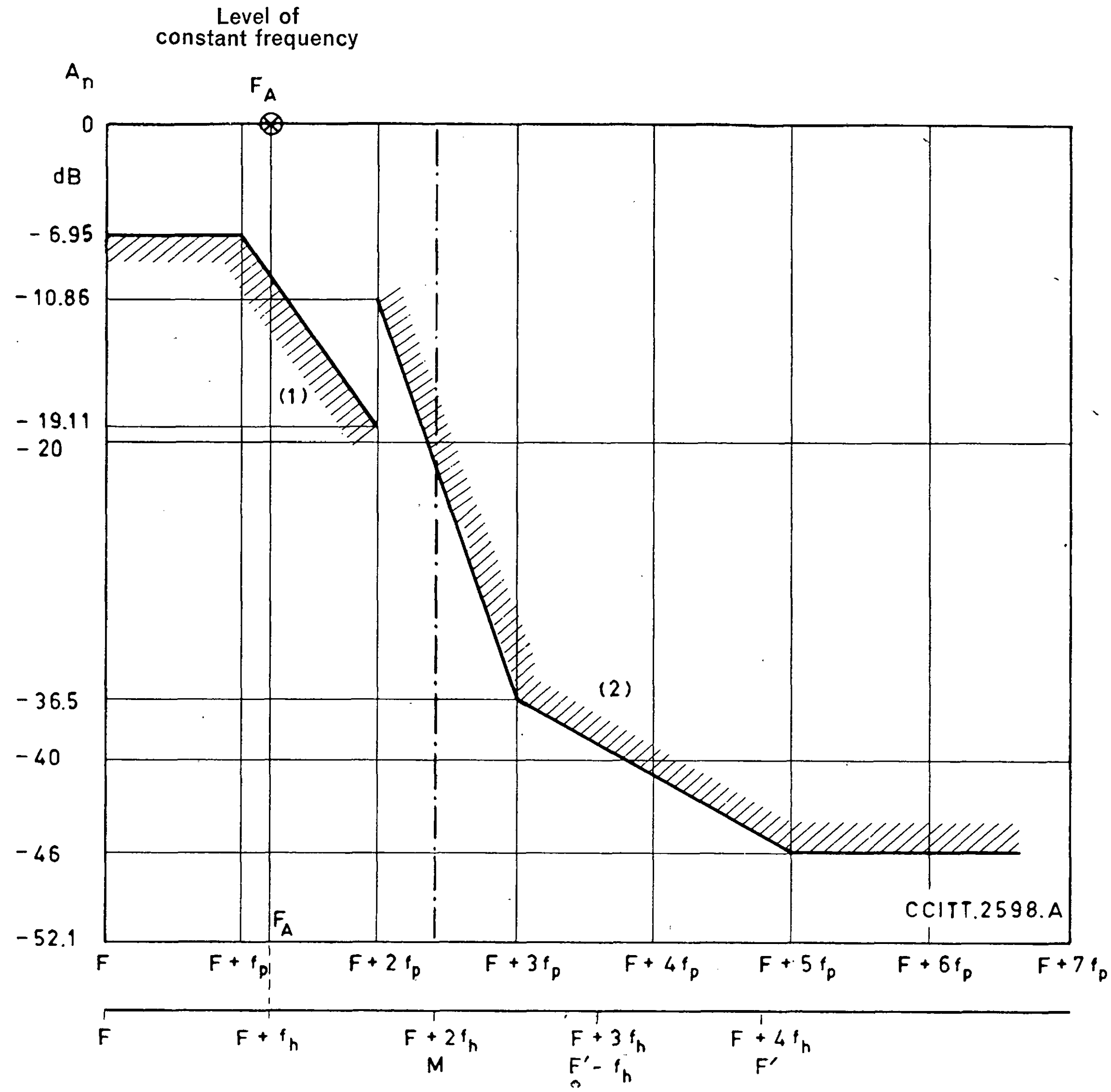
12. The receiving equipment should operate satisfactorily when the receiving level falls to 17.4 dB below the nominal level. The receiving equipment should have been restored to start polarity when the receiving level has fallen to 23.5 dB below the nominal level.

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.



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/R.35. — **Frequency spectrum for 1:1 signals in frequency-modulated 50-baud-120-Hz spacing voice-frequency telegraph systems**

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 8.7 dB above the normal reception level and 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 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. -22.5 dB.

15. The number of significant modulation conditions 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

(Geneva, 1964)

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 consists of two or more channels in tandem, the use of a 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 channels is recommendable only in a special case, due to bandwidth economy, use of long-distance submarine cables, other line conditions, etc.

Very different possibilities for using these channels may 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.

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 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.

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 (200 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 +8.7 dB to −17.4 dB with respect to the normal reception level	7		7	7	8
In the presence of interference by a single sinewave frequency equal to either of two characteristic frequencies with a level of 20 dB below the signal level of the test channel	12		12	10	15
With introduction of a frequency drift (Δf Hz) of the signals	$(5+2.5\Delta f)$		$(5+1.3\Delta f)$	$(5+0.7\Delta f)$	$(6+1.2\Delta f)$

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 are 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 those 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 point 13 a of Recommendation R.37, and point 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).

For the new numbering of channels which has been adopted in the international service see Recommendation R.70 *bis*.

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.

For the new numbering of channels which has been adopted in the international service see Recommendation R.70 *bis*.

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.

For the new numbering of channels which has been adopted in the international service see Recommendation R.70 *bis*.

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, and Geneva, 1972)

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.

For the new numbering of channels which has been adopted in the international service see Recommendation R.70 *bis*.

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 $\delta = 2\frac{|F'_0 - F_l|}{F'_A - F'_Z}$ 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 over a period of 10 seconds;

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

F_l 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.

Note. — To determine the unbalance due to the modulation process by the method indicated above, it is necessary to measure the frequencies F'_A, F'_Z and F_l and to calculate the mean frequency F'_0 and the unbalance

$$\delta = 2\frac{|F'_0 - F_l|}{F'_A - F'_Z}$$

A more rapid method for checking whether or not the unbalance is less than the limit fixed is to measure:

— the mean dynamic frequency F_l with 1:1 signals during 10 seconds

— the mean dynamic frequency F_m with 2:2 signals during 10 seconds

$$\delta = 2\frac{|F'_0 - F_l|}{F'_A - F'_Z} = 4\frac{|F'_0 - F_m|}{F'_A - F'_Z}$$

or to subtract

$$|F_l - F_m| = \frac{1}{4}(F'_A - F'_Z)\,\delta \approx \frac{1}{4}(F_A - F_Z)\,\delta \leq 0.9 \text{ Hz}$$

The absolute value of the difference between the two frequencies measured, F_l and F_m, must be less than 0.9 Hz.

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 1.7 dB in the same channel. Both of these levels must be between ± 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 $2f_p$ (f_p = frequency of modulation) should be in accordance with the limits specified in Figure 1/R.37; 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 17.4 dB below the nominal level. The receiving equipment should have been restored to start polarity when the receiving level has fallen to 23.5 dB below the nominal level.

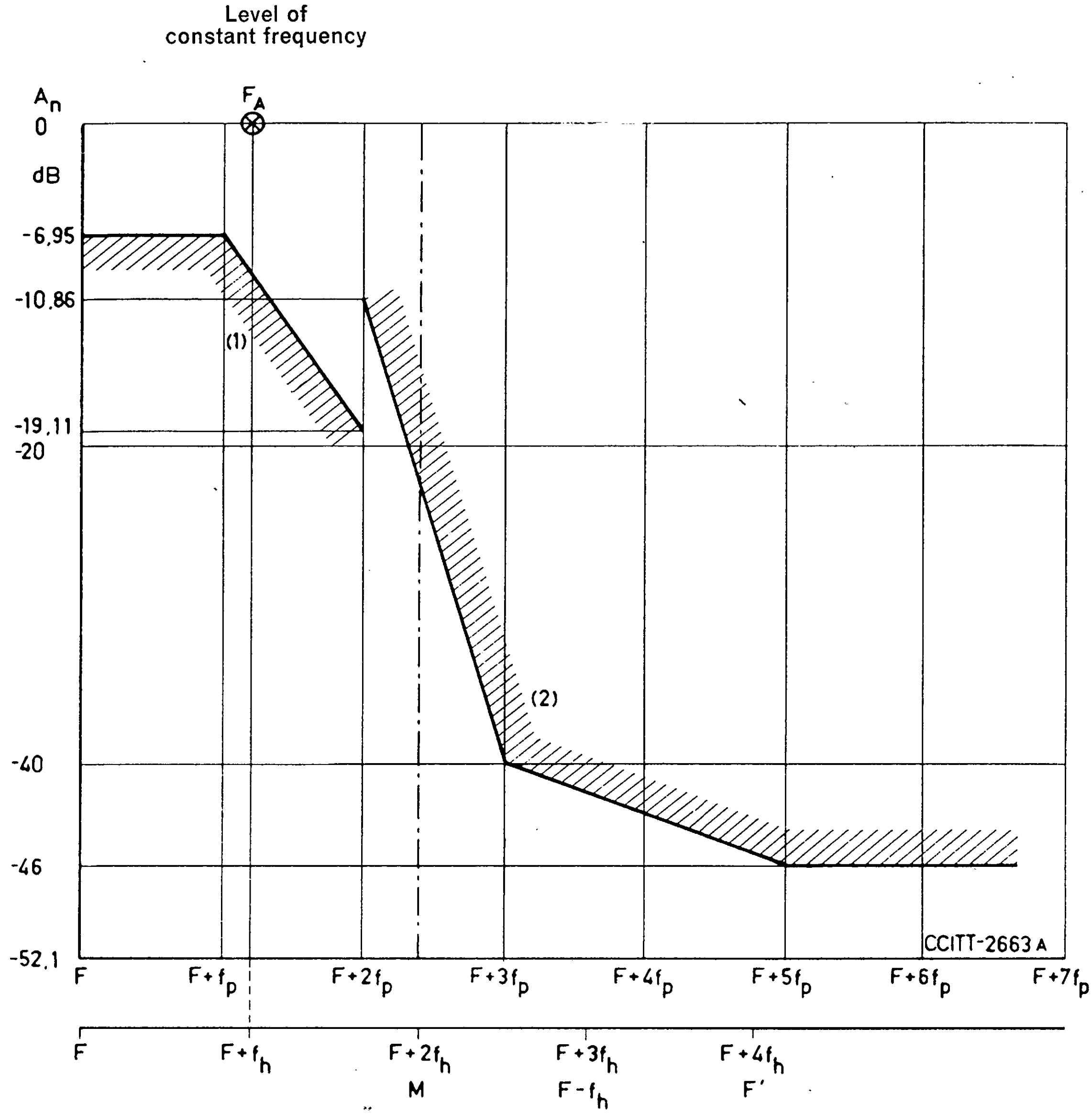
The alarm-control level is left to the choice of each Administration.

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 interchannel interference is to be included in the measurement. These " unrelated signals " can 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;



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/R.37. — **Frequency spectrum for 1:1 signals in frequency-modulated 100 baud-240 Hz and 200 baud-480 Hz spacing voice-frequency telegraph systems**

b) the level being maintained constant, but at a value different from the normal level, for all constant levels between 8.7 dB above the normal reception level and 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 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, and on which the distortion resulting from the frequency drift is not acceptable, 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. -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, and Geneva, 1972)

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.

For the new numbering of channels which has been adopted in the international service see Recommendation R.70 *bis*.

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 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 over a period of 10 seconds;

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

F_l 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.

Note. — To determine the unbalance due to the modulation process by the method indicated above, it is necessary to measure the frequencies F'_A, F'_Z and F_l and to calculate the mean frequency F'_0 and the unbalance

$$\delta = 2\frac{|F'_0 - F_l|}{F'_A - F'_Z}$$

A more rapid method for checking whether or not the unbalance is less than the limit fixed is to measure:

— the mean dynamic frequency F_l with 1:1 signals during 10 seconds

— the mean dynamic frequency F_m with 2:2 signals during 10 seconds

$$\delta = 2\frac{|F'_0 - F_l|}{F'_A - F'_Z} = 4\frac{|F'_0 - F_m|}{F'_A - F'_Z}$$

or to subtract

$$|F_l - F_m| = \frac{1}{4}(F'_A - F)'_Z\,\delta \approx \frac{1}{4}(F_A - F_Z)\,\delta \leqq 1.8 \text{ Hz}$$

The absolute value of the difference between the two frequencies measured, F_l and F_m, must be less than 1.8 Hz

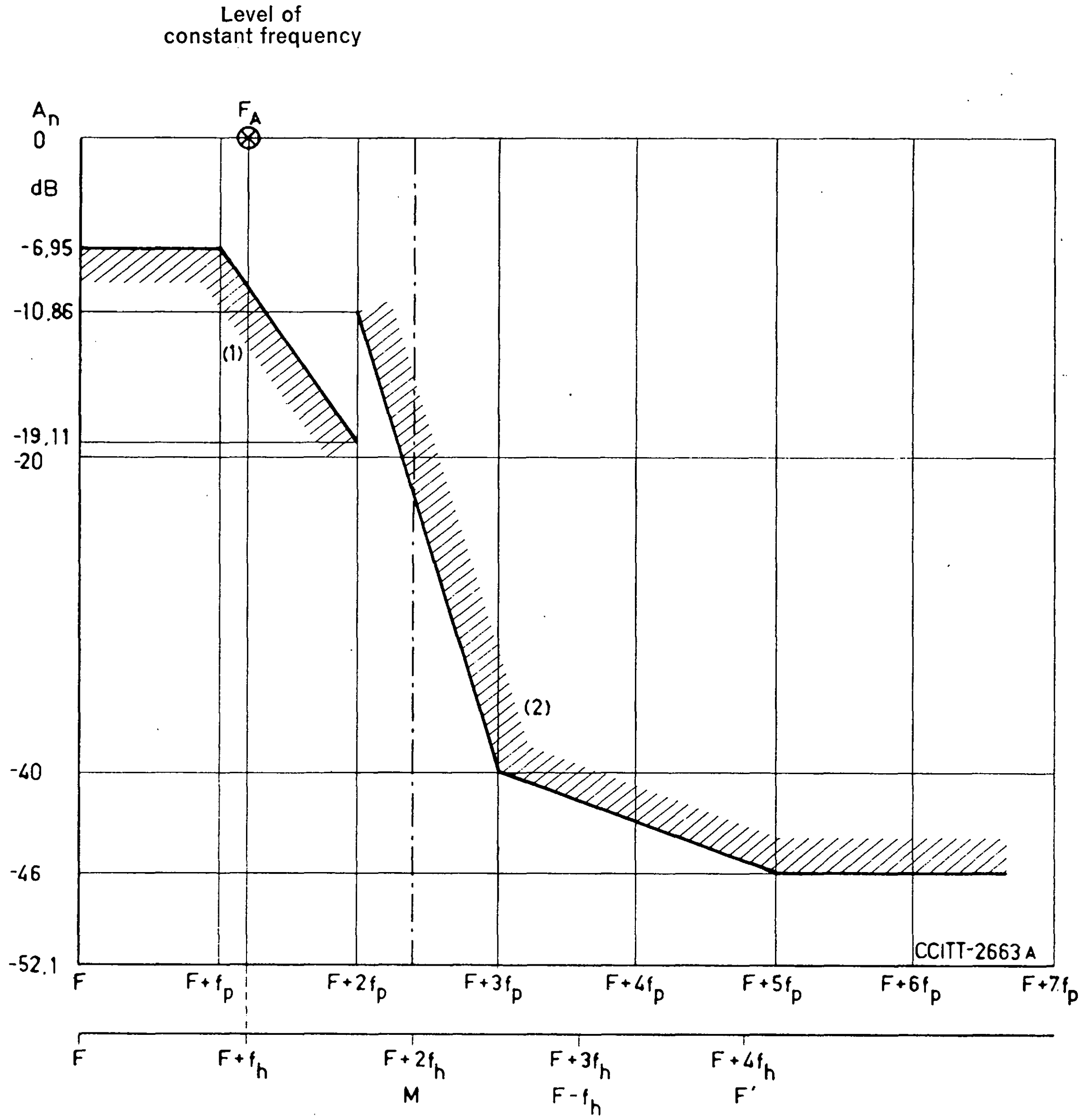
7. The mean power per channel at relative zero level should not be more than 22.4 microwatts.

8. In service, the levels of the permanent " start " polarity signals and the permanent " stop " polarity signals must not vary by more than 1.7 dB on the same channel. These two levels will have to lie between +1.7 dB and −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 frequency is the lower one (see Recommendation V.1).

10. 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.

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/R.38A; 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/R.38 A. — **Frequency spectrum for 1:1 signals in frequency-modulated 100 baud-240 Hz and 200 baud-480 Hz spacing voice-frequency telegraph systems**

12. The receiving equipment should operate satisfactorily when the receiving level falls to 17.4 dB below the nominal level. The receiving equipment should have been restored to start polarity when the receiving level has fallen to 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 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 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: 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 8.7 dB above the normal reception level and 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 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.

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, and on which the distortion resulting from the frequency drift is not acceptable, 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 tolerence 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. -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 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, amended at Geneva, 1972)

1. 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.

For the new numbering of channels which has been adopted in the international service see Recommendation R.70 *bis*.

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 unbalance due to the modulation process $\delta = 2 \dfrac{|F'_0 - F_l|}{F'_A - F'_Z}$ 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 over a period of ten seconds;

F_0 is the mean static frequency measured $= \dfrac{F'_A + F'_Z}{2}$.

F_l is the mean dynamic frequency measured with 1:1 rectangular signals during 10 seconds.

Measurements 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.

Note. — To determine the unbalance due to the modulation process by the method indicated above, it is necessary to measure the frequencies F'_A, F'_Z and F_l and to calculate the mean frequency F'_0 and the unbalance

$$\delta = 2 \frac{|F'_0 - F_l|}{F'_A - F'_Z}$$

A more rapid method for checking whether or not the unbalance is less than the limit fixed is to measure:

— the mean dynamic frequency F_l with 1:1 signals during 10 seconds

— the mean dynamic frequency F_m with 2:2 signals during 10 seconds

$$\delta = 2\frac{|F'_0 - F_l|}{F'_A - F'_Z} = 4\frac{|F'_0 - F_m|}{F'_A - F'_Z}$$

or to subtract

$$|F_l - F_m| = \frac{1}{4}(F'_A - F'_Z)\,\delta \approx \frac{1}{4}(F_A - F_Z)\,\delta \leqq 1.3 \text{ Hz}$$

The absolute value of the difference between the two frequencies measured, F_l and F_m, must be less than 1.3 Hz.

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

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

10. The " start " polarity frequency is the higher of the two characteristic frequencies, and the " stop " polarity is the lower one (see Recommendation V.1).

11. 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.

12. The receiving equipment should operate satisfactorily when the receiving level falls to 17.4 dB below the nominal level. The receiving equipment should have been restored to start polarity when the receiving level has fallen to 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 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 8.7 dB above the normal reception level and 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 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.

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, and on which the distortion resulting from the frequency drift is not acceptable, 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. −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.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

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

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

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) 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 ALTERNATING 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 Recommendation H.31),

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 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 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. (*Green 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 -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 Volume VII of the *White Book*, 1968).

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 inputs 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

Character	*5-unit international code No. 2*	*6-unit international code No. 4*
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
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

1A, 2A, 3A, 4A, 5A, 6A
—, 2B, 3B, 4B, 5B, 6B } full rate
1C, 2C, 3C, 4C, 5C, 6C

(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 bypassed 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 bypassed 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 (±1) 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	
9 (±1)-24 11/36 ms	1 element (24 11/36 ms)	For A polarity, 45 ms
24 11/36-48 11/18 ms	1 element (24 11/36 ms) or 2 elements (48 11/18 ms)	For Z polarity, 33 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 bypassed 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 ±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 ±45%.

d) The maximum speed error for the start-stop output signals should not be greater than ±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 *Green 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 (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 -20 dB referred to one milliwatt at a point of zero relative level.

For amplitude modulation the tolerance on the sent frequency will be ± 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.,

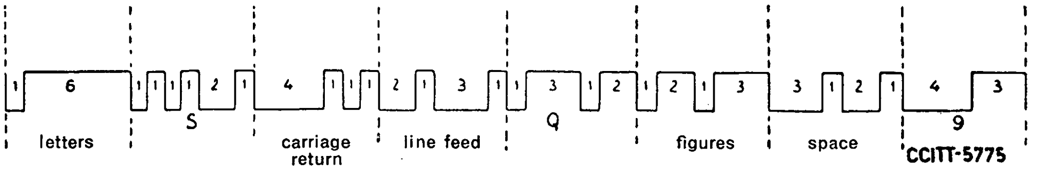
considering

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, 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].

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.

[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.

Recommendation R.57

STANDARD LIMITS OF TRANSMISSION QUALITY TO BE APPLIED IN PLANNING INTERNATIONAL POINT-TO-POINT TELEGRAPH COMMUNICATIONS AND SWITCHED NETWORKS USING 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 and switched telegraph communications, Administrations should use the following standard limits valid for start-stop apparatus and for 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%

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

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%.

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/R.58) shows the points of entry and exit of the national network and the ends of the international junction circuit.

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.

[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.

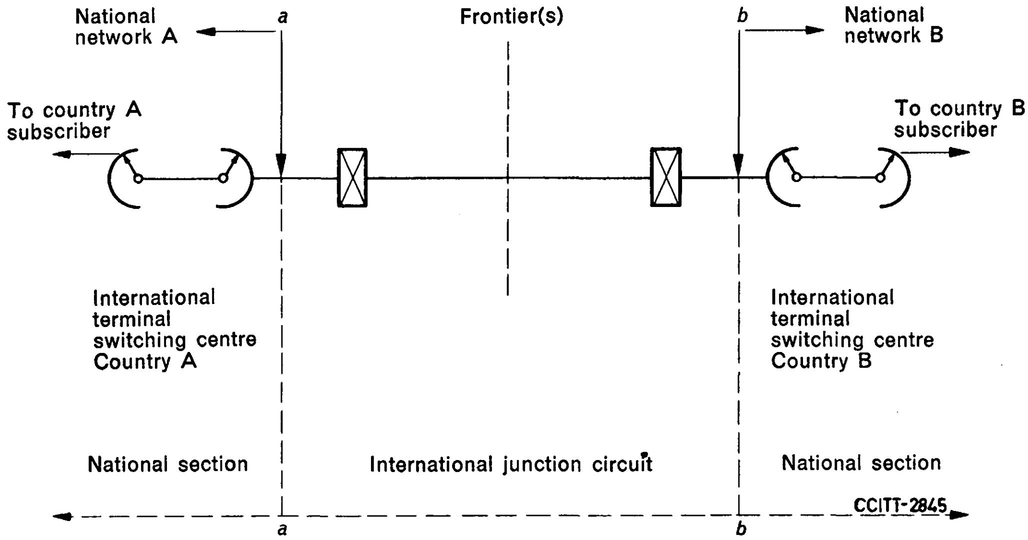


FIGURE 1/R.58

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 has been 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 $\pm 0.5\%$;

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 INTERNATIONAL 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 / Rec. R.35 } 50 bauds/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 cooperation 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 station.*

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 coordination 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 coordinating 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 inquiries 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 cooperation 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 technical supervision of operations, 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 a switched network;

3. that when it is observed that the number of maladjustments is too high, supplementary measurements should be performed by agreement between the 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 should be made outside busy hours as far as possible;

6. that when maintenance measurements are carried out on circuits in operation, every precaution should 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 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 text are not intended to establish a law relating the degree of start-stop distortion to the degree of isochronous distortion; this law of relationship depends on the constitution of the distortion (relative magnitudes of characteristic and random distortion).

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/R.77 illustrates the composition of an international voice-frequency telegraph system and the nomenclature used.

B. 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/R.77 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 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/R.77 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/R.77), 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.

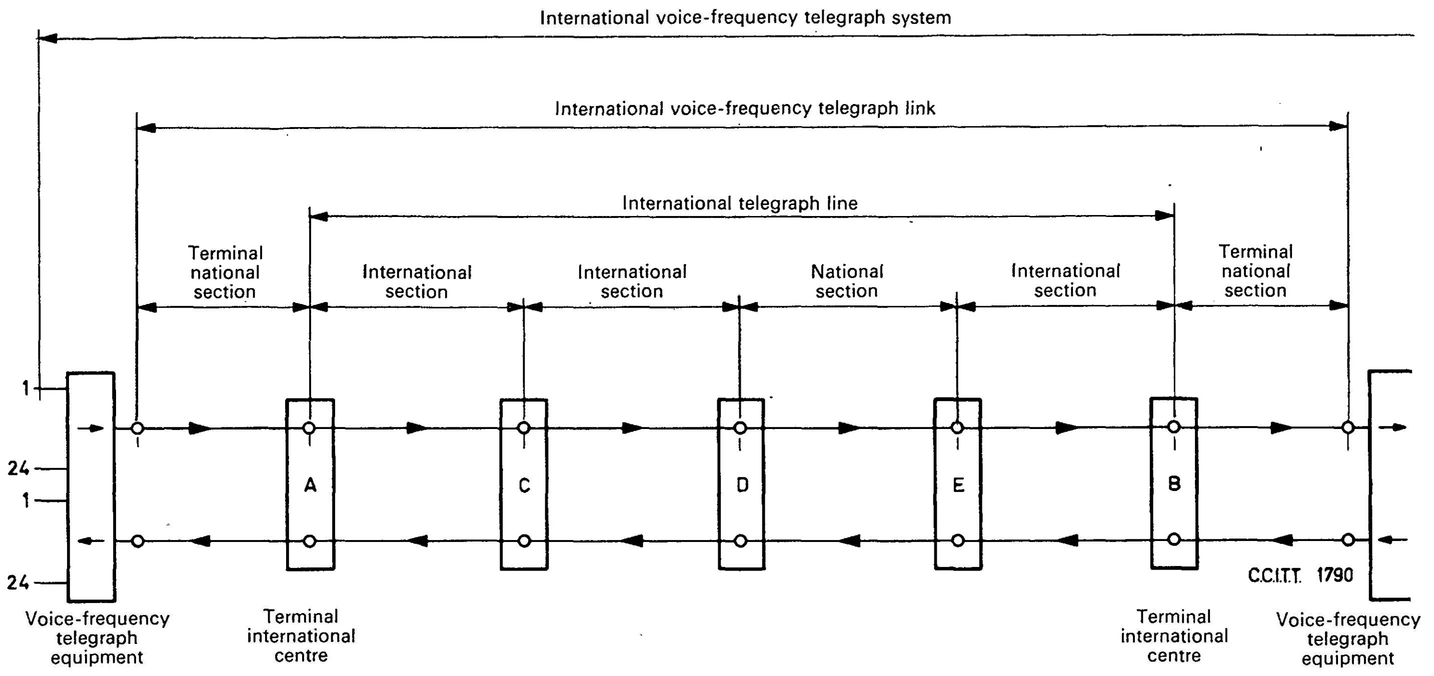


FIGURE 1/R.77. — **The components of an international voice-frequency telegraph system**
(At the intermediate centres C, D and E and at the terminal international centres A and B, the signals transmitted are at audio frequencies. At these points it is possible to make measurements.)

C. RESERVE ARRANGEMENTS FOR INTERNATIONAL VOICE-FREQUENCY TELEGRAPH BEARER CIRCUITS

All necessary action should be taken to enable the duration of interruptions on 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 of 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/R.77).

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 *White 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 C.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/R.77) 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 it 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/R.77 could be applied to sections of the international line mentioned under C.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).

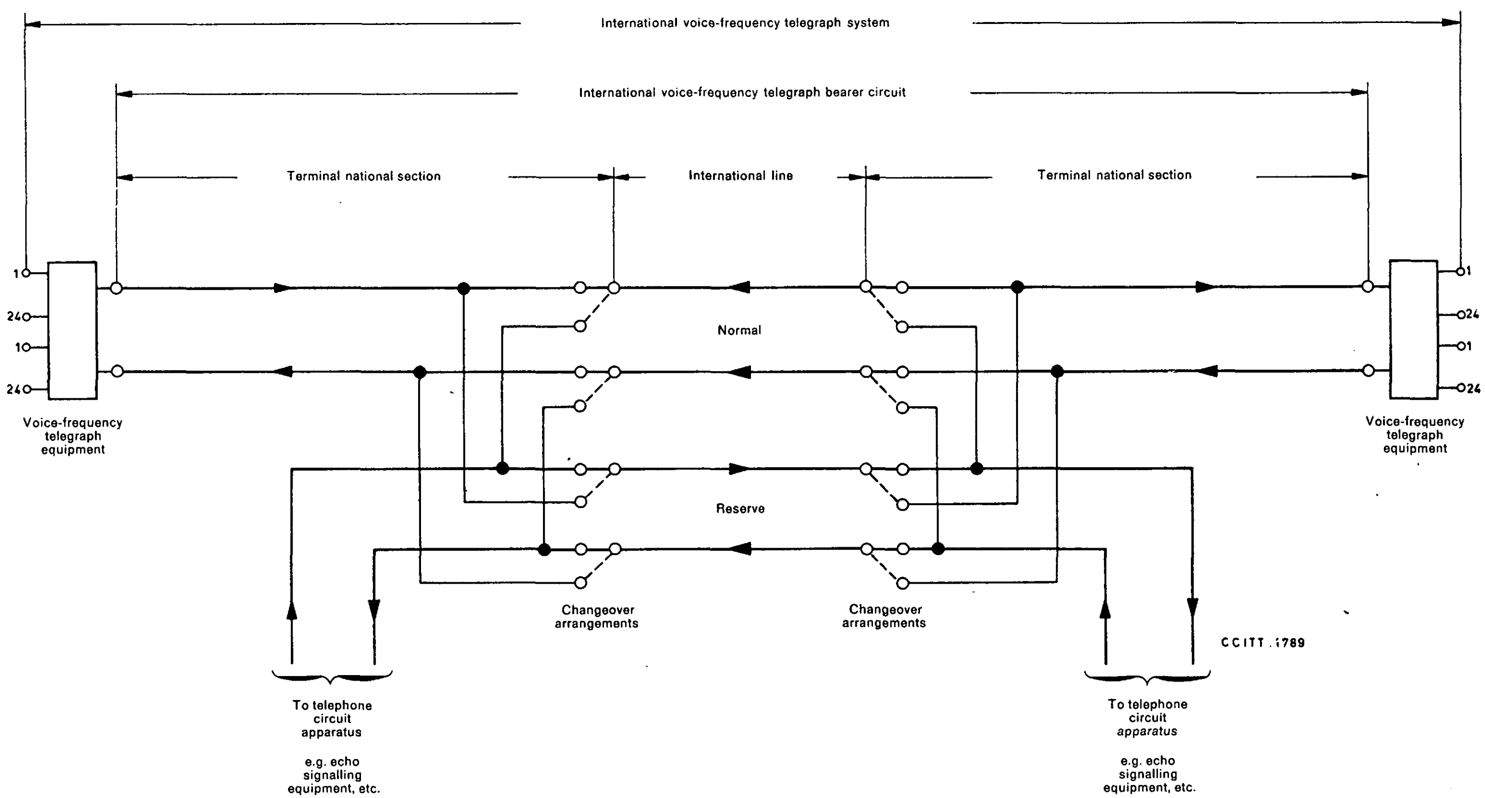


FIGURE 2/R.77. — **An example of how an international telephone line can be used as the reserve for the international line of an international voice-frequency telegraph bearer circuit**

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 an 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 frequency should, as far as possible, be 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, amended at Geneva, 1972)

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].

[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.

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 sense 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 be classified " doubtful " only if the decision level is exceeded *twice* during the measurement.)

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 can only with difficulty 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 on the backward signalling path will commence as soon as possible after the start of the test signals on the forward signalling path.

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 both telex and 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 indicated by the return of 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.

Network B will indicate that it is ready to accept test signals Q9S by sending the ready-for-test signal consisting of 4 × combination No. 11(K) of International Telegraph Alphabet No. 2.

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 verification of the ready-for-test 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, a timetable for the automatic tests 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, or on which busy conditions from the distant network are encountered when testing, 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.s) 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 connected in tandem.

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 direction 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 $\pm 0.5\%$.

A circuit shall be considered doubtful in the rapid tests if the degree of distortion measured on each transmission direction 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. This will be followed by the identification code (either automatically returned or returned in response to the WRU sent by station A) and then by the ready-for-test signal with a delay not exceeding 500 ms after the end of the preceding block.

Station A will receive the call-connected signal, the identification code and the ready-for-test signal.

It may be necessary either as part of the normal signalling requirements of network B or for maintenance purposes for network B to send the " Who are you? " signal to network A. Station A will always return its identification in response to the " Who are you? " sequence. Station B will delay transmission of the ready-for-test signal until the identification code has been received in response to the " Who are you? " signal. The ready-for-test signal will be sent with a delay not exceeding 500 ms after the last character of this block has been received.

The identification code returned by station A will correspond to that returned by station B with the exception that the characters indicating the decision level will be replaced by figure shifts. In this case the identification code returned by station A will correspond to a total of 20 characters.

8. Having verified that the RFT signal is correct, station A will then send six cycles of Q9S signal with a delay not exceeding 500 ms from the end of the reception of the ready-for-test signal.

In the event that the block of signals representing the ready-for-test signal proves to be erroneous or the signal was not received in the time permitted the circuit under test will be indicated as doubtful.

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 ($\pm 20\%$) 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 within 500 ms.

Any call set up for the automatic testing of a circuit shall be automatically cleared if it lasts longer than 30 s. The circuit on which a call has been released in this manner will be marked doubtful for further examination.

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.

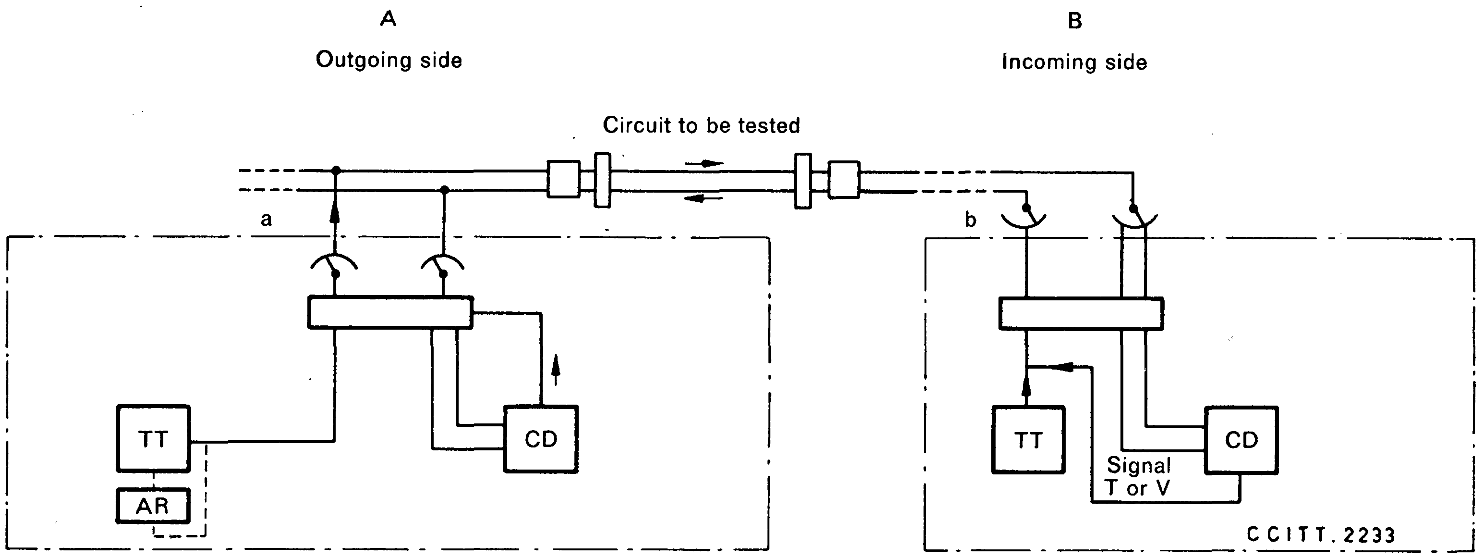
The station in the passive position will not have to intervene.

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.

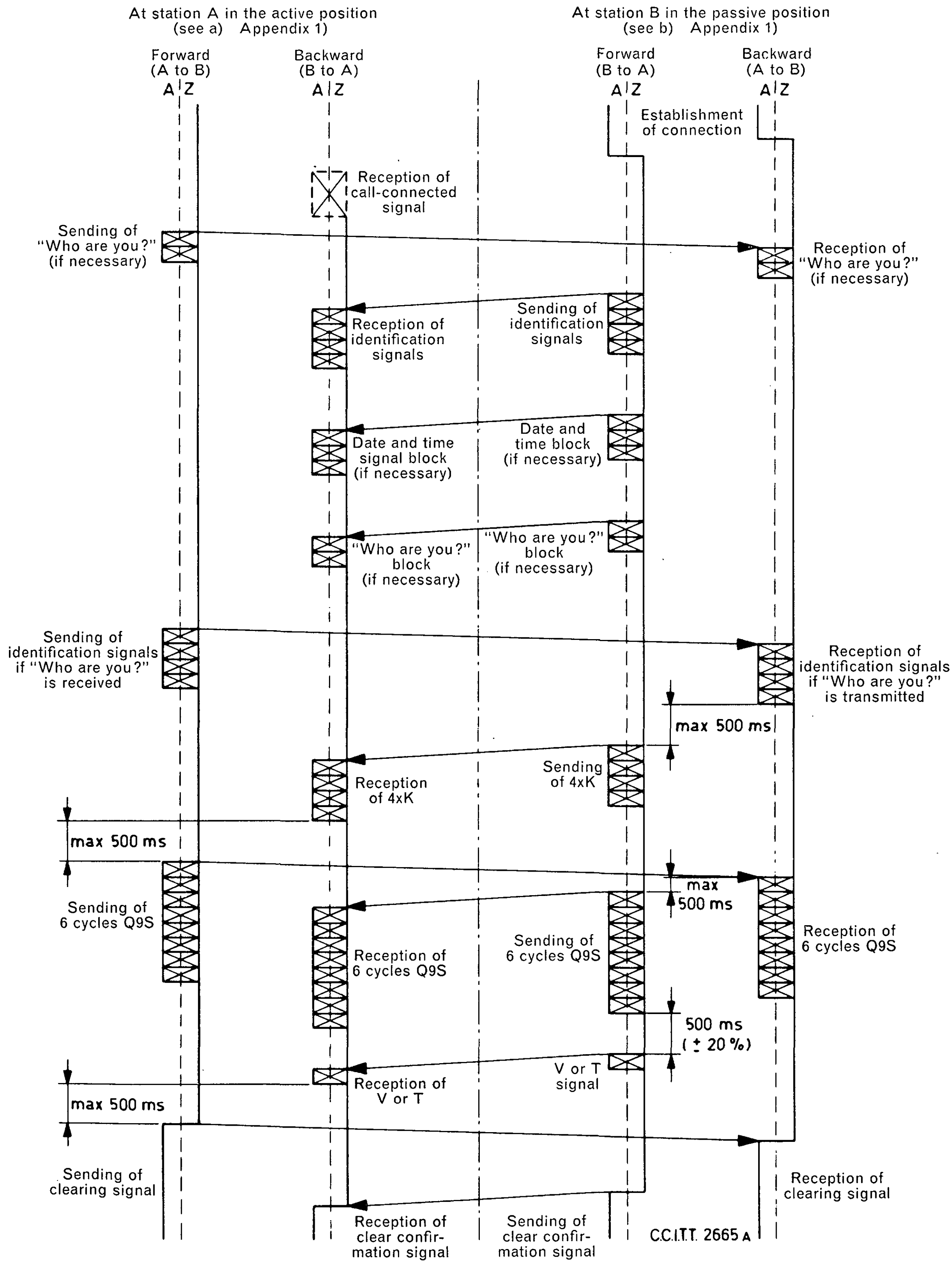
(This Recommendation is the subject of further study: see Question 22/IX = 11/X.)

Note. — Appendix 1 shows a typical block diagram of the equipment. Appendix 2 contains a typical time diagram for one test and shows the optional and mandatory signals.

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 (microphonics) 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 of 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 particularly avoided;
— limit the crosstalk mentioned in Recommendation R.80;
— limit induced voltage caused by electric power and traction systems;
— limit the microphonics 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];

[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.)

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 increases markedly during the normal hours when maintenance staff are present, and is reduced when, despite very heavy traffic, maintenance is suspended, so that 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 practical measures to remedy the situation.

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 cooperating 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 coordinating 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 cooperate 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. cooperates 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/R.90).

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 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 interruptions or reduce the quality of transmission;

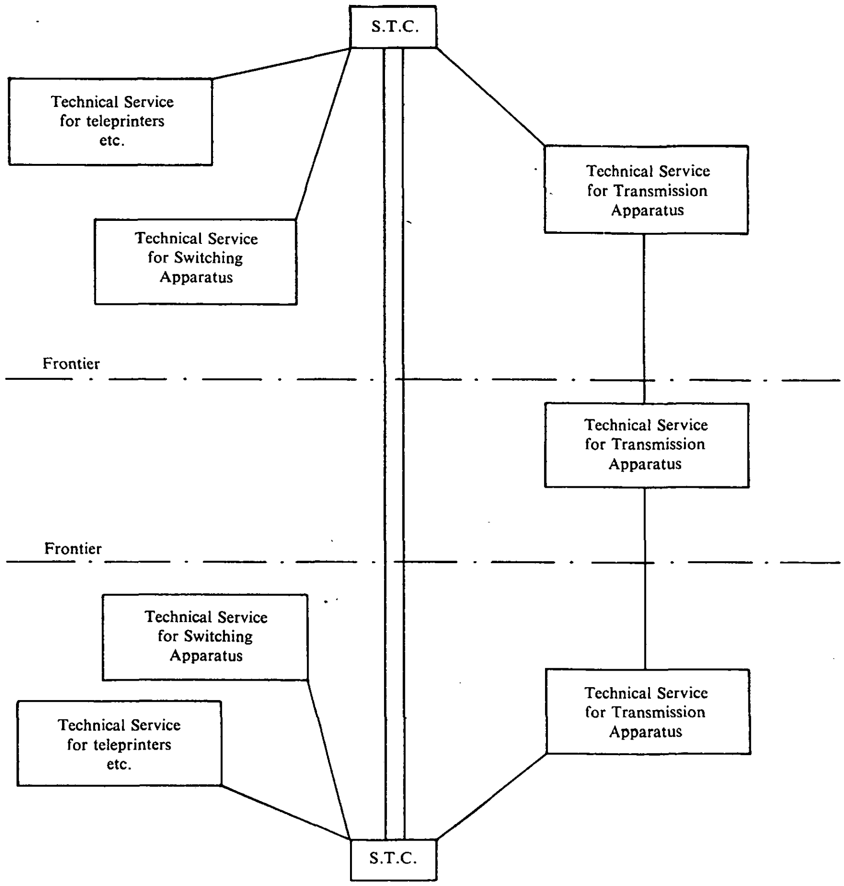


FIGURE 1/R.90

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 inquiries 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 circuits 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

No.	Français English	Abréviation Abbreviation
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	DQIS . . .
14	Appelez-moi dans ..... minutes s'il vous plaît Please call me in ..... minutes	RAP . . . MNS SVP
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 n° ..... Meet me on circuit No.	MEET . . .
19	Veuillez vérifier l'abonné n° ..... 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 . . .

No.	Français English	Abréviation Abbreviation
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
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

No.	Français English	Abréviation Abbreviation
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
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

No.	Français English	Abréviation Abbreviation
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 nº............ 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 nº............ I am receiving errors in 5-unit code — Please check channel No............	RFC
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 system............	OPH...

No.	Français English	Abréviation Abbreviation
66	Multiplex.......... sans protection; veuillez rétablir signal de répétition automatique (ARQ) Multiplex.......... unprotected; please re-establish automatic request for reception (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 As 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.s) 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.

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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 pieces of 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 equipment, 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 units (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:

- 7.5-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 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 networks. 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 units (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:

— 7.5-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 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 units.

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:

— 7.5-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 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, Geneva, 1964, and Geneva, 1972)

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* (Geneva Revision, 1958) 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 as, for instance, 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 R.79,S.11, U.21, U.22, V.10, 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);

g) KKKK ready-for-test signal, for automatic tests of transmission quality.

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),
((((	= corresponding to KKKK	(combinations Nos. 11, 11, 11, 11).

h) 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);

i) 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 seconds, 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.h, C.i, 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 of combinations recommended	Method of operation		
		Message switching (including storage)	Through switching (without message storage)	Point-to-point operation
Start of message	26 3 26 3	Required in most systems	Could be useful in special cases	Not ordinarily required
Suppression of delay signals	8 8 8 8	Not required (delay signal not envisaged)	Required for some types of message (e.g. cypher) when routed over synchronous error-corrected radio-telegraph channels	Not required on public systems (delay signal not envisaged)
End of telegram	26 26 26 26	Could be useful in special cases	Could be useful in special cases	Not ordinarily required
End of message	14 14 14 14	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)	3 3 3 3	Not normally used (as storage is 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)	6 6 6 6			
Connection of data equipment	19 19 19 19	Not normally used	Used for switching into data transmission equipment in association with telex networks	Could be useful for special purposes
Ready for test	11 11 11 11	Not normally used	Used for automatic maintenance of telex circuits	Could be useful for special purposes

TABLE OF COMBINATIONS USED IN RECOMMENDATION S.4

INTERNATIONAL TELEGRAPH ALPHABET No. 2

Combination No.	Number of impulse							Indication	
	Start	1	2	3	4	5	Stop	Letter Case	Figure Case
3	A	A	Z	Z	Z	A	Z	C	:
6	A	Z	A	Z	Z	A	Z	F	Note 1
8	A	A	A	Z	A	Z	Z	H	Note 1
11	A	Z	Z	Z	Z	A	Z	K	((L. H. bracket)
14	A	A	A	Z	Z	A	Z	N	, (comma)
19	A	Z	A	Z	A	A	Z	S	' (apostrophe)
26	A	Z	A	A	A	Z	Z	Z	+

Note 1. — The figure case indication of this code combination is available for the internal service of each Administration or recognized private operating agency.

Note 2. — Symbols A and Z have the meanings defined in the *List of definitions*, Part I, definition 31.38. For punched tape working, A represents no perforation, Z represents a perforation.

Recommendation S.5

STANDARDIZATION OF PAGE-PRINTING START-STOP APPARATUS AND COOPERATION BETWEEN PAGE-PRINTING AND TAPE-PRINTING START-STOP APPARATUS

(Brussels, 1948, 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 cooperation 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 ≡ 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, Geneva, 1964, and Geneva, 1972)

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

considering

that 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 (Note 3),
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.

Note 3. — With reference to point 3, these signals should be selected in accordance with Recommendations F.21 or F.60, Article 22, as applicable.

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

(Mar del Plata, 1968)

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 a 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,

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.10

TRANSMISSION AT REDUCED CHARACTER TRANSFER RATE OVER A STANDARDIZED 50-BAUD TELEGRAPH CHANNEL

(Geneva, 1972)

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

considering

1. that there is a requirement for transmission at reduced character transfer rates on leased telegraph circuits;

2. that the cost of devices to subdivide a standardized 50-baud telegraph channel for simultaneous use by a number of users is relatively high;

3. that a number of Administrations meet the demand for transmission at reduced character transfer rates by providing a separate standardized 50-baud telegraph channel for each user and that the number of transmitted characters per minute is then limited by controlling the operation of the telegraph apparatus;

4. 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 combination 29 of international alphabet No. 2 (" letter shift ") and to wait at least 2 seconds after the emission of this signal before recommencing transmission (Recommendation S.7, paragraph c),

unanimously declares the view

1. that the preferred method of providing transmission at reduced character transfer rate on standardized 50-baud telegraph channels is an arrangement which employs one transmitted character followed by a period of stop polarity, the duration of which is determined in accordance with paragraphs 2 and 3 below,

2. for quarter speed operation (100 characters per minute), the duration of the period of stop polarity required is equivalent to 3 character periods,

3. for half-speed operation (200 characters per minute) the duration of the period of stop polarity required is equivalent to 1 character period.

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 réperforator 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;

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

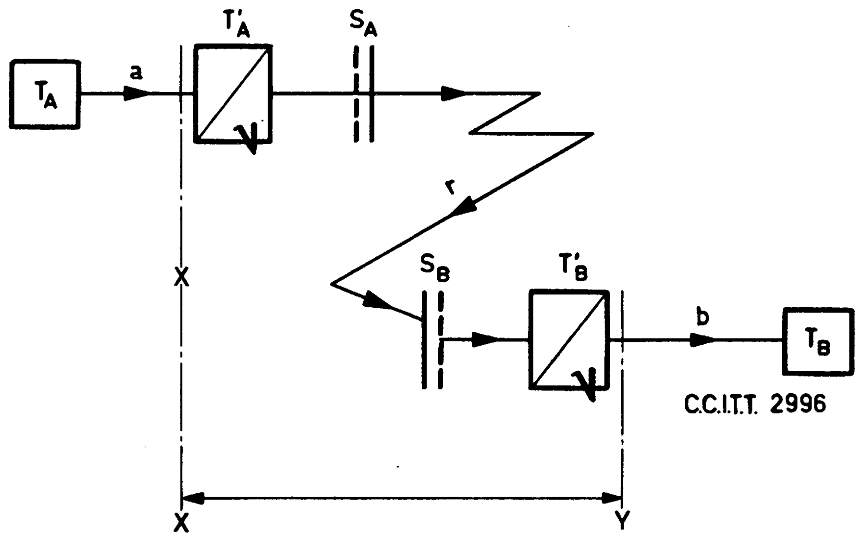
that the start-stop signals provided by the retransmitting portion of the receiving termination of the synchronous system shall have the following characteristics:

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/S.12.



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/S.12. — **Synchronous system**

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, at Mar del Plata, 1968, and at Geneva, 1972)

(This Recommendation corresponds to the C.C.I.R. Recommendation 342-2, New Delhi, 1970)

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 1

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 1, 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*).

4. *Channel D*

As for Channel A (see Figures 1*d* and 2*d*).

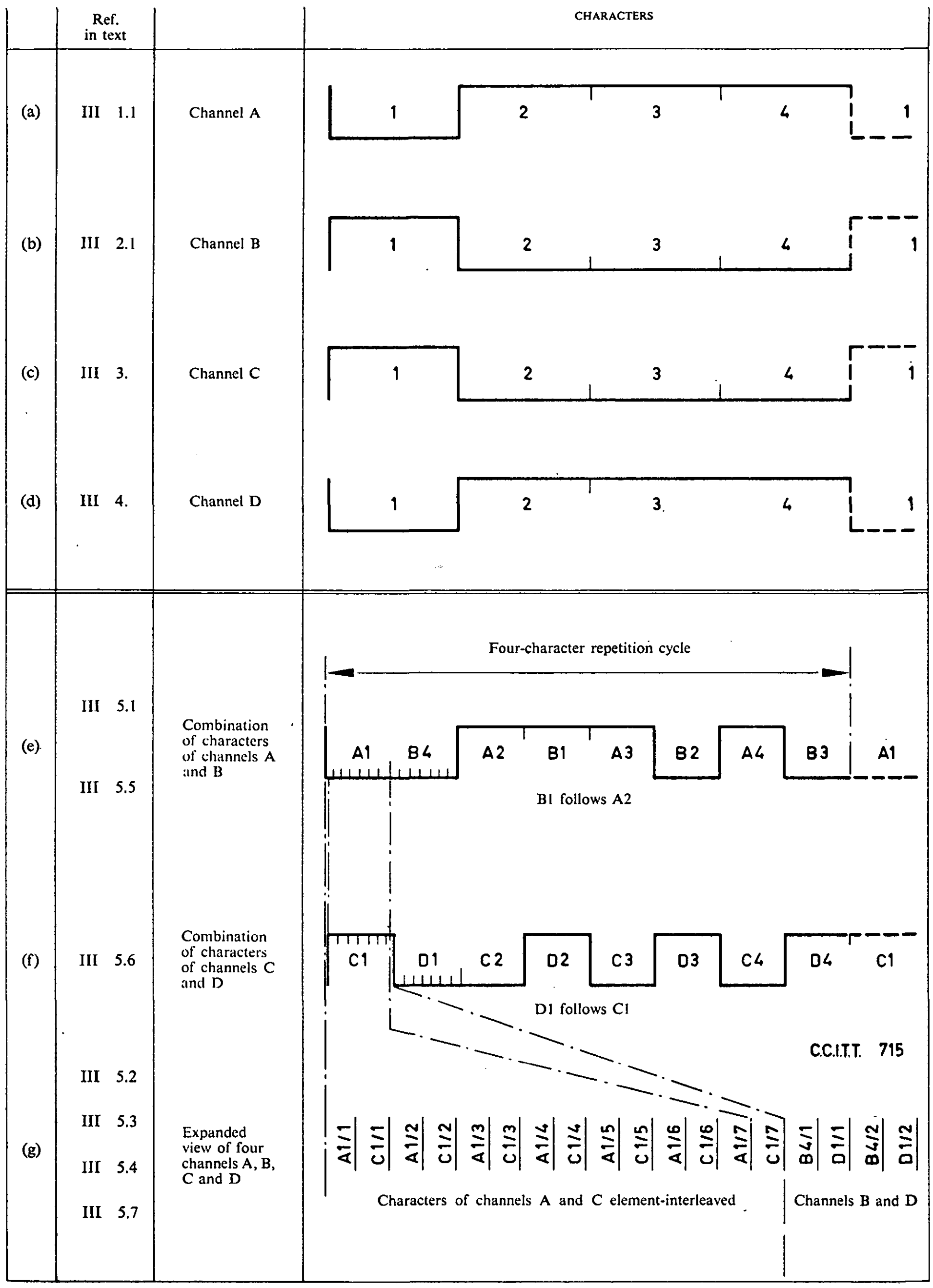


FIGURE 1/S.13. — **Channel arrangement for a four-character repetition cycle**

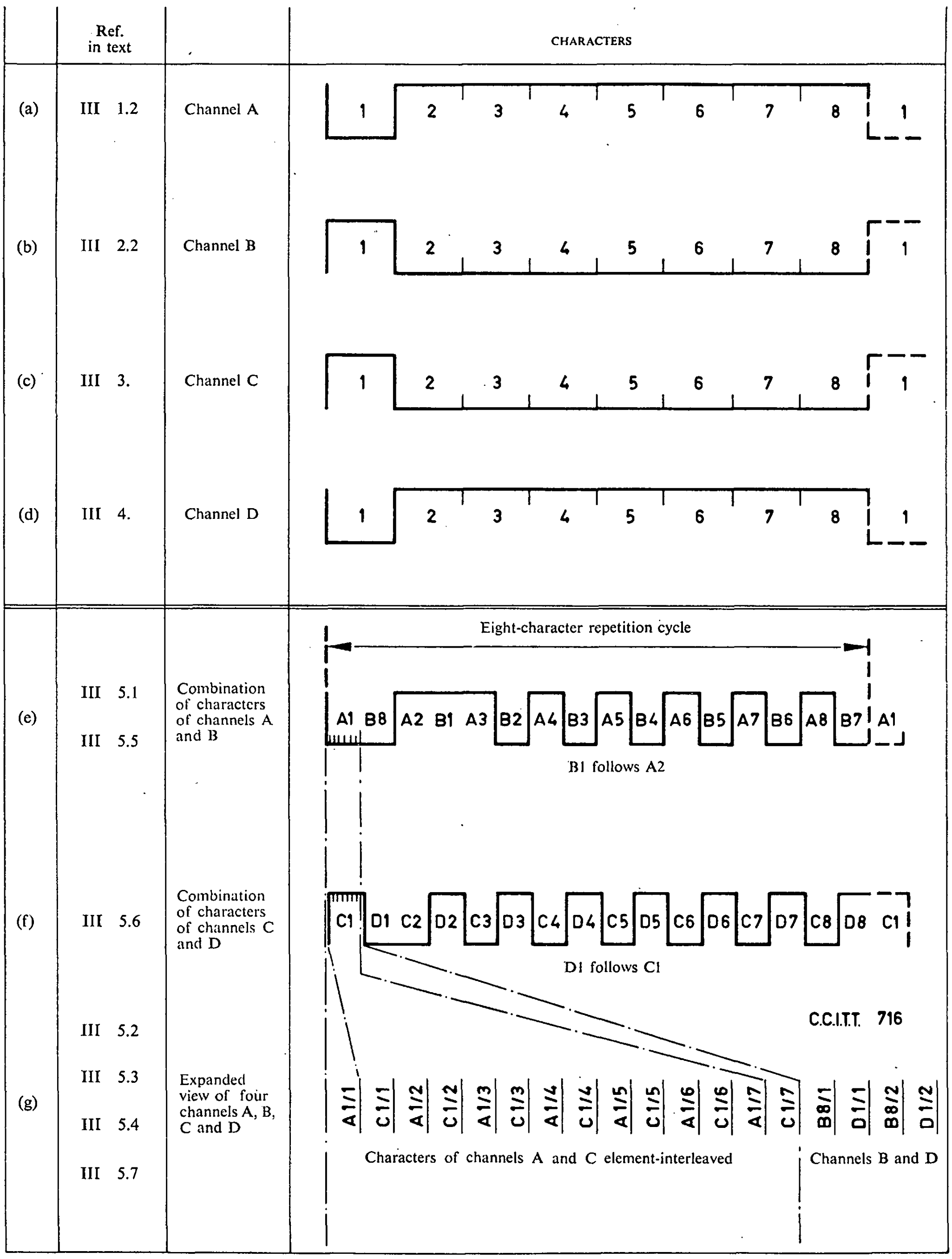


FIGURE 2/S.13. — **Channel arrangement for an eight-character repetition cycle**

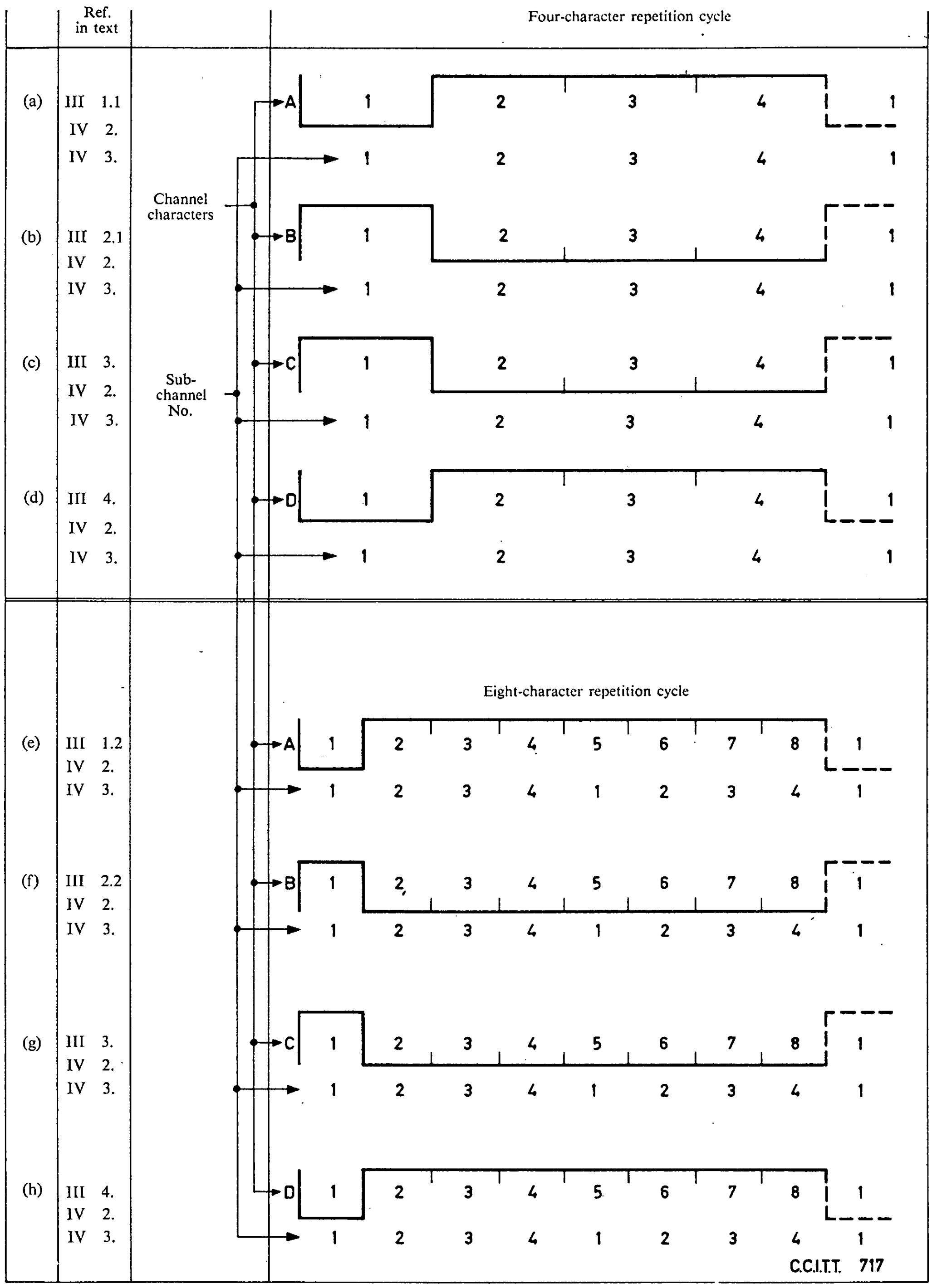


FIGURE 3/S.13. — **Sub-channelling arrangements for a four- and eight-character repetition cycle**

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 2.

TABLE 2

Proportion of full-channel character rate	Combination of fundamental 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
(1) quarter (2) three-quarters	No. 1 Nos. 2, 3 and 4

V. *Designation of aggregate signal*

To assist in identifying the signal condition when applying the aggregate telegraph signal to modulate the radio channel,[1] the following designation for the aggregate signal should be used:

[1] With a frequency shift system, the higher frequency should correspond to aggregate condition B and the lower frequency should correspond to aggregate condition Y.

TABLE 3

Seven-unit code condition	Aggregate signal condition	
	Erect character	Inverted character
A	B	Y
Z	Y	B

VI. *Diagrams*

As a result of the characteristics specified in II, III and IV above, the transmission of characters wil be as shown in Figures 1, 2 and 3.

VII. *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, 1965, amended at New Delhi, 1950)

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.

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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 cooperation*

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

The preferred alternative index, for use when less dense scanning is required, or when the characteristics of circuits (and particularly combined radio and metallic circuits) so demand, is 264 (a factor of cooperation of 829). The admissible tolerances on the above-mentioned values are $\pm 1\%$.

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 cooperation M, factor of cooperation C, drum diameter D, total length of scanning line L, scanning pitch P and scanning density F for apparatus in most common use:

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 cooperation) are interconnected, there will be a slight change in size and the reproduction will bear the same proportion as the original, the ratio being that of the total lengths of the scanning lines.

5. *Drum rotation speed—Scanning line frequency*

5.1 The table below gives the normal and approved alternative combinations of drum rotation speeds or of scanning line frequencies and indices of cooperation:

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

[1] Measured in the direction perpendicular to the scanning line.

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 FACSIMILE APPARATUS FOR DOCUMENT TRANSMISSION [1]

(Mar del Plata, 1968, amended at Geneva, 1972)

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 is extensive in the international service on telephone-type circuits;

2. that such a service may be requested either alternatively with telephone conversation, or when either or both stations are not attended; in the latter case one of the stations will have automatic calling facilities;

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 [2]:

1. *Scanning track*

The message area should be scanned in the same direction in the transmitter and receiver. Viewing the message area in a vertical plane, the scanning direction should be from left to right, and subsequent scans should be adjacent and below the previous scan.

[1] *Document transmission* is intended to indicate the facsimile transmission of black, white and limited range of half-tones without the use of a photographic process at the receiver.

[2] See Recommendation T.4 as regards the remote control and associated equipment.

2. *Index of cooperation*

The nominal index of cooperation is 264. In cases where a lower vertical resolution is acceptable, and by agreement between the users, an optional index of cooperation of 176 may be used.

These values should be observed with a nominal tolerance of $\pm 1\%$ for each equipment.

3. *Dimensions of apparatus*

3.1 The apparatus should accept documents up to a minimum of A4 size.

3.2 The total scanning line length (active sector plus dead sector) should be nominally 215 mm. Nominally 200 mm should be available for scanning or recording, the remainder being the dead sector.

3.3 For any one document the nominal number of scans should be 1144 for an index of cooperation of 264 (762 scans for an index of 176). The receiver should be capable of recording nominally 1144 scans per document for an index of cooperation of 264 (or 762 scans for an index of 176).

3.4 Apparatus with other dimensions may be used provided that the index of cooperation is respected, that the total scanning line length lies between 210 and 250 mm and the usable recording line length retains the same ratio to the total scanning line length.

4. *Scanning density*

" Scanning density " is normally 3.85 lines per mm.

5. *Scanning line frequency*

In the subscriber-to-subscriber service via the general switched telephone network, the scanning line frequency should be 180 lines per minute (Note).

In the leased circuits service the best line frequency, which may be higher or lower than 180 lines per minute, may be chosen according to the circuit characteristics.

The scanning line frequency during the transmission should be kept within ± 10 parts in 10^6 of the nominal value.

Note. — With manual control at the two ends of connection set up over the general switched telephone network, another scanning line frequency (e.g. 240 per minute) may be chosen by agreement between the two operators.

6. *Phasing*

The duration of the phasing signal for transmitters should be 15 ± 1 seconds.

In a preferred method of phasing, the transmitter sends a series of alternating white and black signals in such a way that the white pulse (phasing pulse) is 4 to 6% of the total scanning line length and the leading edge is 2 to 3% in advance of the middle of the dead sector.

Receiving apparatus should synchronize the middle of its dead sector 0.5 to 4.5% lagging the leading edge of the received phasing pulse (Note 2).

Note 1. — In a permitted method of phasing for present generation machines, the transmitter sends a series of white and black signals in such a way that the white pulse is 2 to 12% of the total scanning line length and the leading edge is 2 to 3% in advance of the middle of the dead sector.

Note 2. — Maximum reduction of recorded scanning line length due to synchronizing misalignment should not exceed 3% of total scanning line length. Maximum reduction of recorded scanning line length due to the combined effect of deviations of the transmitter and receiver scanning line frequencies should not exceed 4% of total scanning line length. The effect of these reductions of recorded scanning line length may cause it to be less than the nominal 200 mm.

7. *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 connections 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.

Note. — There are equipments currently in operation on the switched telephone networks which use amplitude modulation. The question of a standardized modulation method for future generations of machines is for urgent study.

b) *Frequency modulation* (for leased circuits and for switched connections)

The frequency corresponding to black will normally be $f_0 - 400$ Hz and the frequency corresponding to white will normally be $f_0 + 400$ Hz (Note 1).

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 user, in some cases, wishes to use the apparatus on switched connections, $f_0 = 1700$ Hz (Note 2).

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.

Note 1. — There are many equipments currently in operation for which black and white are represented in the opposite sense. The frequencies corresponding to black and white are the subject of an urgent study point in Question 7/XIV.

Note 2. — Where upper frequency of 2100 Hz is not permitted on a network because of risk of interference with telephone signalling, an optional upper frequency of 1900 Hz may be used.

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 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 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, 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 mains 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 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 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.

3. No possibility of adjustment for send level or receive sensitivity should be under the control of the operator.

TABLE I

FULLY AUTOMATIC SERVICE ON THE TELEPHONE NETWORK [a]

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.)
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.)

[a] 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
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.
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* [a] 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.

[a] 9 *bis*, see the end of Table 1.

Transmitter	Signalling →	Function or position	Signalling ←	Reception
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.
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* [a] 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.

[a] 13 *bis*, see the end of Table 1.

Transmitter	Signalling →	Function or position	Signalling ←	Reception
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).
Operator presses call button on facsimile (call should follow not later than 10 seconds after end of signal acknowledging receipt).		14 *bis*. Call from operator at *transmitting 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).				Facsimile receiver reverts to position 1 having received no guard signal for 10 seconds (*automatic* switch to telephony).
Hook-up of telephone (release of call).				

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 from operator *at 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). a) *Automatic* start of transmitter motor by detection of signal received, or b) *Manual* start of transmitter motor.		3. Start of transmitter.	Signal No. 1 (2 s).	*Automatic* dispatch of return signal one second after cut-off of signal No. 1 received.
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.

Transmitter	Signalling →	Function or position	Signalling ←	Reception
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 [a]. — — — — — — — — 7 or 7 *bis* [a] 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.
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 transmitter. — Automatic transmission of signal No. 1.	Signal No. 1 (5 s).	10. Final stop. — — — — — — — — 11 or 11 *bis* follows as appropriate.		As in 6.

[a] 7 *bis*, see the end of Table 2
[b] 11 *bis*, see the end of Table 2.

Transmitter	Signalling →	Function or position	Signalling ←	Reception
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.
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 acknowledgement of receipt within a maximum of 10 seconds). *Automatic* dispatch of call signal repeated every 6 s.	Signal No. 3 (2 s).	12 *bis*. Call from operator at *transmitting station.*		Acoustic signal sent (2 s) repeated every 6 seconds.
Intermittent light-up of luminous signal (2 s).			Signal No. 1 (2 s).	Return call 1 s after end of each sequence train.
Acoustic signal sent (2 s) instead of luminous signal.		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.
Call signals stop. Automatic transmission of return signal 1 second after receipt of signal No. 3.	Signal No. 1 (2 s).			Luminous signal lights up.
Manual switch over to telephony (transmitter reverts to position 1).		Telephony.		*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 from operator at *receiving 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 switchover 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, and at Geneva, 1972)

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 will normally be $f_0 - 400$ Hz and the frequency corresponding to white will normally be $f_0 + 400$ 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*

The limits for attenuation distortion on international circuits used for facsimile service are given in Recommendation G.151 concerning telephone circuits. The attenuation distortion between two terminal national centres shall therefore not exceed the limits indicated in Recommendation G.132 and it will not normally be necessary to compensate the distortion of the lines linking the facsimile stations to the terminal national centres in order to obtain, for amplitude-modulated systems, an attenuation distortion between facsimile stations of less than 8.7 dB in the wanted band.

f) *Variation of circuit overall loss with time* (Note 1)

1. The objective is that:

1.1 The difference between the mean value and the nominal value of the transmission loss value should not exceed 0.5 dB.

1.2 The standard deviation from the mean value should not exceed 1 dB.
However, in the case of circuits set up wholly or partly on older-type equipment, where the international line consists of two or more circuit sections, a standard deviation not exceeding 1.5 dB may be admitted.

2. The method for achieving the above objective values is left to the discretion of Administrations (better maintenance, fitting of automatic regulators, etc.).

3. The assumption is made that these limits for the variation of loss with time of a single circuit may be compared to limits for loss measurements made on a set of circuits at a given time. Experience indicates that such a comparison has a practical validity although it has not been fully demonstrated at this time. Administrations are encouraged to use this Recommendation as giving currently practical limits for sets of circuits. This does not preclude the application of these limits to single circuits, should this prove practical at any time.

Note 1. — See Recommendation M.16 and Supplement No. 1.6 of Volume IV of the *Green Book.*

Note 2. — The provisions specified in this paragraph are provisional and need further study from the facsimile transmission point of view.

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, amended at Geneva, 1972)

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 general switched 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 switched 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 normally 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 multi-channel 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 (*Green 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 (*Green Book*, Volume III), the attenuation distortion in the 400-3000-Hz band is less than 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 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 180 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, at Geneva, 1964, and at Geneva, 1972)

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].

[1] In particular, with the same index of cooperation and speed, frequency-modulation necessitates a wider frequency range than that of amplitude-modulation to obtain a picture of the same quality.

[2] See Recommendation T.15 for phototelegraph transmissions over combined radio and metallic circuits.

However, in the case of circuits subject to sudden level variations or to noise, frequency modulation may be preferable to amplitude modulation; Administrations 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

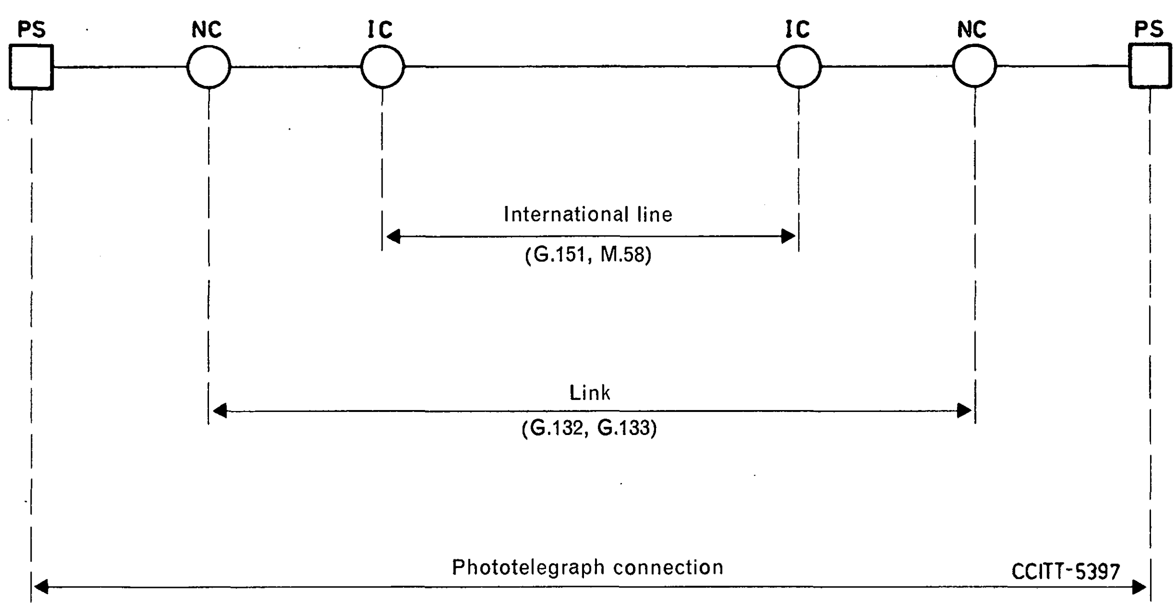
It seems that these circuits are few. In any case, they should even more easily meet the characteristics given in section B below.

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.



IC = international centre NC = national centre PS = phototelegraph station

Note. — The connection is not set up on a chain of switched circuits but on lines according to the terminology used by Study Group IV.

FIGURE 1/T.11. — **Constitution of a phototelegraph connection**

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 power level of the signal is 0 dBm0 for amplitude-modulation phototelegraph transmission and −10 dBm0 for frequency-modulation phototelegraph transmissions. In the case of amplitude-modulation the level of the signal corresponding to black is usually about 30 dB 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*

The limits for attenuation distortion on international circuits used for phototelegraphy are given in Recommendation G.151 concerning telephone circuits. The attenuation distortion between two terminal national centres shall therefore not exceed the limits indicated in Recommendation G.132 and it will not normally be necessary to compensate the distortion of the lines linking the phototelegraph stations to the terminal national centres in order to obtain, for amplitude-modulated phototelegraph transmission, an attenuation distortion between phototelegraph stations of less than 8.7 dB in the wanted band.

f) *Variation of circuit overall loss with time* (Note 1)

1. The objective is that:

1.1 The difference between the mean value and the nominal value of the transmission loss value should not exceed 0.5 dB.

1.2 The standard deviation from the mean value should not exceed 1 dB.

However, in the case of circuits set up wholly or partly on older-type equipment, where the international line consists of two or more circuit sections, a standard deviation not exceeding 1.5 dB may be admitted.

2. The method for achieving the above objective values is left to the discretion of Administrations (better maintenance, fitting of automatic regulators, etc.).

3. The assumption is made that these limits for the variation of loss with time of a single circuit may be compared to limits for loss measurements made on a set of circuits at a given time. Experience indicates that such a comparison has a practical validity although it has not been fully demonstrated at this time. Administrations are encouraged to use this Recommendation as giving currently practical

limits for sets of circuits. This does not preclude the application of these limits to single circuits, should this prove practical at any time.

Note 1. — See Recommendation M.16 and Supplement No. 1.6 of Volume IV of the *Green Book.*

Note 2. — The provisions specified in this paragraph are provisional and need further study from the facsimile transmission point of view.

g) *Phase distortion* (see also Recommendation T.12)

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

$$\Delta t \leq \frac{1}{2 f_p}$$

f_p = Maximum modulating frequency corresponding to the definition and scanning speed.

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 single-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 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.

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/T.12), are not to be exceeded;

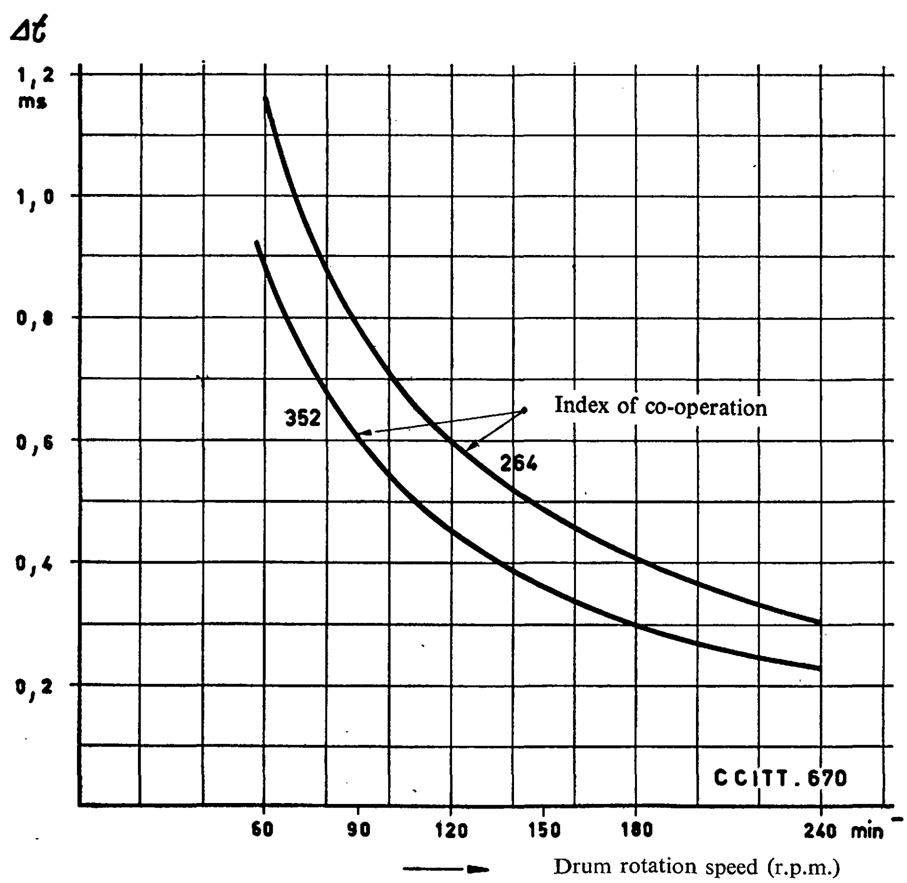


FIGURE 1/T.12. — **Permissible delay distortion in the transmitted frequency band as a function of the phototelegraph transmission speed**

Note. — The scanning 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

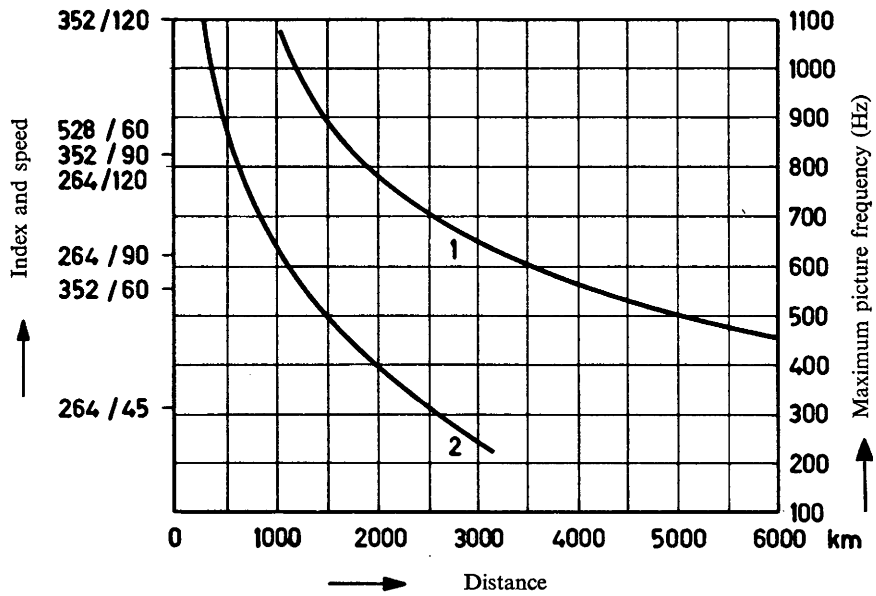
1. The greater the differences between the delays in the transmission intervals, the narrower should be the bandwidth chosen (leading to a lower phototelegraph definition or transmission speed).

2. Hence, audio-frequency circuits should in any case be lightly loaded circuits.

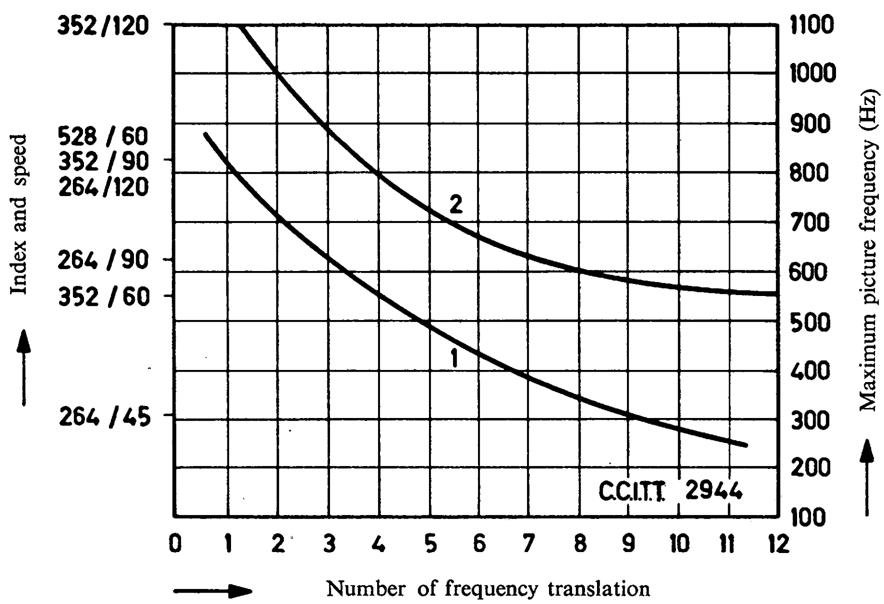
3. Phase distortion is well within the limits indicated above, in the case of carrier circuits, if a single modern-type carrier system is considered (and considering especially the telephone channels in the middle of a 12-channel group of such a system).

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 2/T.12. — **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:

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:

[1] This Recommendation corresponds to C.C.I.R. Recommendation 344-2.

[2] The transmission over communication-satellite systems will be the subject of later study.

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 if the two radio circuits terminate in neighbouring countries. The typical circuit for this connection is shown in Figure 1/T.15.

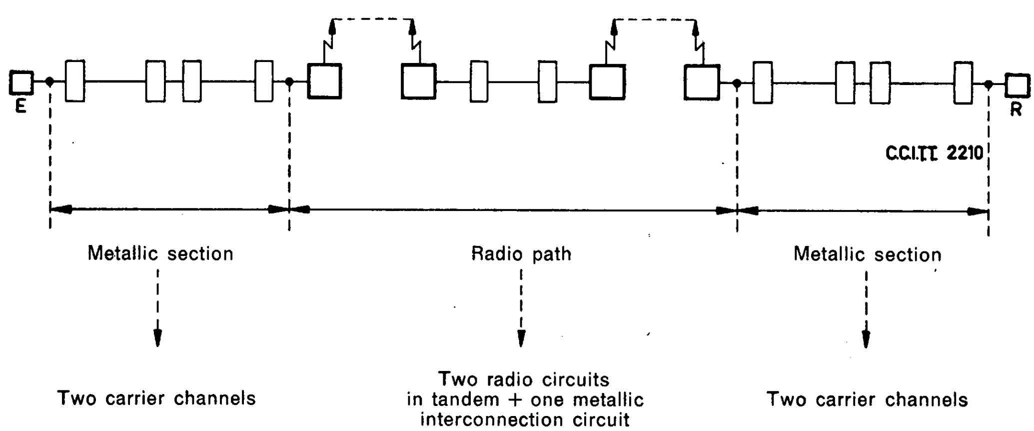


FIGURE 1/T.15. — **Typical circuit in a world-wide phototelegraph connection**

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:

$$\Delta F = \sqrt{3 \times 16^2 + 5 \times 2^2} = 28\, Hz$$

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 realized,

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 two permissible modulation variants exist for 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;

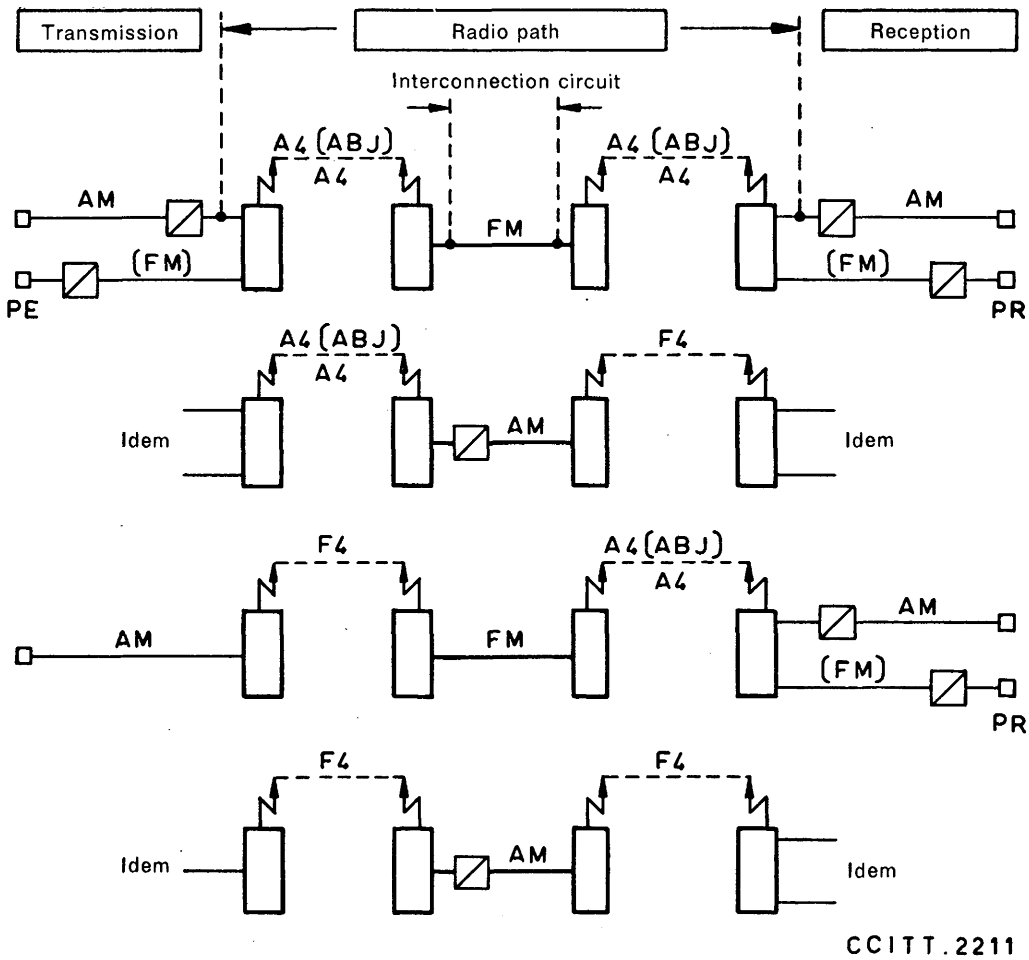
unanimously declares the following view

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:

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/T.15).



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/T.15. — **Position of modulation converters** (▱)

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;

[1] This Recommendation corresponds to C.C.I.R. Recommendation 343-1.

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 frequency) . . .	f_0
frequency corresponding to black	f_0-400 Hz
frequency corresponding to white	f_0+400 Hz

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 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

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.

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;

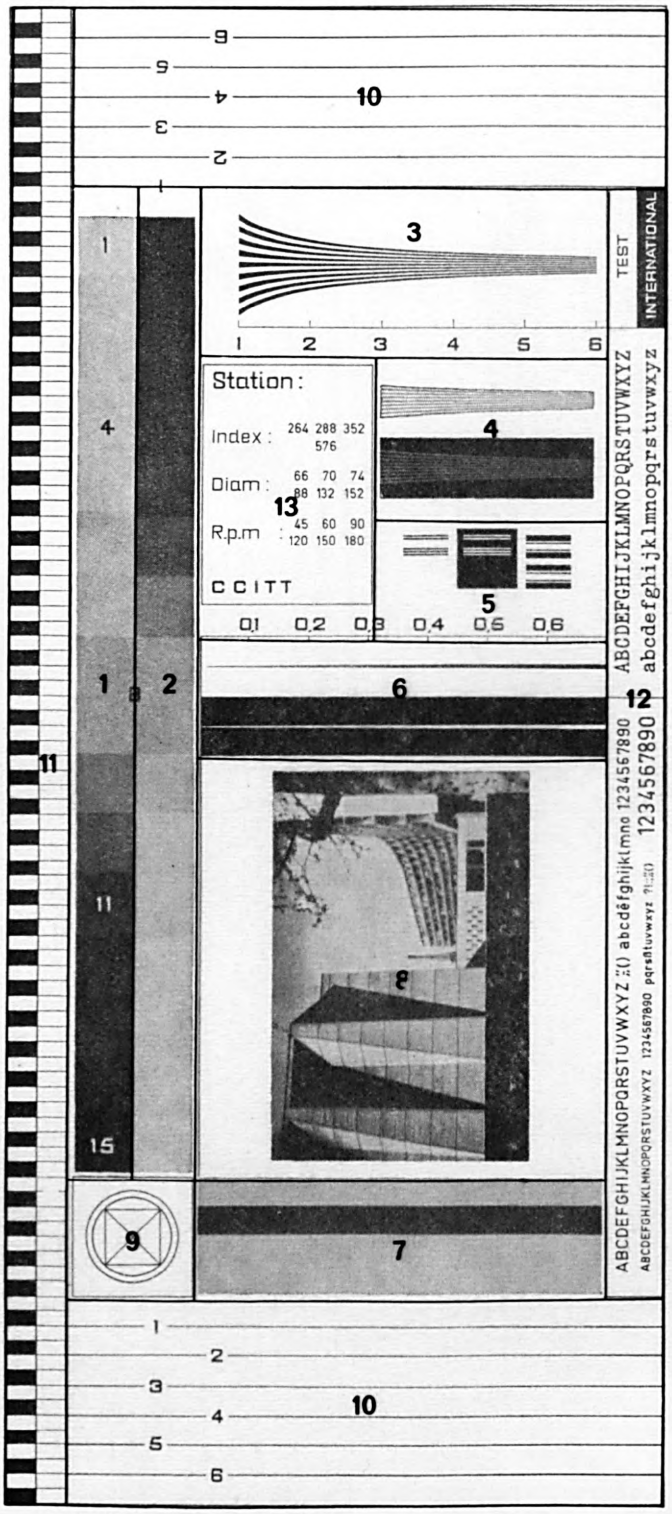
— the cooperation indices most often used;

— the diameters in millimetres of the drums most often used;

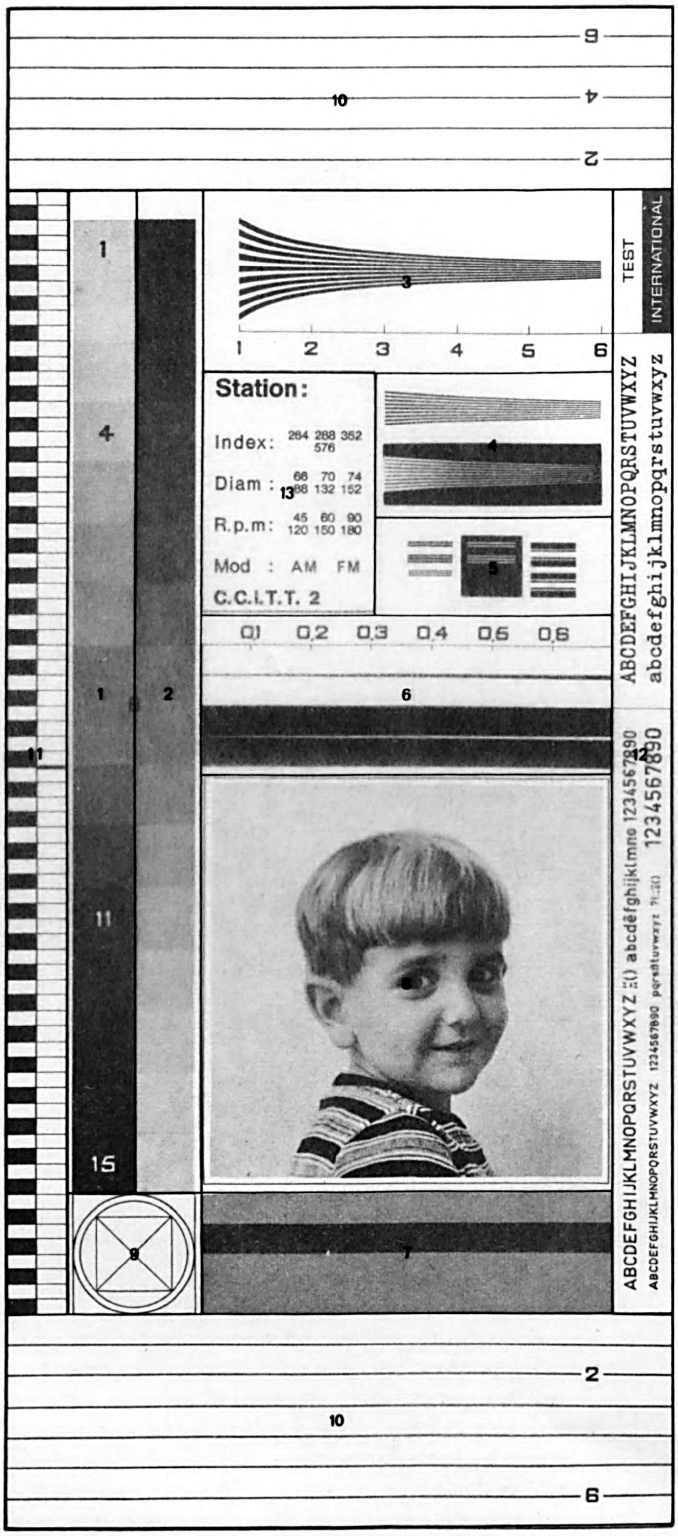
— the r.p.m. of the drums;

— " 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.



Test chart (first edition)



Test chart (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, New Delhi, 1960, Geneva, 1964, Mar del Plata, 1968, and Geneva, 1972)

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 1 a, 1 b and 2 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.

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[1] In certain existing networks, this time may be 4 seconds.

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, it is preferable that the subscriber's number consist of a uniform number of characters.

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 is completed without undue delay. In particular, where excessive delays are encountered, the incoming country may cause the connection to be cleared. When selection 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 the time interval between two successive selection signals (either pulse trains or teleprinter characters) exceeds 5 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. 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).

If the incoming country automatically returns the obtained subscriber's answer-back, the interval between the start of the call-connected signal and the start of the answer-back signals (or, if applicable, of other signal sequences, such as date and time signals) should be at least two seconds to allow satisfactory reception of teleprinter signals by the calling subscriber. In order to restrict charging on unsatisfactory calls, the particular interval should be kept as short as possible and should not exceed:

3 seconds for new networks,

6 seconds for existing networks.

If the call has been routed via a transit centre the two-second minimum period for the call-connected signal, which is transmitted by the destination network, may have been reduced on signalling conversion and the answer-back signals may be received at the originating network after a minimum duration of 1050 milliseconds.

If the incoming country normally returns the obtained subscriber's answer-back code automatically, and the answer-back transmission fails to appear for some reason, the signal DER followed by the clearing signal should be transmitted to the country of origin within 6 seconds from the start of the call-connected signal.

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 a sequence of signals, such as date, time or identity signals, this sequence should be limited to not more than 12 characters and it should be followed within 1100 milliseconds by the answer-back code.

d) If the answer-back of the obtained subscriber is followed by a sequence or sequences of signals, the interval between the end of the answer-back and the completion of the sequence (excluding the answer-back of the calling subscriber if taken automatically) should be as short as possible and should not exceed 4 seconds.

e) For future networks the sending of date, time and other signals, however with exclusion of WRU signals to the calling subscriber, which are additional to the obtained subscriber's answer-back (either preceding or following it), should be avoided on international calls.

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 to 1000 milliseconds.

b) *Clear-confirmation signal*

The clear-confirmation signal is a 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 carriage return and line feed and then immediately by the clearing signal in all cases. Where additional information is transmitted, the long-term objective should be to strictly standardize the format of service signals. Such additional information should consist of four characters and be sent before the service signal at maximum speed. The composition of the complete service signal train should then be:

$\alpha\ \beta\ \gamma\ \delta$ CR LF LS service code CR LF

where α may be a letter-shift or figure-shift.

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.

Access to swichboards 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 $\pm 30\%$) (Note 1) ii) 165-260-ms pulse of " stop " polarity followed by teleprinter signals and then by " start " polarity for 1500 ms (tolerance $\pm 20\%$) (Note 1)

Note 1. — This sequence of signals may be repeated until a clearing signal is sent over the forward signalling path.

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 compromise 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.

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) *Re-test 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 ±20%).

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 positions, 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 1 a, 1 b and 2.

I. International telex circuits terminated on distant automatic switching equipment

TABLE 1 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 ($\pm$ 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: $\pm 30\%$) (Note 1) ii) 165-260-ms pulse of " stop " polarity followed by teleprinter signals and " start " polarity for 1500 ms (tolerance: $\pm 20\%$) (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: $\pm 30\%$) (Note 1) iii) 165-260-ms pulse of " stop " polarity followed by teleprinter signals and " start " polarity for 1500 ms (tolerance: $\pm 20\%$) (Note 1)

Note 1. — This sequence of signals may be repeated until a clearing signal is sent over the forward signalling path. However, with transmission systems having significant propagation delay, e.g. satellite or multiplex systems, it may be preferable to prevent such repetitions.

TABLE 1 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 by 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 ms (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. However, with transmission systems having significant propagation delay, e.g. satellite or multiplex systems, it may be preferable to prevent such repetitions.

Note 2. — The use of this signal should be avoided if possible.

II. International telex circuits terminated on distant manual switching équipment

TABLE 2

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 among 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, and Geneva, 1972)

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 certain Administrations have introduced automatic telex transit switching facilities based upon the signalling standards shown 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 supplements to the documents of the VIIIth Plenary Assembly of the C.C.I.T., and subsequent Plenary Assemblies of the C.C.I.T.T.);

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. The diagrams should show the signalling conditions applicable to transit as well as to terminal calls, including any conversion of the signals which are received from the destination network.

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 bypassed;

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) and the clearing signal, 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 ±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 signal.* 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 ±30%, separated by intervals of " start " polarity lasting 1.5 seconds ±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 destination 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.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.

For the above reason, 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 at 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, and Geneva, 1972)

It is necessary to standardize an intercontinental signalling system to be used between intercontinenta 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 collisions, 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 number of the called subscriber will be signalled as a single group of characters without awaiting backward path signals. There may be some advantage with regard to reducing the occupancy of intercontinental trunks and equipment and in preventing the mutilation of signals, if the complete group of selection signals is assembled preferably by the originating country before commencing to route the call. However, the retransmission of 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 1.

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 1, 2 and 3 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, see Recommendation S.13, Table 1.

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. The clearing signal is then sent and the trunk is released.

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 on the circuit concerned and re-offer the call to the route.

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 transit centre will be provided with an identification code consisting of seven characters of which the uniform format is:

Combination No. 29—either one letter combination and combination No. 29 or two letter combinations designating the transit Administration[a]—combination No. 30—a one, two or three-digit number identifying the centre and/or equipment in the network of the transit Administration[a].

If the numerical portion of the transit centre identification code comprises one or two digits, two or one combinations No. 30 should be added to maintain the seven-character format.

The letter (or two letters) designating the transit Administration[a] shall be the letter (or two letters) of the telex network identification code as far as possible.

The transit centre identification code will be returned automatically in all cases and will continue as far as the calling country. If several transit centres are involved in setting up a call, the calling network will receive the codes of these transit centres 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 for each call will be allowed at only one centre.

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).

[a] or recognized private operating agency.

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.

7.1.3 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					Condition signalled
	1	2	3	4	5	
	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).

Category	Combination	Class-of-traffic					Combination	Class-of-traffic check					Function	
		1	2	3	4	5		1	2	3	4	5	Gentex, telex, telex and gentex combined, or special category	Previously alternatively routed (overflowed)
A	11	Z	Z	Z	Z	A	20	A	A	A	A	Z	Telex	yes
A	21	Z	Z	Z	A	A	15	A	A	A	Z	Z	Telex	no
A	10	Z	Z	A	Z	A	8	A	A	Z	A	Z	Transit between service positions	yes
A	1	Z	Z	A	A	A	13	A	A	Z	Z	Z	Transit between service positions	no
A	6	Z	A	Z	Z	A	12	A	Z	A	A	Z	Gentex	yes
A	19	Z	A	Z	A	A	7	A	Z	A	Z	Z	Gentex	no
A	4	Z	A	A	Z	A	16	A	Z	Z	A	Z	Special category (see note in paragraph 7.2)	yes
A	5	Z	A	A	A	A	22	A	Z	Z	Z	Z	Special category (see note in paragraph 7.2)	no
B	3	A	Z	Z	Z	A	26	Z	A	A	A	Z		yes
B	9	A	Z	Z	A	A	2	Z	A	A	Z	Z		no
B	18	A	Z	A	Z	A	25	Z	A	Z	A	Z		yes
B	28	A	Z	A	A	A	24	Z	A	Z	Z	Z		no
B	14	A	A	Z	Z	A	23	Z	Z	A	A	Z		yes
B	31	A	A	Z	A	A	30	Z	Z	A	Z	Z		no
B	27	A	A	A	Z	A	17	Z	Z	Z	A	Z		yes
B	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 forward signalling path 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 and provide a similar check of the backward signalling path. Failure to receive the reception confirmation and transmission confirmation signals correctly within 5 seconds from the start of the calling signal, or receipt of the transmission failure signal, should initiate the automatic re-test signal on the circuit concerned.

9. The equipment of Centre Y should preferably begin the forward selection as soon as the first digit of the called number has been registered, but in the case of 2-digit destination codes forward selection may be postponed until the second 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, on any intercontinental circuit XY the sequence of selection signals, including those for calls terminating in the country Y, will be as follows.

Case of a called country having a 2-digit destination code	*Case of a called country having a 3-digit destination code*
Class-of-traffic	Class-of-traffic
Class-of-traffic check	Class-of-traffic check
D1	D1
D2	D2
N1	D3
$\vec{N2}$ } start of forward selection	N1
→	→ start of forward selection
N3	N2
.	.
.	.
N*n*	N*n*
Combination No. 26	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 re-rest signal should be initiated on the circuit concerned as indicated in Sections 2 and 8, another attempt to select a circuit should be made (once only) and, if unsuccessful, the transit failure signal should be returned to the preceding exchange. The circuit should be tested for a period of 2½ or 3 minutes (i.e. five tests) and a check made to confirm the receipt of backward path signals up to and including 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 taken out of service, continuous start polarity transmitted on the forward path and an alarm given.

In order to cater for the possibility that a faulty circuit may be seized at both ends, the automatic re-test 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 re-tests 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 seconds 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 receiving equipment 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 receiving equipment congestion is positively identified, and not in the case of a fault in the register access equipment.

Receipt of a receiving equipment congestion signal by a transit centre either on the first attempt or after a single recall (either on the same route or on an alternative route) should cause the transit failure signal to be returned to the calling network.

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 2).

The incoming equipment may release the connection if any of the consecutive combinations of the calling and selection signals is delayed for five or more seconds. In this case the transit failure signal should be returned after the reception confirmation, the transmission confirmation and transit centre identification code signals; and be followed by the clearing signal.

An Administration may release the connection or recall if the transit centre identification 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 1 signals on the intercontinental circuits and vice versa.

5) Alternatively, whether this signalling would be established according to type C signalling.

6) It is permitted to transmit over the intercontinental transit network the digits of the called station number (except the first one or two digits) as and when received from the calling subscriber. It

is to be noted, however, that in that case backward path signals may be received by the calling subscriber or operator during his selection. This may prevent correct printing of the forward and backward path signals and even lead to mutilation of the forward selection signals. This difficulty, as well as unnecessary loading of the intercontinental transit network by selection faults and slow selection can be avoided by assembling the subscriber's selection information, preferably in the originating network.

To give some guidance to Administrations Tables 2 and 3 below have been set up.

Table 2 corresponds to the case of access to the intercontinental transit centre through the adjacent continental centre.

Table 3 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 1 could be applied.

TABLE 1

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 (±10%) after the end of receipt of the class-of-traffic signal. *Combination No. 22 :* returned 450 ms (±10%) after the inversion to stop polarity on the backward path.

TABLE 1 *(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. (see Section 15, sub-paragraph 6)
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.
Transit centre identification		Combination No. 29 Either 1 letter and Combination No. 29 or 2 letters to identify transit centre Y Combination No. 30 1, 2 or 3 digits followed by 2, 1 or 0 Combinations No. 30 respectively	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. In the case of Type-A signalling in the destination network the format of the Type C call-connected signal is either a) Combination No. 32 and 8 Combinations No. 29 transmitted at automatic speed but then preceded by the Type A call-connected signal (150 ms ± 11 ms) followed by 150-300 ms stop polarity, or b) Combination No. 32 followed by 0-300 ms stop polarity and 8 Combinations No. 29 transmitted at automatic speed. In the case of Type B signalling in the destination network the format of the Type C call-connected signal will be always Combination No. 32 and 8 Combinations No. 29 transmitted at automatic speed. In the event of non-receipt of a call-connected or service signal from the destination network within 60 seconds of the transmission of the end-of-selection signal, the last transit centre will return an appropriate service signal and release the connection. Non-receipt of the call-connected or service signal at the first transit centre within approximately 60 seconds of transmission of the end-of-selection signal will cause this transit centre to return the NC service signal and release the connection.

TABLE 1 *(continued)*

Signal or function	Forward path (X towards Y)	Backward path (Y towards X)	Remarks
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) 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 continuous start polarity in the direction of clearing		The minimum recognition time for this signal is 300 ms.
Clear confirmation	Inversion to continuous start polarity in the opposite direction, within 500±100 ms of the commencement of the clearing signal		

TABLE 1 *(concluded)*

Signal or function	Forward path (X towards Y)	Backward path (Y towards X)	Remarks
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 re-test purposes. 30 seconds for one centre. 36 seconds for the other centre. The automatic re-test signal is initiated: — in the case of a head-on collision, on failure to receive the second Combination No. 20, — or on failure to receive the reception confirmation and transmission confirmation signals correctly, — or on receipt of the transmission failure signal.
Backward busy	Continuous stop polarity for a maximum of 5 minutes		
Receiving equipment 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 receiving equipment free to be connected to receive the selection signals within 425 ms of the start of the calling signal. This signal will have to be absorbed by the switching equipment at X and should not be able to go through that equipment to arrive at the preceding centre.
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 as soon as possible following the transit centre identification 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 any of the consecutive incoming Y selection signals is delayed for 5 seconds or more, 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, or when the receiving equipment congestion signal is received from another transit centre.
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. 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.

TABLE 2

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 on the backward signalling path 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 on the backward signalling path occurs after the transit access code digits 00 have been selected. The transit access codel is selected in accordance with the same signal ing arrangements as those used for the terminal traffic into the national network.
Selection signals [a]	Combination No. 30 Class-of-traffic 2 or 3 digit destination code Digits of called number Combination No. 26		
Transit centre identification code signals		As in Table 1 Returned within 150 ms of recognition of the class-of-traffic signal (or the end of selection signal if the method using assembling of selection signals (see Section 15, sub-paragraph 6), is adopted)	
Call connected		As in Table 1	
Service signals		As in Table 1	
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			

[a] 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 3

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 1		
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 1	
Selection signals	As Tables 1 or 2		As Table 1
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 1 and then as soon as the class-of-traffic check combination has been correctly received.
Transit centre identification code signals		As Table 1	
Call connected		As Table 1	
Service signals		As Table 1	
Idle circuit	As Table 1		
Clearing	As Table 1		
Clear confirmation	As Table 1		
Automatic re-test	As Table 1		
Backward busy	As Table 1		
Receiving equipment congestion		As Table 1	
Transit failure		As Table 1	
Transmission failure		As Table 1	

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 1 is recommended.

Recommendation U.12

TERMINAL AND TRANSIT CONTROL SIGNALLING SYSTEM FOR TELEX AND SIMILAR SERVICES ON INTERNATIONAL CIRCUITS BETWEEN ANISOCHRONOUS DATA NETWORKS

(Geneva, 1972)

The C.C.I.T.T.

considering that

1. new networks are being introduced based upon stored programme control techniques;

2. these networks, which may be synchronous or anisochronous, are being provided to carry either telex and similar services or these services in combination with data traffic;

3. the equipment provided for these networks facilitates an enhanced range of facilities compared with those available on existing types of telex network;

4. these factors justify the establishment of a new type of signalling, enabling both telex and other traffic to be handled, as far as practicable, by common processes;

5. for interworking between these anisochronous networks for telex and similar switched telegraph services a signalling standard based upon that described in Recommendation X.70 for start-stop data services on anisochronous networks has been adopted and designated type D;

6. at this stage priority has been given to signalling in an all-type D environment and a recommendation agreed. Further detailed study is required of interworking between type D and other existing signalling standards which might reflect on these agreements;

7. the signalling to apply in connection with synchronous networks remains for further study,

unanimously declares the view

that point A of Recommendation U.1, concerning the responsibility for signal conversion, should be the ultimate aim for interworking between networks using type D signalling on the one hand and types A, B or C signalling on the other.

However, in order to avoid unnecessary inconvenience during the introductory stages of the new signalling system, it is recommended that countries employing type D signalling systems should provide for incoming international traffic type A or B signalling and possibly for transit working type C signalling. The question as to when point A of Recommendation U.1 will become fully effective is yet to be resolved.

1. *The following general switching and signalling principles should apply:*

1.1 Decentralized signalling will apply, the same channel being used for control signalling and information transfer.

1.2 Both terminal and transit operation will be required. Due to the inclusion of transit operation, link-by-link signalling control of calls will be adopted.

1.3 Transit and incoming terminal centres will commence onward selection as soon as sufficient routing information is available from the received signals (overlapping of selection signals).

Selection signals will be transmitted in a single block at automatic speed by the originating country, in which case the end-of-selection signal may be omitted. Alternatively, selection signals may be converted (see Section 2, Note 4) and retransmitted as they are received from the subscriber and in this case an end-of-selection signal will be included. Only one of these alternatives will apply on a route. The incoming country will decide which method will apply.

1.4 Alternative routing will be permitted. The principle of a few high usage circuits will be adopted, with overflow on to adequately provided routes between main centres.

In order to prevent repeated alternative routing causing traffic to circulate back to the originating point, alternative routing will be restricted to once per call.

1.5 Both-way operation will be assumed and inverse order testing of circuits on both-way routes, or a close approximation to it by testing the route in small groups in fixed order always starting the search from the same position, will be specified in order to minimize head-on collisions.

1.6 The grade of service to apply for the provision of circuits should not exceed one lost call in fifty (as stipulated in Recommendation F.64) for routes carrying overflow traffic or from which overflow is not permitted.

Where used, high usage direct link circuits would be provided at a grade of service to be agreed bilaterally.

1.7 Sufficient switching equipment will be provided to ensure that congestion will not be signalled on more than 0.4% of calls in the busy hour, and only then when congestion has been positively identified.

The following specific signals will be employed under the conditions indicated:

2. *Specific signalling characteristics*

Notes applicable to this section

Note 1. — X denotes the international centre which originates the call under consideration on the international link concerned. Y denotes the international centre which receives the call under consideration on the international link.

Centre X and Centre Y will provide any necessary signalling conversion to the type of signalling employed on the preceding and succeeding links if these do not use type D signalling.

Note 2. — Timings shown are within the exchange concerned with no allowance being made for propagation and other delays, such as slow sending of selection signals by the originating subscriber.

Note 3. — In accordance with Recommendation X.70, the times for permanent start polarity (A) and stop polarity (Z) are indicated in the following signal descriptions as integral multiples of a character (see Note 4). Compared with Recommendation X.70, some other multiples are selected in order to enable simpler interworking with systems operating according to Recommendation U.1 (U.11).

Note 4. — The 4-unit code with one parity bit and single-unit start and stop element used in this control signalling system is listed in Table 8.

The parity bit of the signal should correspond to the even parity with regard to elements of Z-polarity. The individual bits should be transmitted at the nominal modulation rate of 50 bauds with the low order bit (i.e. b_1) first and completed by the parity bit (b_5).

2.1 The signalling system for telex and similar services between two anisochronous networks using type D signalling is described in Table 1.

2.2 The incoming equipment may release the connection if the calling signal exceeds the maximum period of two characters. Start polarity will be maintained on the backward signalling path from Centre Y to Centre X.

2.3 The first forward path signal following the calling signal (class-of-traffic signal) is distinctive from the first backward path signal to provide a guard against head-on collisions in the case of both-way operation.

A head-on collision is detected by the fact that Centre X receives a first class-of-traffic character instead of the reception confirmation or reception congestion signal.

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. In the case of a transit centre, the NC service signal (combination No. 2) followed immediately by the clearing signal will be returned to the preceding centre after the reception confirmation signal and the country identification code.

2.4 Failure to receive the reception confirmation or reception congestion within 2 seconds from the start of the calling signal or, if the received signal is spurious, as indicated by a character other than a first class-of-traffic character, or the combination of the reception confirmation or reception congestion signal, should initiate the automatic re-test signal on the circuit concerned.

In the case of the failure to receive the correct reception confirmation or reception congestion signal, another attempt to select a circuit should be made (once only). In the case of transit calls, if the second attempt is unsuccessful, the NC service signal (combination No. 2) followed by the clearing signal will be returned to the preceding centre after the reception confirmation signal and the country identification code.

2.5 Selection signals can be divided into two parts. The first part designated as the network selection signals contains information regarding network and subscriber requirements and may be composed of one to seven possible characters (see Tables 2, 3, 4 and 5). The second part comprises the address signals (the called subscriber number which is preceded by the destination code in the case of a transit call).

The network selection signals used in the forward direction (see also Appendix 1 to this Recommendation) are further subdivided and assembled as follows for signalling purposes:

1) *First class-of-traffic character* (see Table 2)

The calling signal is always followed by at least one class-of-traffic character. The bit functions of this character were so chosen that no further characters are needed for most connections. If there is a need for indication of further requirements, a second class-of-traffic character may be used. Whether the second class-of-traffic and user-class characters follow or not will be indicated by the bits b_3 and b_4 of the first class-of-traffic character.

2) *User-class character* (see Table 3)

This character, if used, will follow the first class-of-traffic character and will be required when, for example, this information cannot be derived from the incoming line.
When eight user-class characters in Table 3 are not sufficient, a second user-class character may be added by means of an escape character. Whether a second class-of-traffic character follows or not, it will be indicated by the bit b_4 of the first user-class character.

3) *Second and further class-of-traffic characters* (see Table 4)

These characters follow any user-class characters required.
The number of these class-of-traffic characters depends on the number of user facilities available. The bit b_4 of the second class-of-traffic character will indicate whether a third class-of-traffic character follows or not.

4) *Closed user group character* (see Table 5)

Closed user group is defined as follows: " A number of users of a public switched communication service who have the facility that they can communicate with each other but access is barred to and from all other users of the service.

Note 1. — A special facility, permitting a user in a closed group to call any other user connected to a public switched communication service or to any other network with which interworking is permitted, may be offered.

This is termed " Closed User Group with Outgoing Access ". Access to users of this facility is restricted to other members of the closed user group.

Note 2. — A closed user group may incorporate the direct call or abbreviated address calling facilities.

The closed user group characters are only used in conjunction with the second and possibly subsequent class-of-traffic signals which may follow.

Eight different closed user groups can be specified by Table 5.

If there is a need for further possibilities, a second closed user group character may be used.

This character will be indicated by the bit b_4 of the first closed user group character. Similarly, a third closed user group character may be added, if necessary.

The numerical characters used for the second part of the selection signals are shown in Table 6. When the first class-of-traffic character indicates a terminal call, the Recommendation F.69 telex destination code will be omitted.

2.6 The incoming equipment should maintain start polarity on the backward signalling path by releasing the connection if the first received character is spurious, as indicated by a character other than a first class-of-traffic signal. This procedure prevents the possibility of regarding a second selection signal as a first class-of-traffic character and provides a further safeguard against false calls.

In the case of receipt of a spurious signal as indicated by a character other than a selection signal (with the exception of the first class-of-traffic signal), the incoming equipment should return the NC signal to the preceding centre (after the reception confirmation, and possibly the country identification code), followed by the clearing signal.

The incoming equipment may release the connection if any of the selection signals are not completely received within a period of 15 seconds.

2.7 The maximum number of digits to be expected in the sum of the destination code and national number is 12.

2.8 In the case of receipt of the reception congestion signal at a transit centre, the NC service signal (combination No. 2) should be returned to the preceding centre (after the reception confirmation and possibly the country identification in the case of a transit centre) and followed by the clearing signal.

2.9 The country identification code shall be sent following the reception confirmation signal in all cases of transit calls but not for terminal calls. However, when a service signal is returned from the destination network for reasons other than failure or congestion of the called subscriber line, or the called number is spare, it should be followed immediately by the country identification code.

If several transit countries are involved in setting up a call, the calling network will receive the country identifications one after the other.

This information could be useful for retracing the route followed by a call (for traffic statistics, international accounts, analyses of unsuccessful calls and the clearing of faults).

It is possible for a transit centre to receive backward path signals, such as country identification codes, call-connected signal or service signals, from subsequent centres whilst the backward path signals originated locally are still being sent. It is necessary for the transit centre to ensure that the received signals are retransmitted to the preceding centre without mutilation or loss.

2.10 The backward path signals indicating effective and ineffective call conditions are scheduled in Tables 7 and 7a.

2.11 If at the first transit centre the call-connected or service signal is not received within 60 seconds from the end of selection, then the NC signal will be returned to the preceding centre.

Note. — The need of this signal and its timing are subject to further study.

2.12 If the called station is not able to receive information immediately, the connect-through signal and possibly the call-connected signal should be delayed accordingly.

2.13 In this type of signalling originating and terminating national exchanges are assumed to contain the identification of the calling or called subscribers respectively. These identifications may be exchanged within the network as an optional subscriber's feature during the establishment of the connection.

Additionally, tripping of the answer-back of the called subscriber's terminal equipment is required.

For terminal calls tripping of the answer-back of the called subscriber will be the responsibility of the originating exchange. For transit calls the last transit exchange will be responsible for obtaining the answer-back of the called station, if this is not returned automatically by the destination network.

Note. — For connections established over networks using type D signalling, there may be some advantages if the originating exchange trips the called subscriber's answer-back. This point should be studied further.

2.14 The connect-through signal confirms that the identification of the calling or called subscriber has been completely received by the terminating or originating exchange respectively and converted and retransmitted to the subscriber as explained in the following Table A:

TABLE A

USE OF THE CONNECT-THROUGH SIGNAL [a]

		The identification of the called subscriber is required by the originating exchange (signalled on the forward path) and sent by the terminating exchange (backward path)	
		No	Yes
The identification of the calling subscriber is required by the terminating exchange (signalled on the backward path) and sent by the originating exchange (forward path)	No	— [b]	Forward path [b]
	Yes	— Backward path	Forward path Backward path

[a] See also Appendix 2.
[b] In these cases the call-connected signal additionally serves the purpose of the connect-through signal.

2.15 The guard period on clearing should be a period of 7 characters measured from the appearance of start polarity on both signalling paths. The equipment at the incoming end shall be completely released and ready to receive a new call after a maximum period of 7 characters.

2.16 The automatic re-test signal will be initiated as indicated in section 2.4.

The circuit should be tested five times and a check made to confirm receipt of the reception confirmation signal in response to each test. When the reception confirmation signal is received, the circuit should be returned to service. If no reception confirmation is received on any of the five test cycles, it should be permanently taken out of service for outgoing traffic and an alarm should be given.

In order to cater for the possibility that a faulty circuit may be seized at both ends, the automatic re-test 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 circuit should be made different to be sure that successive re-tests do not overlap at both ends. When a circuit is still faulty after five tests it should be busied out for outgoing traffic but incoming calls should be accepted.

The use of a special first class-of-traffic character for re-test permits the incoming centre to be informed about re-tests on its incoming circuits.

2.17 If at the receiving end parity does not check, provisionally the connection should be cleared down unless otherwise specified. However, the possibility of different actions remains open for further study.

TABLE 1

SIGNALLING FOR TELEX AND SIMILAR SERVICES
BETWEEN ANISOCHRONOUS NETWORKS

Note. — For the combination numbers mentioned refer to Table 8.

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 a minimum period of one character and a maximum period of two characters and then followed immediately by selection signals		The equipment at centre Y must be connected and ready to receive selection signals within one character period. The minimum and consequently the maximum period will be lengthened at the request of the incoming country Y.
Reception confirmation		Stop polarity followed by combination No. 14	Stop polarity returned within one character period after the end of receipt of the first class-of-traffic signal. The return of combination No. 14 shall be commenced within one to two character periods after the inversion to stop polarity. 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.
Selection signals	At least one (first class-of-traffic signal only) and possibly several network selection signals depending on the network requirement (see Appendix 1), the two or three digits of the F.69 telex destination code of the called country, the digits of the called station number and (possibly) an end-of-selection signal (combination No. 11)		These signals are transmitted immediately after the calling signal without awaiting the reception at X of the reception confirmation signal. The destination code will be omitted for terminal calls. When no end-of-selection signal is employed, the selection signals will be transmitted in a single group at automatic speed.

TABLE 1 *(continued)*

Signal or function	Forward path (X towards Y)	Backward path (Y towards X)	Remarks
Country identification		Combination No. 12 followed by the F.69 telex destination code	For transit calls the combination No. 12 follows the reception-confirmation signal at automatic speed within one to two character periods. These signals must go through Centre X and arrive at the originating country. For terminal calls the combination No. 12 follows the service signal character(s), when specified, at automatic speed within one or two character periods.
Reception congestion		Stop polarity for a period of one or two characters followed by the clearing signal	This signal is returned within one character period after receipt of the calling signal when the selection signals cannot be received. This signal should be absorbed by Centre X and not allowed to be received by a preceding country.
Call connected		One combination of the control signalling code (see Table 7)	See Appendix 2.
Subscriber identification (if required)	Combinations of the calling subscriber's identification code transmitted within one to two character periods of receipt of the call-connected signal	Combinations of the called subscriber's identification code transmitted within one to two character periods of the transmission of the call-connected signal	The combinations of the subscriber's identification code comprise the F.69 code (for an international call) followed by the digits of the subscriber's number.
Connect through (if required)	Combination No. 13 sent after identification has been completely received and retransmitted to the subscriber	Combination No. 13 sent after identification has been completely received and retransmitted to the subscriber	See Appendix 2.
Service signals		One or two combinations of the control signalling code (see Table 7), possibly followed by the country identification signals (see para. 2.9) followed by clearing signal	
Idle circuit	Stop polarity	Stop polarity	
Clearing	Inversion to start polarity in the direction of clearing. The minimum recognition time is 2 characters and the maximum time is 4 characters		
Clear confirmation	Inversion to continuous start polarity in the opposite direction after a minimum duration of 3 characters of clearing signal and a maximum duration of 7 characters		

TABLE 1 *(continued)*

Signal or function	Forward path (X towards Y)	Backward path (Y towards X)	Remarks
Guard delay	Period of 7 characters, measured from the appearance of start polarity on both signalling paths		Equipment at the incoming end shall be completely released and ready to receive a new call after this period.
Automatic re-test	Stop polarity for 1-2 character periods followed by combination No. 13, stop polarity for 1 second and then start polarity for 30 or 36 seconds repeated		30 seconds of start polarity for one centre and 36 seconds of start polarity for the other centre.
Backward busy	Continuous stop polarity for a maximum of 5 minutes		

TABLE 2

CODE OF SIGNALS OF THE FIRST CLASS-OF-TRAFFIC CHARACTER

Combination				Condition signalled
b_4	b_3	b_2	b_1	
A	A			No further network selection signals follow
A	Z			Second class-of-traffic character follows without any user-class character
Z	A			User-class character follows (and possibly a second class-of-traffic character)
			A	Transit traffic
			Z	Terminal traffic
		A		Alternative routing not allowed
		Z		Alternative routing allowed
Z	Z	A	A	Re-test signal
Z	Z	A	Z	Not allowed (used for reception confirmation on the backward path)
Z	Z	Z	A	Reserved for national use
Z	Z	Z	Z	Reserved for national use

TABLE 3

CODE OF SIGNALS OF THE USER-CLASSES [a]

Combination				Condition signalled
b_4	b_3	b_2	b_1	
A				No second class-of-traffic character follows
Z				A second class-of-traffic character follows
	A	A	A	[b]
	A	A	Z	[b]
	A	Z	A	Service
	A	Z	Z	Telex
	Z	A	A	Gentex
	Z	A	Z	Reserve
	Z	Z	A	[b]
	Z	Z	Z	Escape character when a second user-class character follows

[a] The user-class character may be omitted if, for example, the information can be derived from the incoming line.
[b] Used in data networks (see Recommendation X.70).

TABLE 4

CODE OF SIGNALS OF THE SECOND CLASS-OF-TRAFFIC CHARACTER

Combination				Condition signalled
b_4	b_3	b_2	b_1	
A				No third class-of-traffic character follows
Z				Third class-of-traffic character follows [a]
	A			No closed user-group character follows
	Z			Closed user-group character follows
		A		Identification of the called subscriber not required
		Z		Identification of the called subscriber required
			A	Unallocated
			Z	Unallocated

[a] Reserve for future needs.

TABLE 5

CODE OF CLOSED USER-GROUP CHARACTERS

Combination				Condition signalled
b_4	b_3	b_2	b_1	
A				No further closed user-group character follows
Z				Further closed user-group character follows
	A	A	A	0 Octal digit of closed user-group
	A	A	Z	1 Octal digit of closed user-group
	A	Z	A	2 Octal digit of closed user-group
	A	Z	Z	3 Octal digit of closed user-group
	Z	A	A	4 Octal digit of closed user-group
	Z	A	Z	5 Octal digit of closed user-group
	Z	Z	A	6 Octal digit of closed user-group
	Z	Z	Z	7 Octal digit of closed user-group

TABLE 6

TABLE OF DECIMAL DIGITS AND MISCELLANEOUS SIGNALS

Combination				Condition signalled
b_4	b_3	b_2	b_1	
A	A	A	A	Digit 0 — Used to express destination code, country identification code, called subscriber's number and subscriber identification
A	A	A	Z	,, 1
A	A	Z	A	,, 2
A	A	Z	Z	,, 3
A	Z	A	A	,, 4
A	Z	A	Z	,, 5
A	Z	Z	A	,, 6
A	Z	Z	Z	,, 7
Z	A	A	A	,, 8
Z	A	A	Z	,, 9
Z	A	Z	A	End-of-selection signal
Z	A	Z	Z	Reserve
Z	Z	A	A	Connect-through signal
Z	Z	A	Z	Not allowed (used for reception confirmation on the backward path)
Z	Z	Z	A	Reserve
Z	Z	Z	Z	Reserve

TABLE 7

CODE OF SIGNALS FOLLOWING THE RECEPTION-CONFIRMATION SIGNAL

Combination				Condition signalled
b_4	b_3	b_2	b_1	
A	A	A	A	OCC
A	A	A	Z	NC
A	A	Z	A	DER
A	A	Z	Z	ABS
A	Z	A	A	NA
A	Z	A	Z	NP
A	Z	Z	A	NCH
A	Z	Z	Z	Escape character for further service signals [1]
Z	A	A	A	Escape character for further call-connected signals [2]
Z	A	A	Z	Reserve
Z	A	Z	A	Reserve
Z	A	Z	Z	Start of country identification code
Z	Z			Call-connected signal
			A	,, ,, ,, call metering
			Z	,, ,, ,, no call metering
		A		,, ,, ,, no identification of the calling subscriber required
		Z		,, ,, ,, identification of the calling subscriber required

[1] See Table 7a.

[2] This extension is not yet specified. It will be necessary to define expanded ranges of call-connected facility when they are known.

TABLE 7a

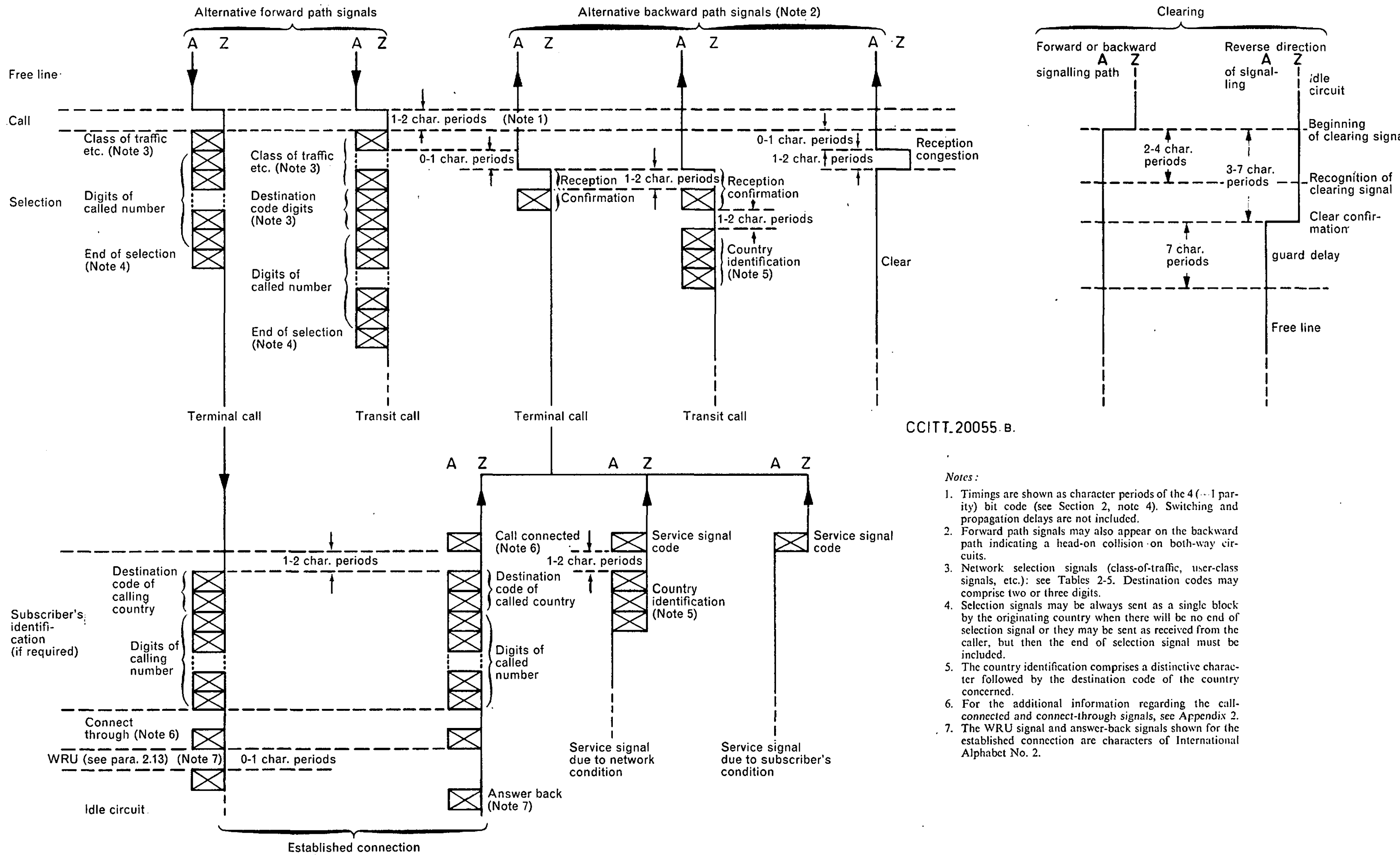
CODE OF SIGNALS FOLLOWING THE ESCAPE CHARACTER AZZZ
(see Table 7)

Combination				Condition signalled
b_4	b_3	b_2	b_1	
A	A	A	A	INF
A	A	A	Z	Reserve for international purposes
A	A	Z	A	
A	A	Z	Z	
A	Z	A	A	
A	Z	A	Z	
A	Z	Z	A	
A	Z	Z	Z	
Z	A	A	A	Reserve for national purposes
Z	A	A	Z	
Z	A	Z	A	
Z	A	Z	Z	
Z	Z	A	A	
Z	Z	A	Z	
Z	Z	Z	A	
Z	Z	Z	Z	

TABLE 8

TABLE OF THE CONTROL SIGNALLING CODE

No.	Combination			
	b_4	b_3	b_2	b_1
1	A	A	A	A
2	A	A	A	Z
3	A	A	Z	A
4	A	A	Z	Z
5	A	Z	A	A
6	A	Z	A	Z
7	A	Z	Z	A
8	A	Z	Z	Z
9	Z	A	A	A
10	Z	A	A	Z
11	Z	A	Z	A
12	Z	A	Z	Z
13	Z	Z	A	A
14	Z	Z	A	Z
15	Z	Z	Z	A
16	Z	Z	Z	Z



Notes:

1. Timings are shown as character periods of the 4 (+1 parity) bit code (see Section 2, note 4). Switching and propagation delays are not included.
2. Forward path signals may also appear on the backward path indicating a head-on collision on both-way circuits.
3. Network selection signals (class-of-traffic, user-class signals, etc.): see Tables 2-5. Destination codes may comprise two or three digits.
4. Selection signals may be always sent as a single block by the originating country when there will be no end of selection signal or they may be sent as received from the caller, but then the end of selection signal must be included.
5. The country identification comprises a distinctive character followed by the destination code of the country concerned.
6. For the additional information regarding the call-connected and connect-through signals, see Appendix 2.
7. The WRU signal and answer-back signals shown for the established connection are characters of International Alphabet No. 2.

FIGURE 1. — **Signalling system type "D"**

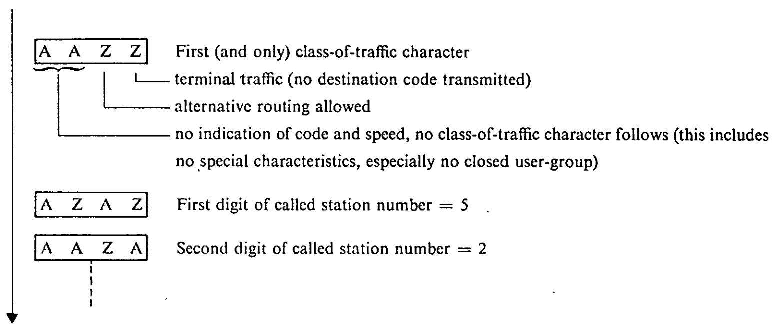
APPENDIX 1

(to Recommendation U.12)

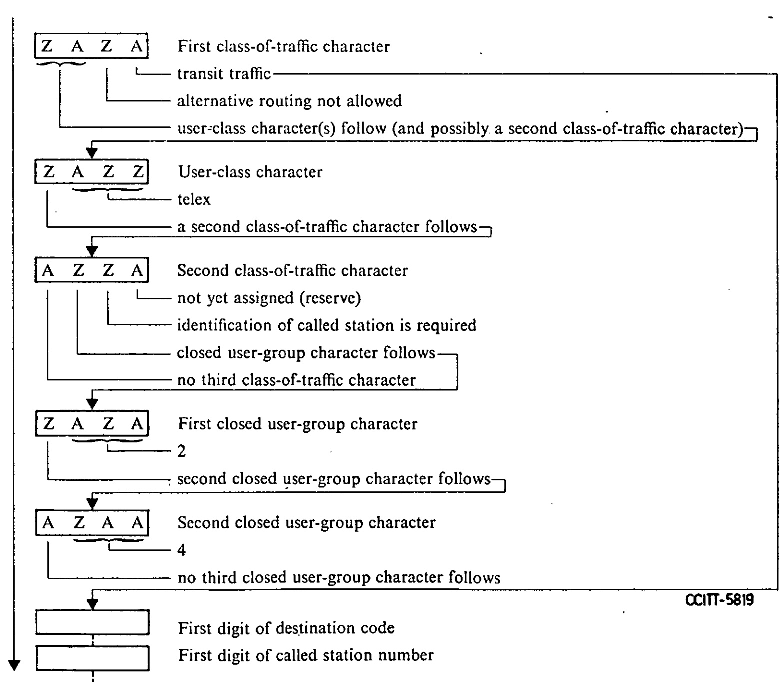
Examples of network selection signals

1. *First example (minimum sequence of network selection signals)*

This example shows a sequence of minimal length. (The preceding calling signal, start and stop elements and the parity bit are not shown. *The bits are shown in the order* b_4, b_3, b_2 *and* b_1.)



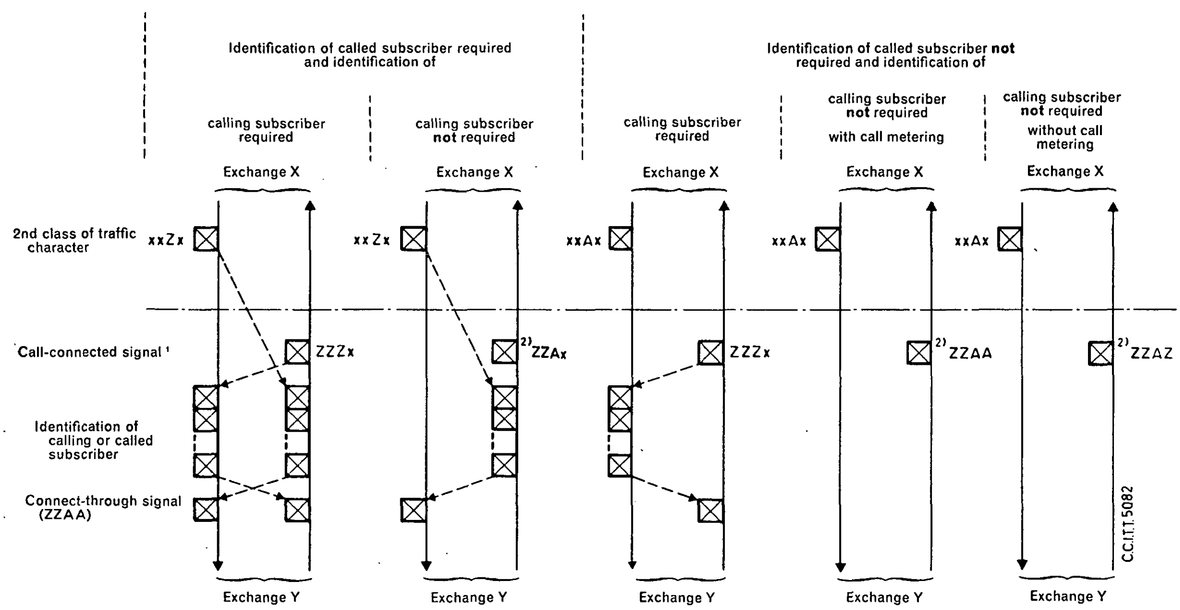
2. *Second example (a sequence of network selection signals including closed user-group characters)*



APPENDIX 2

(to Recommendation U.12)

Use of connect-through signal



[1] Escape character for further call-connected signals (see Table 7) is not considered here.
[2] In these cases the call-connected signal additionally serves the purpose of the connect-through signal.

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, Mar del Plata, 1968, and Geneva, 1972)

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 re-test 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 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 (preceded by transit access codes, if required) 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.

[1] For some existing systems this delay will be 4 seconds.

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 (preceded by transit access codes, if required) 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.

In the case of transit operation where the first circuit in the connection is an ARQ radio circuit and the second circuit in the connection uses Type A or B signalling to a country which returns the answer-back automatically, to avoid mutilating the answer-back, the number of combinations No. 29 of the radio call-connected signal may be reduced to eight.

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.

[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.

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:

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

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 not 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 least 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 cshould be accepted but the call-confirmation signal should not be returned until the transmission of the 7* α signals has been completed.

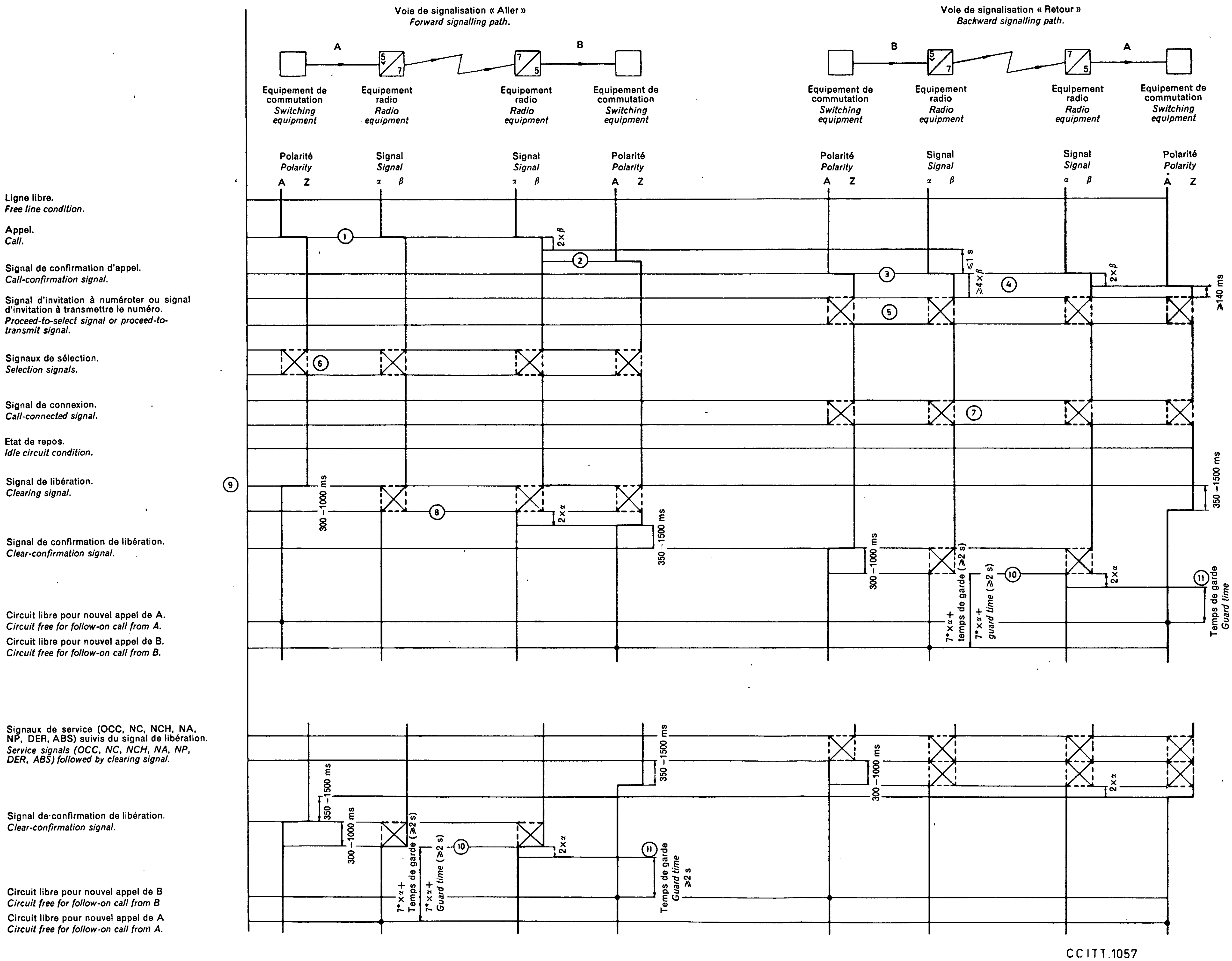
* For radio circuits using an 8-character cycle with 4 characters stored, a sequence of 8 α signals shall be used. For radio circuits using an 8-character cycle with 7 characters stored, a sequence of 11 α signals shall be used.

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.
☒ Teleprinter signals.
FRXD = Fully-automatic reperforator transmitter distributor.

This diagram does not show delays caused by propagation time, cooperation between start-stop and synchronous systems and possible repetitions.

Telex signalling on radio channels



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) or 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 seconds 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 cypher 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 seconds 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 through.

4. The calling and also the called subscribers 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, amended at Geneva, 1972)

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.

Some study has been made 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.

However, due to the declining importance of radio circuits incorporating ARQ equipment for fully automatic traffic in the telex network and the tendency for them to be relegated to the role of standby circuits, further study of the method of charging based upon efficient time has been abandoned.

The alternative solution of charges based upon elapsed time has now been adopted as the standard to be applied.

It will then be necessary before incorporating a circuit with ARQ equipment in the fully automatic telex service to ensure that it meets with certain stability requirements.

Safeguard measures, designed to avoid, in certain cases, an excessive overcharge of the calling subscriber, as indicated in the present Recommendation, will be necessary.

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;

b) the average overcharge for a call must not exceed five per cent;

c) the maximum overcharge for a call must not exceed twenty-five per cent.

3. *Control of forced release*

Administrations employing radiotelegraph circuits incorporating ARQ equipment should use the efficiency factor for controlling the forced release of an established connection.

With this arrangement, an established connection will be cut whenever the efficiency factor, averaged over 60 consecutive seconds, falls below 80%.

This form of control, 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.

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.

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 $\frac{137 - 4^* r.}{137}$ Hence, it is sufficient to count the number of repetition cycles because if, in a period of

* This figure is 8 in the case of an 8-character-repetition cycle.

20 consecutive seconds, there are 7** 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. Administrations may therefore select either method.

If, during a counting period, the number of repetition cycles has 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 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 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.

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.

** 3.5 with an 8-character-repetition cycle.

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.

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%); 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.

2. 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. For 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.

4. 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 called side, the mean efficiency factor during two consecutive periods of 60 seconds is lower than 80%, the release of the connection will be given to the called end.

5. 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.

6. 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;

[1] Definition of the efficiency factor (in time): definition 33.23 of the *List of definitions.*

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 suitable storage to reconcile the two character rates (400 and 411 per minute);

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 — $\pm 3\%$ 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.

ANNEX TO RECOMMENDATION U.24

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 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)
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

For notes, see the end of the tables.

TABLE 2 *(continued)*

TELEX SIGNALLING THROUGH THE MULTIPLEX EQUIPMENT — TYPE B SIGNALLING

Signalling condition	Signal received from telex (Recommendation U.1)	Signal on channel aggregate path	Signal transmitted to telex
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 re-test 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 may be lengthened by 450 ms maximum
Reception confirmation (or receiving equipment 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 (figures 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 1 b of the characteristics of signals of Section E 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.

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LIST OF THE QUESTIONS ON TELEGRAPH TECHNIQUE TO BE STUDIED DURING THE PERIOD 1973-1976

STUDY GROUP VIII

(Telegraph and data terminal equipment)

Question No.	Title	Remarks	Page
9/VIII	Standardization of data terminal equipment with Alphabet No. 5	also concerns S.G.I. (Question 6/I) and Sp. A (Question 1/A, point C)	265

STUDY GROUP IX

(Telegraph transmission)

Question No.	Title	Remarks	Page
1/IX	Characteristics of telegraph channels obtained from a leased telephone-type circuit used for the simultaneous transmission of different facilities	In assocaition with JWP LTG [1]	269
2/IX*	Reduction of transmission levels in frequency-modulated voice-frequency telegraph systems	JWP LTG to be kept informed; special aspect of Question 27/XV	269
4/IX	Routing of MC VFT systems on PCM telephone bearer circuits	JWP LTG to be kept informed	280
5/IX	Methods of noise and error measurements on circuits for telegraphy and data transmission		280
6/IX	Transmission plan		282
11/IX	Definitions concerning telegraph transmission quality		283
12/IX	Effect on telegraph distortion of sudden changes in level		283
14/IX	Frequency-modulated voice-frequency telegraph systems		283
22/IX	Automatic maintenance tests of telegraph circuits	To be studied by J.W.P. MAT [2]	285
24/IX*	Time-subdivision of a telephone circuit for telegraphy and data transmission	JWP LTG to be kept informed	285
26/IX	Synchronous systems for special codes		285
28/IX	Effect of sudden phase changes on telegraph distortion	Also concerns S.G. IV (Question 3/IV)	287
29/IX	Telegraph frequency division multiplex systems for data signalling rates above 200 bit/s		287
31/IX*	Time division of a PCM system and of a primary group for telegraphy and data transmission		291

* Urgent question.

[1] Study Group IX should first study the characteristics of telegraph channels and then JWP LTG the methods of deriving them.

[2] Question 22/IX = Question 11/X.

STUDY GROUP X

(Telegraph switching)

Question No.	Title	Remarks	Page
1/X	Automatic originating and answering of calls in the telex network		293
2/X	Further standardization of telex and gentex signalling in accordance with Recommendation U.1 (type A and type B) and Recommendation U.20		293
3/X*	Continuation of the study of the terminal and transit control signalling system for telex and similar services according to Recommendation U.12 (type D)	Also concerns S.G. VII (see Question 1/VII, point I)	293
5/X*	What technical problems should be considered in introducing new service requirements for telex ?		294
8/X*	Further standardization of telex and gentex intercontinental transit signalling in accordance with Recommendation U.11 (type C) on the basis of experience gained		294
10/X	Signal transfer delay in the telex network		295
11/X	Automatic maintenance tests of telegraph circuits	To be studied by JWP MAT [1]	295

STUDY GROUP XIV

(Facsimile telegraph)

Question No.	Title	Remarks	Page
1/XIV	Transmission of black-and-white facsimile on telegraph-type circuits		296
2/XIV	Digital facsimile equipments over various transmission facilities	Also concerns Study Group VII	297
3/XIV	Increase in transmission speed of facsimile telegraphy in case of analogue transmission on telephone-type circuits	Results to be transmitted to JWP LTG	297
5/XIV*	Permissible power levels in facsimile transmission on telephone-type circuits	Results to be transmitted to JWP LTG	304
6/XIV	Use of leased telephone-type circuit for the simultaneous transmission of signals of 1) facsimile and telegraph, 2) facsimile and speech and 3) facsimile and data	To be studied by J.W.P. LTG	306
7/XIV*	Facsimile service between subscribers		307
8/XIV	Facsimile transmission of colour documents		307
9/XIV	High-speed facsimile transmission on wide-band circuits	Results to be transmitted to JWP LTG	308
10/XIV	Definitions for facsimile telegraphy		309
11/XIV	Facsimile transmission over earth satellites		309

* Urgent question.
[1] Question 11/X = Question 22/IX.

QUESTIONS ON TELEGRAPH AND DATA TERMINAL EQUIPMENT TO BE STUDIED BY STUDY GROUP VIII

Chairman : Mr. G. BAGGENSTOS (Switzerland)

Vice-Chairman : Mr. I. SAVITZKY (Ukrainian S.S.R.)

Question 9/VIII — Standardization of data terminal equipment with Alphabet No. 5

(Mar del Plata, 1968, amended at Geneva, 1972)

What standards should be set for the characteristics of data terminal equipment, working at standardized rates above 50 bauds with Alphabet No. 5, used by Administrations and recognized private operating agencies for services which they provide ?

Points for study :

1. Further study on the permissible transmitter distortion and tolerable margin at the interface between the data terminal equipment (DTE) and the data circuit terminating equipment (DCE). This is to include clarification and definition of (new) terms, new measurement techniques and limits.

This work should cover all the signalling rates standardized by the C.C.I.T.T. and should be carried out in cooperation with the I.S.O.

2. Bearing in mind the data signalling rates recommended in Recommendation X.1, should additional data signalling rates be recommended for data terminal equipment? If additional data signalling rates are necessary, what should these rates be and for what reasons?

3. What should be the length of the stop element when characters of Alphabet No. 5 are transmitted in start-stop operation?

Bearing in mind:

On the one hand that a single stop element gives an advantage in character transfer rate; on the other hand, that a single stop element:

- places more stringent demands on the receiver when the stop element is shortened by distortion, which may have a maximum of 40%;
- may give rise to longer resynchronization time, when character synchronization is lost;
- creates difficulties in character-oriented synchronous transmission systems and switching systems;
- creates difficulties if two subscribers cooperate in synchronous mode using block checking and/or cyphering equipment;

— creates difficulties when regenerative repeaters are required in a conventional transmission path.

Note. — Character-oriented systems are required to operate with a character cycle slightly shorter than that corresponding to the nominal speed. This can be achieved only by means of a shortened stop element.

4. Study of methods of incorporating error detection and/or correction techniques in data terminal equipment operating with Alphabet No. 5.

5. Study of the methods of applying control characters, i.e. HT (0/9), VT (0/11), FF (0/12) and BS (0/8).

Note. — Study of point 5 is connected with Question 6/I of Study Group I and I/A, point C of Special Study Group A.

6. What provisions should be made for the interchange of traffic between existing C.C.I.T.T. standard machines using Alphabet No. 2 and one or more classes of new data terminal equipments using Alphabet No. 5?

— The new DTEs must be defined and the requirements established (viz, an estimate must be made of the magnitude of customer needs for the transfer of traffic between different classes of terminals and the signalling rates to apply). Because of the costs of equipment, it would seem that a substantial need would be required to justify the development of recommendations to define this interchange on an automatic basis.

— It is possible that centralized code translation and speed change equipment will have to become a part of the switching plan(s); in these circumstances Study Groups X and VII would have to become involved.

— In defining any new DTE, consideration must be given to the possible need to momentarily stop transmission from it when it is transmitting to a lower speed terminal. This stopping of transmission would be controlled by the code translation and speed change equipment, whenever the characters in its buffer storage exceeded a specified number of characters.

7. Possible provisions to be made in equipment working with Alphabet No. 5 which print only one set of letters (" reduced character-set " equipment), to allow for interworking with equipment which print the full character set.

ANNEX

(to Question 9/VIII)

Points to be standardized for equipment using Alphabet No. 5

(Extract from the Final Report of Study Group VIII to the Vth Plenary Assembly)

1. *Tentative list of signalling speeds*

Character/sec	Signal elements/ character	Bauds	Remarks
10	11 [a]	110	Higher rates will be preferred in future developments (Recommendation X.1)
13.6	11 [a] [b]	150	Use at international level only by special agreement (Recommendation X.1)
18.2	11 [a] [b]	200	Recommendations R.38, V.21 and X.1. Further study should be based preferably on this rate
27.3	11 [a] [b]	300	
60	10 [a]	600	Recommendation V.23
75	8 [c]	600	Recommendations V.23 and X.1
120	10 [a]	1200	Recommendation V.23
150	8 [c]	1200	Recommendation V.23
240	10 [a]	2400	Recommendation V.23
300	8 [c]	2400	Recommendations V.26, V.26 *bis* and X.1
480	10 [a]	4800	
600	8 [c]	4800	Recommendation V.27
1200	8 [c]	9600	Recommendation X.1
6000	8 [c]	48000	Recommendations V.35 and X.1

[a] = Start-stop operation

[b] = Receiving equipment functioning at these rates should be capable of recognizing characters with 10 single elements correctly (cf. Recommendation V.4)

[c] = Synchronous operation; system using 8 signal elements per character, character synchronism will be attained and maintained by use of the synchronous idle (SYN) character defined in Recommendation V.3.

This list indicates the envisaged signalling speeds of terminal equipment which need not necessarily be identical with that of the data signalling rates offered by public data networks (see also Recommendation X.1 — User classes of service and data signalling rates for public data networks). Indeed, the full range of terminal equipment speeds listed above may be accommodated on a few network signalling rates only.

2. *Identification of apparatus*

In a switched network it is essential to provide means by which the identity of subscriber and user and the apparatus can be ascertained at equipment and/or switching levels.

3. *Keyboards*

It is not considered necessary to seek international standardization of keyboards by Administrations in view of the work of I.S.O. and E.C.M.A. in this area.

4. *Printers*

4.1 *Number of characters per line*

While the length of line has been standardized at 80 characters in Recommendation X.30, provision should be made for the possibility of extending the line to accommodate 120 or 132 characters for computer use.

4.2 *Width of paper*

Study Group VIII considers that this question is a matter for the I.S.O.

4.3 *Protection against errors*

In connection with the use of a parity bit, Study Group VIII decided that the question of the action to be taken as soon as an error appears is left to the discretion of individual Administrations.

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 1/IX — Characteristics of telegraph channels obtained from a leased telephone-type circuit used for the simultaneous transmission of different facilities

(Geneva, 1972)

What characteristics should be proposed for such telegraph channels when the division of a telephone circuit is achieved by:

a) frequency division?

b) time division?

The simultaneous facilities envisaged in the study should include with telegraph:

1) speech

2) data transmission

3) phototelegraph transmission

4) black and white facsimile transmission.

Note. — Item 2 is to be studied in liaison with Study Group Sp. A and Joint Working Party LTG (see Question Sp. A, point J). Items 3 and 4 are to be studied in liaison with Study Group XIV and Joint Working Party LTG (see Question 6/XIV).

Question 2/IX* — Reduction of transmission levels in frequency-modulated voice-frequency telegraph systems

(Geneva, 1972 ; JWP LTG to be kept informed; special aspect of Question 27/XV)

Noting that it is desirable, would it be possible to reduce the power level on bearer circuits for voice-frequency telegraphy to prevent overloading of carrier systems because of the increasing demand for non-telephone circuits to be routed over these systems?

What power levels could be recommended instead of those indicated in Recommendations R.35, R.37, R.38A and R.38B ?

A. Field tests should be carried through, taking the following into account:

1) a reduction of 1.5, 3, 4.5 and 6 dB;

2) the following aspects, which may arise from such reductions:
   - increase of inherent start-stop distortion,
   - increase of inherent isochronous distortion,
   - increase in the number of transitions exceeding the limit of 8 % start-stop distortion in a single 50-baud channel,
   - increase of bit error rate,
   - increase of character error rate.

B. It is desirable to indicate all relevant circumstances of the performed tests, e.g.:
   - noise in pW per km of the bearer circuit,
   - unweighted noise voltage,
   - weighted noise voltage,
   - impulsive noise rate during a 15-minute interval at thresholds of −30 dBm0, −33 dBm0 and −36 dBm0 with a dead-time of 125 ms,
   - routing, composition and length of the circuit,
   - number and kinds of VFT systems and other non-speech systems in the primary group involved.

C. All measurements should be carried out during busy hours.

ANNEX 1

(to Question 2/IX)

Reduction of FM VFT transmission levels

(Extract from Contribution COM IX—No. 40—Australia)

Tests have been carried out in Australia to examine the effects of the reduction of FM VFT channel levels on a typical intercontinental circuit exhibiting noise characteristics of less than 3 pW per km and generally complying with Recommendation G.153.

1. *Test arrangements*

The measurements were made at Sydney on a looped bearer circuit extending from Sydney to Guam and return. The circuit was routed over part of the SEACOM cable system consisting of microwave and submarine cable broad-band sections. The looped path involved 4930 and 8910 km of each transmission medium respectively. The bearer circuit was established and lined-up in accordance with Recommendation M.81 and occupied channel 12 of a 16-channel group (complying with Recommendation G.235). The group was demodulated to audio-frequency at one additional point between Sydney and Guam. All telephone channel translating equipment employed was of modern design (the SEACOM system was brought into service in 1967) and is of transistorized construction.

The FM VFT system used for the tests was manufactured by T.M.C. (Australia) and is of recent transistorized design (type B.481) and complies with Recommendation R.35. Apart from the test FM VFT system, all other non-telephone type services routed via the broad-band systems were operated at currently recommended levels.

The allocation of telegraph channels for the individual tests performed is shown in the Appendix.

2. *Measurements*

The following are details of the measurements performed:

2.1 *Bearer circuit noise*

Unweighted and weighted channel noise measurements were conducted. The test results are shown in Table 1.

2.2 *Bearer circuit impulsive noise*

Impulsive noise counts were measured on the bearer circuit using an Impulsive Noise Measuring Instrument which complied with Recommendation V.55 and had a dead-time of 125 milliseconds. The tests covered four 15-minute periods during busy hours at threshold levels of −30 dBm0, −33 bBm0 and −36 dBm0. Results of the tests are shown in Table 2.

2.3 *Telegraph error rate*

Error rate measurements were carried out on pairs of FM VFT channels operated at levels of −22.5 dBm0, −25.5 dBm0, −27 dBm0 and −28.5 dBm0 for periods totalling 72 days. Owing to difficulties involved in performing conventional error rate tests over a prolonged period, a method of measuring simulated 50-baud telegraph character errors was employed. A brief description of the simulated error rate technique is given in Annex 2 to Question 5/IX. Results of these error rate tests are shown in Table 3.

2.4 *Telegraph channel impulsive noise*

Concurrently with the simulated error rate tests, impulsive noise tests were carried out by terminating the output of one FM VFT channel filter with a multi-level impulsive noise counter having a dead-time of 11.5 milliseconds and threshold level setting of −22 dBm0, −28 dBm0 and −34 dBm0. The results of these tests are shown in Table 4.

2.5 *Telegraph distortion*

Distortion tests at the 50-baud rate were carried out over periods totalling twelve busy hours on telegraph channels adjusted to line levels of −22.5 dBm0 and −28.5 dBm0. Received test transmissions of the standard Q9S text (Recommendation R.51) were terminated in distortion monitors which counted the number of received telegraph characters which exceeded an 8% start-stop distortion threshold. The test results are shown in Table 5 a.

During the above tests, manual reading of start-stop distortion levels was performed (in accordance with Recommendation R.5) on channels operating at levels of −22.5 dBm0, −25.5 dBm0 and −28.5 dBm0. The results of these tests are shown in Table 5 b.

3. *Results*

The test results indicate that the bearer circuit employed had a moderately high noise level of −44.5 dBm0 with the incidence of impulsive noise increasing rapidly at levels lower than −30 dBm0.

The count of impulsive noise disturbances in the bandwidth of an individual FM VFT channel indicated that a rapid increase in magnitude occurred at levels below −22 dBm0.

The long-term telegraph error rates observed show that telegraph errors were more than doubled when the transmit level of individual FM VFT channels was reduced by 6 dB. The reduction in channel transmit levels also had the effect of increasing by approximately 6% the peak values of received start-stop telegraph distortion and resulted in a high proportion of received telegraph characters exceeding an 8% distortion limit.

4. *Discussion of results*

The telegraph transmission objectives currently recommended by C.C.I.T.T. for 50-baud telegraph circuits are:

i) the telegraph character error rate due to interruptions and noise on telephone circuits carrying telegraph systems should not exceed 1 in 100 000 characters (Recommendation R.54),

ii) the limit of inherent start-stop distortion of a single international voice-frequency telegraph channel on standardized text should not exceed 8% (Recommendation R.53).

The results obtained on the 50-baud telegraph channels derived from a 14 000-km intercontinental telephone bearer circuit revealed that:

a) when using the present recommended telegraph channel transmission level of −22.5 dBm0

i) the telegraph character error rate objective was not achieved in the individual channels tested (2.6 simulated character errors per 100 000 character periods were experienced), but

ii) the inherent start-stop distortion achieved (4%) was considerably lower than the specified limit.

b) when using test channels with transmission levels of −28.5 dBm0 (i.e. reduced by 6 dB)

i) the telegraph character error rate achieved was inferior to that obtained simultaneously on normal level channels (6.2 simulated character errors per 100 000 character periods were observed on the lower level channels), and

ii) the inherent start-stop distortion exhibited (10%) was in excess of the present specified limit.

In regard to the telegraph error rate performance objective, it should be noted that the figure of 1 error in 100 000 characters (correctly transmitted) is the objective which applies to the complete transmission path between the sets of telegraph apparatus terminating the circuit (for example, between leased subscriber terminal equipments). On an international telegraph service, the complete circuit may often consist of a number of voice-frequency telegraph channels connected in tandem. Thus the error rate which should be obtained for a single voice-frequency channel operated at normal level should be significantly less than the result obtained on the test channels.

5. *Conclusion*

As it was not possible to reduce the transmission level on telephone channels carrying all other non-telephone services (during the busy hours for the broad-band system employed), no firm conclusion can be reached from these tests of the absolute effect of a reduction of FM VFT system levels. If the levels of all non-telephone type services had been reduced to −15 dBm0, there may have been an improved performance from the telegraph channels under test. The fact remains, however, that the noise contribution in a telegraph bearer circuit will remain proportional to its length. The problem of whether the required signal-to-noise ratio can be obtained on existing long-haul intercontinental bearer circuits when signal levels are reduced will require detailed study. Further, more comprehensive, tests of the transmission characteristics of modern broad-band systems of different lengths would be required to make progress in this study.

Accordingly, for the present, at least in regard to long-haul intercontinental circuits (such as the one tested), it is suggested that no change should be made in telegraph transmission levels. Should examination of the performance of short-haul circuits reveal adequate margin in performance for both telegraph error rate and distortion, then a reduction in transmission levels for non-telephone services on certain routes may be approached more confidently.

TABLE 1

BEARER CIRCUIT NOISE — TEST RESULTS

Bearer circuit noise	
Unweighted	*Weighted*
−44.5 dBm0	−46.7 dBm0p

TABLE 2

BEARER CIRCUIT IMPULSIVE NOISE — TEST RESULTS

Threshold level dBm0	Impulsive noise count over 15 minutes (average of 4 × 15 minute test periods)
−30	28
−33	119
−36	830

TABLE 3
TELEGRAPH ERROR RATE — TEST RESULTS

VFT channel level dBm0	Simulated telegraph errors	
	Measured over 24 hours (average of 72 × 24 hour periods)	Expressed as character errors in 10^6 character periods
−22.5	15	2.6
−25.5	18	3.1
−27.0	21	3.6
−28.5	36	6.2

TABLE 4
VFT CHANNEL IMPULSIVE NOISE — TEST RESULTS

Threshold level dBm0	Impulsive noise count over 24 hours (average of 72 × 24 hour test periods)
−22	2
−28	41
−34	103

TABLE 5 (a)
TELEGRAPH DISTORTION — TEST RESULTS

VFT channel level dBm0	Number of characters exceeding 8% start-stop distortion over 4 hours (average of 3 × 4 hour test period)
−22.5	4
−28.5	5862

TABLE 5 (b)

VFT channel level dBm0	Start-stop distortion observed on a telegraph distortion measuring set	
	Average %	Peak %
−22.5	3.0	4.0
−25.5	3.5	6.0
−28.5	5.0	10.0

APPENDIX

FM VFT system channel allocations

FM VFT *Channel No.*	*Channel level dBm0*	*Test function*
101	−22.5	Idle 50-baud channel
102	NIL	Impulsive noise (Note 2)
103	−22.5	Start-stop distortion
104	−28.5	Start-stop distortion
105	−22.5	Error rate stop polarity
106	−27.0	Error rate stop polarity
107	−25.5	Error rate stop polarity
108	−28.5	Error rate stop polarity
109	−22.5	Error rate start polarity
110	−27.0	Error rate start polarity
111	−25.5	Error rate start polarity
112	−28.5	Error rate start polarity
113, 114, 115, 116 } 404	−16.5	Idle 200-baud channel
117	−22.5	Idle 50-baud channel
118	−22.5	Idle 50-baud channel
119	−22.5	Idle 50-baud channel
120	−22.5	Idle 50-baud channel
121	−22.5	Idle 50-baud channel
122	−22.5	Idle 50-baud channel
123, 124	Not used due to operation over a nominal 3-kHz bearer circuit	
PILOT	−22.5	300-Hz pilot operation employed

Note 1. — Channels 105 and 109, 106 and 110, 107 and 111, 108 and 112 formed pairs of inputs for each of four simulated telegraph error counters.

Note 2. — The impulsive noise measurements were taken at the output of receive channel filter while the input to the send channel filter was correctly terminated but isolated from its normal transmit source.

ANNEX 2

(to Question 2/IX)

Reduction of the transmission level in the case of VF telegraphy

(Extract from Contribution COM IX—No. 20 F. R. of Germany)

Tests were made by the German Administration in order to find out whether it will be possible to operate VFT channels with a reduced level and how much the level can be reduced.

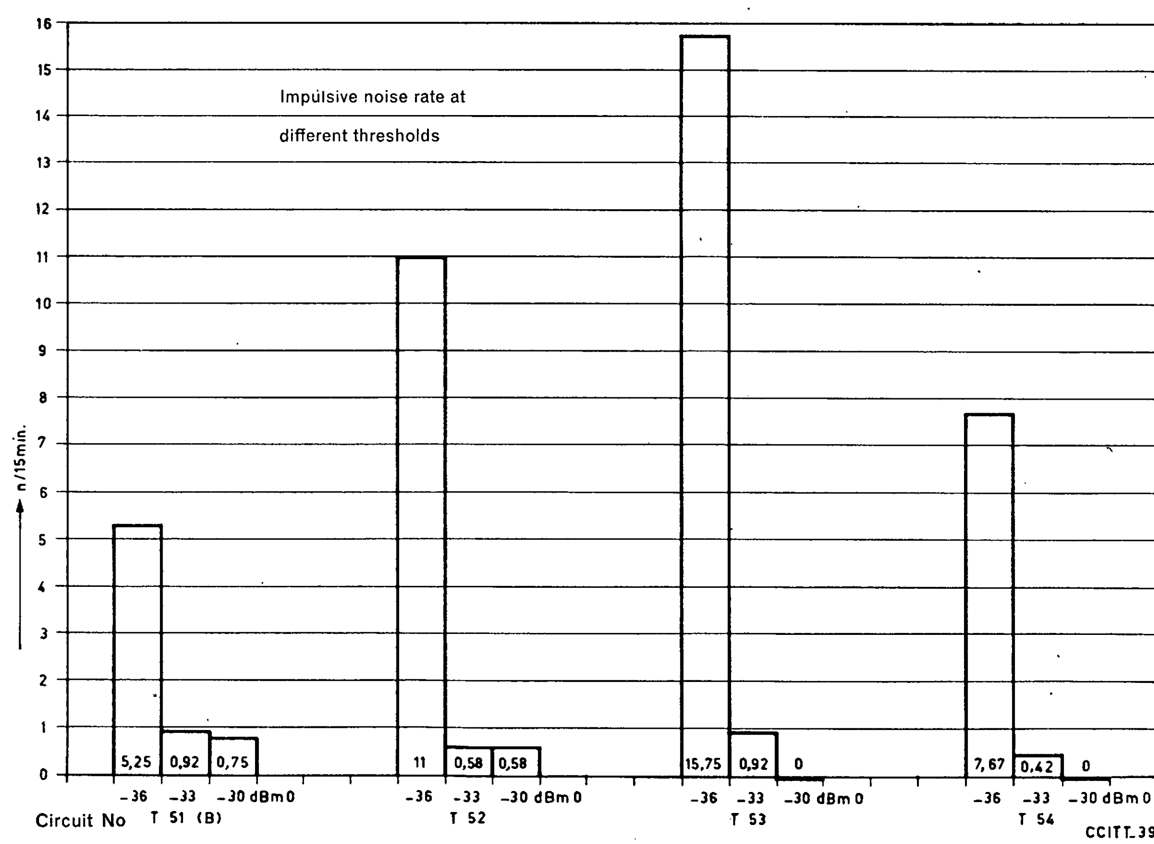
1. *Test conditions*

The measurements were made on five different bearer circuits, each of which consisted of two carrier sections (Frankfurt-München-Frankfurt). The particulars of the circuits are indicated in Table 1.

A 24-channel VFT system which is in conformity with Recommendation R.35 was used for these tests.

TABLE 1

Circuit	Length (km)	Type of channel translating equipment at		No. of channels in the carrier system	Routed over	Mean value of the unweighted noise voltage (dBm0)	Highest observed deviation of the unweighted noise voltage from the mean value (dB)
		Frankfurt	München				
T 51 (A)	956	50 (valves)	52 (valves)	120	Cable	−55	>18
T 51 (B)	956	7 (transistors)	52 (transistors)	120	Cable	−55	6
T 52	1230	52 (transistors)	52 (transistors)	120	Cable	−52	1
T 53	658	52 (valves)	52 (valves)	960	Radio-relay system	−55	12
T 54	812	7 (transistors)	7 (transistors)	960	Radio-relay system	−48	1



2. *Measurement of the unweighted noise voltage*

The unweighted noise voltage in each bearer circuit was measured by means of a psophometer covering a range from 20 Hz to 20 kHz (r.m.s., integration time constant of 200 ms).

The mean values of the unweighted noise voltages and the greatest deviations of the unweighted noise voltage from the mean value, which were observed during these tests, are listed in Table 1.

3. *Measurement of the impulsive noise rate*

An impulsive noise counter was used to determine the impulsive noise rate of four bearer circuits at thresholds of −30 dBm0, −33 dBm0 and −36 dBm0 with a dead time of 125 ms. On each circuit the noise pulses were counted in twelve 15-minute measurements during the busy hour; and the mean value was formed. The results are shown in Figure 1.

4. *Measurement of the error rate*

Error rate measurements at 50 bauds were not carried out, since they take too much time. The study of the distortion distribution conveys also a clear idea of the effect to be expected by a decrease of level.

5. *Distortion measurements*

In the 24-channel VFT system the channels were operated with the following levels:

— channels 101, 105, 109, 113, 117 and 121 with −22.5 dBm0, (as specified in C.C.I.T.T. Recommendation R.35);

— channels 103, 107, 111, 115, 119 and 123 with −25.5 dBm0;

— channels 102, 106, 110, 114, 118 and 122 with −27 dBm0;

— channels 104, 108, 112, 116, 120 and 124 with −28.5 dBm0.

The text standardized in Recommendation R.51 was transmitted on channels 107, 108, 117 and 118. Here the distribution of the start-stop distortion was always determined for about 80 000 transitions. These measurements were made by means of a distortion analyzer during busy hours (on working days between 0900 and 1600 hours). The results are shown in Tables 2 to 6.

The test text was also transmitted on channels 113, 114, 119 and 120. These channels were connected to a distortion monitor which counted how often an 8% start-stop distortion was exceeded during a period of 40 busy hours. The results are indicated in Table 7.

All other channels of the VFT system were in start polarity during the measurements.

6. *Results*

To answer the question whether and how far the levels of the VFT channel can be reduced it is unessential whether the circuit is set up over cable or a radio-relay system. The length of the circuit is also immaterial. The types of telephone channel translating equipments used in the carrier systems is, however, of decisive importance. The characteristics of old valve-type channel translating equipments are considerably poorer than those of modern transistorized equipments.

6.1 *A reduction of the channel level to −25.5 dBm0*

This would be possible throughout the long-distance network of the Deutsche Bundespost without impairment of the quality of the VFT channels. Such a decrease of level, which corresponds to a 50% decrease of the power, would triplicate the permissible number of VFT bearer circuits per group.

6.2 *A reduction of the channel level to −27 dBm0*

This will be possible if the circuit does not comprise any old channel translating equipments of type 50 (built from 1950 to 1952). The equipment of this type still available in the Federal Republic of Germany amounts to some 4%.

A channel level of −27 dBm0 corresponds to a resulting level of −13 dBm0 or a resulting power of 50 μW0. Thus the permissible number of VFT bearer circuits per group could be sextupled.

6.3 *A reduction of the channel level to −28.5 dBm0*

This will be possible if the VFT bearer circuits comprise neither the very old channel translating equipments type 50 nor channel translating equipments type 52 (valves) (built from 1952 to 1960) of which there are still about 29.5% in the long-distance network of the Deutsche Bundespost.

A resulting power of 34 μW0 which approximately corresponds to the mean speech power is obtained with a channel level of −28.5 dBm0. Thus, there would be no limitation of the permissible number of VFT bearer circuits.

7. *Effect of the reduction of level on VFT channels set up in conformity with C.C.I.T.T. Recommendations R.37 and R.38 A*

Preliminary measurements reveal that the effect of a decrease of level on the transmission performance of channels with a broader bandwidth is slighter than in the case of channels which correspond with Recommendation R.35, since these channels are already operated with a higher power.

TABLE 2

CIRCUIT No. T 51 (A) FRANKFURT — MÜNCHEN — FRANKFURT

δ st	Number of transitions at a channel level of			
%	−22.5 dBm0	−25.5 dBm0	−27.0 dBm0	−28.5 dBm0
0	68 235	66 799	51 763	44 991
1	11 248	11 910	21 067	24 432
2	133	334	5 126	7 937
3	3	11	725	1 314
4	2	3	46	98
5		1	3	30
6				11
7				5
8				1
9				1
10				
11				1
12				
13				
14				1
15				1
16				

TABLE 3

CIRCUIT No. T 51 (B) FRANKFURT — MÜNCHEN — FRANKFURT

δ st	Number of transitions at a channel level of			
%	−22.5 dBm0	−25.5 dBm0	−27.0 dBm0	−28.5 dBm0
0	71 963	71 607	70 566	67 079
1	314	454	1 473	4 935
2			3	2
3			2	
4			1	
5				

TABLE 4

CIRCUIT No. T 52 FRANKFURT — MÜNCHEN — FRANKFURT

δ st	Number of transitions at a channel level of			
%	−22.5 dBm0	−25.5 dBm0	−27.0 dBm0	—28.5 dBm0
0	71 642	74 509	72 947	65 336
1	4 054	351	2 429	9 510
2	2	7		73
3			2	2
4		1	1	
5				

TABLE 5

CIRCUIT No. T 53 FRANKFURT — MÜNCHEN — FRANKFURT

δ st	Number of transitions at a channel level of			
%	−22.5 dBm0	−25.5 dBm0	−27.0 dBm0	−28.5 dBm0
0	64 631	66 257	49 085	40 944
1	7 792	6 525	20 053	24 231
2	93	48	3 207	7 370
3	2	1	247	1 001
4			7	63
5		1	1	2
6			1	
7				

TABLE 6

CIRCUIT No. T 54 FRANKFURT — MÜNCHEN — FRANKFURT

δ st %	Number of transitions at a channel level of −22.5 dBm0	−25.5 dBm0	−27.0 dBm0	−28.5 dBm0
0	69 141	72 988	60 695	56 085
1	3 830	1 785	12 899	15 646
2	3	1	583	1 577
3	2		1	14
4				
5				1
6				
7		1		
8				
9			1	
10				

TABLE 7

Circuit	−22.5 dBm0	−25.5 dBm0	−27.0 dBm0	−28.5 dBm0
T 51 (A)	40	64	114	110
T 51 (B)	0	5	3	5
T 52	14	20	21	24
T 53	6	14	13	17
T 54	11	21	22	31

This table shows how often the 8% start-stop distortion is exceeded at different channel levels during a period of 40 busy hours.

ANNEX 3

(to Question 2/IX)

Extract from the Report of Joint Special Study Group C — Geneva, 1972

For transmission systems not exceeding 1000 km the permissible number of telegraph systems may be increased if the power per telegraph channel is reduced according to the following table:

Total number of circuits provided by the transmission system (N)	Approximate number of circuits that may be used for 24-channel FM voice-frequency telegraph systems with the indicated power level/Tg channel (dBm0)			
	−22.5	−25.5	−27.0	−28.5
12	12	12	12	12
60	20	60	60	60
120	14	42	84	120
300 or more	N/30	N/10	N/5	N

A similar table in respect of transmission systems longer than 1000 km cannot be drawn up at this time.

Question 4/IX — Routing of MC VFT systems on PCM telephone bearer circuits

(Geneva, 1972; part of former Question 31/IX; JWP LTG to be kept informed)

Can the voice channels of a PCM system be used as bearers for VF telegraph systems?

ANNEX

(to Question 4/IX)

Extract from the Report of Study Group IX — Geneva, 1972

With regard to the use of a PCM voice channel directly as a bearer circuit for voice-frequency telegraphy and data, test results of one Administration show that the problem is not the quantizing but the non-linearity of the input-output characteristics which creates difficulties for telegraph transmission. For example, a ± 0.2 dB amplitude/amplitude non-linearity leads to an additional isochronous distortion of 2 to 3% per PCM link for an FMVFT system to Recommendation R.35. New developments in the use of encoders and decoders with improved linearity characteristics appear to be more suitable for telegraphy and data transmission. The distortion experienced when using such new devices may be of the same order as present-day voice-frequency telegraph links.

Question 5/IX — Methods of noise and error measurements on circuits for telegraphy and data transmission

(continuation of Question 5/IX, 1961-1964, amended; also interests Study Groups XV and Special C)

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 VF telegraph channels, placed at different positions on the bearer circuit;
- methods of measuring error rates on voice-frequency telegraph channels.

ANNEX 1

(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.

ANNEX 2

(to Question 5/IX)

Simulated telegraph error measuring equipment

(from an Australian contribution)

Summary

A simple method has been developed to continuously check the telegraph error rate performance of international voice-frequency telegraph channels. This method, which is outlined below, involves the observation of stability of spare channels rather than the verification of information transmitted on test or traffic channels. Reasonable correlation is obtained between this simple method and the conventional one of determining error rates. The availability of continuous records of error rate performance on a particular route would enable effective supervision to be maintained over the transmission performance of telegraph bearer circuits. Standardization of a simple error rate measurement technique would thus provide a valuable maintenance aid.

Introduction

Telegraph transmission performance is most commonly measured by examining the degree of distortion. Of perhaps more fundamental importance to the user, however, is the telegraph error rate that is experienced. It is because of the ease of taking distortion measurements that this means is usually employed to ascertain whether the quality of telegraph transmission is being maintained at an acceptable level. On the other hand, the conventional measurement of telegraph error rates is normally time-consuming and inconvenient; it is thus seldom employed as a maintenance aid.

The two methods of checking telegraph transmission performance are complementary, however. This is particularly so for long-distance telegraph channels which may suffer from irregular transmission disturbances. Such events may not be detected on the infrequent occasions when routine distortion measurements are conducted because the test period is of limited duration. There is thus a need to supplement distortion measurements on such channels with a regular simple check of the telegraph error rate performance. A more reliable guide to the quality of telegraph transmission provided can be obtained if both measurement techniques are used.

Detection of transmission disturbances

To check whether long-distance telegraph channels are affected by transmission disturbances, spare channels of a voice-frequency telegraph system can be monitored. Where FM VFT systems are employed, the stability of a pair of spare channels should preferably be examined. When a transmission disturbance is experienced in the telegraph bearer channel, then, depending on the intensity and duration of the impairment, some evidence of the disturbance will normally be detected in the individual telegraph channel receivers.

With cooperation from the distant terminal, one of the spare telegraph channels should be controlled to send the frequency corresponding to continuous stop polarity while the other channel is controlled to send the frequency corresponding to continuous start polarity. By combining the telegraph outputs of these two channels at the receiving terminal it is possible, by monitoring, to determine whether either channel has been affected by a transmission disturbance. For example, in the presence of cross-talk or impulsive noise, transitions may be detected in the output of either telegraph channel. If a break or sudden drop in level was experienced, the channel resting on stop polarity should fail to start polarity. For a short period at the commencement of such an event both channels may emit transitions before effective control is obtained and a steady-state output is maintained.

Simulated telegraph error counter

If false transitions are received during a normal start-stop telegraph transmission, there is a probability that incorrect selection may occur in the receiving device. A telegraph error may therefore result. The probability of incorrect reception increases as the duration of the period of instability increases. For 50-baud telegraph transmission, a single information element, although 20 milliseconds in duration, may not be received correctly if a disturbance of between, say, 2 and 10 milliseconds is experienced. A disturbance extending beyond 10 milliseconds would almost certainly precipitate incorrect reception. The critical factor is the time of occurrence of the disturbance relative to the instant(s) of selection of the receiving device.

Owing to the lack of redundancy in the Telegraph Alphabet No. 2, the incorrect detection of a single element will invalidate the character concerned. Further, when instability is observed in spare channels of a telegraph system, there is strong evidence that traffic channels in the same system would experience similar difficulties. Thus, once false transitions are detected for a period in excess of, say, 10 milliseconds, incorrect reception of a character in a traffic channel is probable at that time. An error detection process can then be said to be simulated. Once an error has been detected in this manner, the monitoring function should then revert from continuous scrutiny, to one of periodically gating the inspection of channel stability. This action is necessary to span the remainder of what may have been a character period. Thus, if after 150 milliseconds from the receipt of the initial false transition(s), the stability of the " spare " channels is again observed, a decision can be made whether a second character error could occur.

The results obtained from sampling conducted in this manner could be designated as a count of simulated telegraph errors. By arranging a read-out of the count every four hours, the result for 50-baud transmission can be expressed as simulated errors in 10^5 character periods. Experience to date using this technique indicates that the results obtained are within 10 per cent of those obtained using the conventional method of checking telegraph error rates on 50-baud circuits when the detection period employed is 10 milliseconds.

Anomalies in the results may occur, however, if counting is permitted to continue during long outage periods. To guard against this situation, it is suggested that an initial period of, say, 300 milliseconds be standardized, after which the error count should be stopped and the remainder of the time recorded as outage time.

Correlation of results with event recorders

One of the most common problems associated with error rate statistics is to obtain information relating to the distribution of errors with time. To cater for this requirement it is possible, using relatively inexpensive chart recorders, to arrange for the outputs of the test telegraph channels and the group or supergroup pilot of the system providing the bearer channel to be logged. So long as the sensitivity of the recorder can enable transmission " hits " in excess of a few milliseconds to be registered, the chart speed need only be several inches per hour.

The occurrence of individual, or groups, of telegraph errors using the above arrangements can readily be correlated with the cumulative result which may be printed out at the end of each four-hour period. From an examination of parallel pilot records, it may be possible to identify the source of the disturbances which gave rise to particular telegraph errors. Effective continuous supervision of the transmission performance of both the bearer channel and derived telegraph channel can thus be obtained.

Standardization of a form of continuous transmission testing using a simulated error count technique similar to that described in this contribution would provide a valuable maintenance aid.

Question 6/IX — Transmission plan

(continuation of Question 6/IX, 1964-1968, amended at Mar del Plata, 1968, and Geneva, 1972)

Transmission plan for networks composed of VFT channels which are operated at their nominal modulation rate. Study of the limits of isochronous and start-stop distortion to be applied in planning international switched and point-to-point telegraph type communications. Modulation rates to be considered:

1. a) 100 bauds using equipment to Recommendation R.37;
   b) 200 bauds using equipment to Recommendation R.38 A;
   c) 200 bauds using equipment to Recommendation R.38 B.

2. Study of the distortion as a function of the modulation rate and subsequent study of the transmission plan for networks composed of 50-baud VFT channels to Recommendations R.31 and R.35, operated at 75 bauds.

Measurements should be made in accordance with Recommendation R.51 or X.33, with suitable modulation rates, for isochronous distortion. A particular point for study should be the effect of interchannel interference.

Question 11/IX — Definitions concerning telegraph transmission quality

(continuation of Question 11/IX, 1961-1964, amended at Geneva, 1972)

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);
3. to take account of the terms referred to Study Group IX by other Study Groups (e.g., concerning definitions on reliability and availability).

Question 12/IX — Effect on telegraph distortion of sudden changes in 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 the Annexes to Question 12/IX and Supplements Nos. 4, 5 and 6 in Volume VII of the *White Book*, Mar del Plata, 1968; see also Supplement No. 6 to the present volume.

Question 14/IX — Frequency-modulated voice-frequency telegraph systems

(continuation of Question 14/IX, 1964-1968, amended at Mar del Plata, 1968, and Geneva, 1972)

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. Fixing a definitive limit for the unbalance δ due to the modulation process.

3. Application of the outcome of studies called for in Question 12/IX to lay down limits for inherent isochronous distortion resulting from abrupt variations in reception level.

4. Determination of the preferred limits for time delays employed within frequency-modulated voice-frequency telegraph systems to control the output polarity of individual derived telegraph channels when the bearer circuit is subjected to breaks in transmission.

5. Investigation of alarm control systems capable of satisfactory operation in the presence of noise under bearer failure conditions.

ANNEX

(to Question 14/IX)

In regard to point 4 of the Question, the study should include, but not necessarily be restricted to, the following aspects:

A. The effective transmission time (T_e) that is lost when a break occurs in the received voice-frequency tones of a frequency-modulated voice-frequency telegraph (FM VFT) channel may be made up of 3 distinct increments which are:

i) the actual duration of the break in the received channel tones (t_b),

ii) the time delay incorporated within the FM VFT channelling equipment before start polarity is signalled at the channel output following the commencement of the transmission break (t_s),

iii) the time delay incorporated with the FM VFT channelling equipment before keying of the channel output can recommence following the restoration of voice-frequency tones (t_p).

That is: $$T_e = t_b + t_r, \quad \text{where} \quad t_r \geqq t_s$$

and $$T_e = t_b,$$

where: $$t_b < t_s; \; t_r = 0$$

B. The condition which is important for the minimum disturbance of the operation of switched telegraph services is the duration for which continuous start polarity may be maintained on a channel during the progress of an established connection. If this period is denoted by T_s:

then $$T_s \geqq t_b - t_s + t_r \quad \text{where} \quad t_b \geqq t_s$$

It should be noted that during t_s, the channel output is not positively controlled. Thus if it rests on start polarity during the whole of this increment of time

then $$T_s = T_e = t_b + t_r$$

In those cases where $t_b < t_s$; $$t_r = 0$$

then $$T_s \leqq t_b.$$

Example. — When the duration of time T_s exceeds 300 milliseconds on international telegraph channels employed in existing 50-baud switched telegraph networks employing signalling schemes in accordance with C.C.I.T.T. Recommendation U.1 or U.11, it is likely that established connections may be accidentally released.

From a study of the frequency and distribution of the duration of breaks experienced in the bearer circuits of international FM VFT systems, it should be possible to assign preferred limits for the values of t_s and t_r applicable to certain defined types of telegraph circuits, taking into account the inherent time parameters of the channel (e.g. those of the filters and of the control device) and to specify practical values of admissible tolerances.

Question 22/IX — Automatic maintenance tests of telegraph circuits

(continuation of Question 11/X = 22/IX, 1964-1968, amended at Mar del Plata, 1968, and Geneva, 1972 ; concerns Study Groups IX and X ; to be studied by Joint Working Party 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);
3. How automatic testing methods could be employed on circuits which may include regeneration, to check:
   a) the margin of regenerative repeaters or the start-stop channel input of the time division multiplex equipment,
   b) the start-stop output signals from such equipment (e.g., degree of distortion some 2 to 3 %).

Note. — See Annex to Question 11/X in Volume VII of the *White Book*, Mar del Plata, 1968.

Question 24/IX* — Time-subdivision of a telephone circuit for telegraphy and data transmission

(Question 24/IX, 1964-1968, amended at Mar del Plata, 1968, and Geneva, 1972 ; JWP LTG to be kept informed)

What characteristics should be standardized for a time-subdivision system providing simultaneous transmission on a telephone circuit of several telegraph or data signals operating at 50 bauds and possibly higher modulation rates?

This study should deal mainly with the following points:

1) Structure of the frame to be transmitted on 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) Method of transmitting phasing and re-phasing signals.
5) Signals to be transmitted when channels are not used or not equipped.
6) Methods of transmitting agreed telex signalling schemes.
7) Determination of the acceptable limits for the inherent delay time of time division multiplex systems.

Question 26/IX — Synchronous systems for special codes

(continuation of Question 26/IX, 1964-1972)

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.)

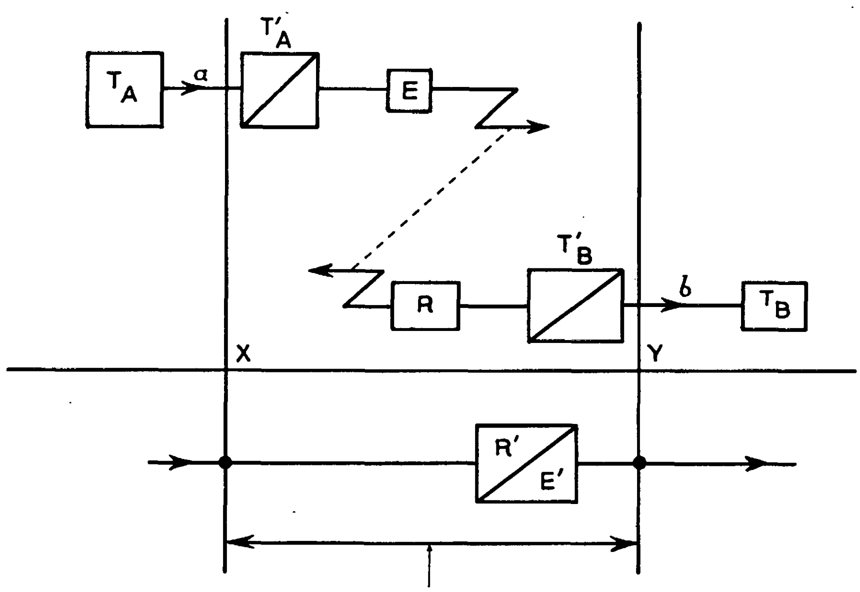
In particular, the study should be made to fix the minimum storage capacity and to specify what the user can expect to receive in the way of information if the storage device is full.

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).

Comments

1. The radiotelegraph channel is defined as being in conformity with Figure 1 given below.



Radiotelegraph channel

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 with 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 — Phase changes

(new wording for former Question 3/IV—1964-1972)
(in conjunction with Study Group IX—Question 28/IX)

What are the causes of phase changes (sudden or continuous), phase jitter and incidental FM in the international network of telephone type circuits and groups, supergroups, etc.?

What are the magnitudes of these impairments and how often do they occur?

What recommendations are required to specify instruments for measuring these impairments and what should the specifications be?

Question 29/IX — Telegraph frequency division multiplex systems for data signalling rates above 200 bit/s

(Mar del Plata, 1968, amended at Geneva, 1972)

A. Is it desirable to consider the frequency division of a primary group into several telegraph channels for the purposes of data transmission at 600 bauds?

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 levels should be recommended?

— How should the combined systems (co-existence of channels with different modulation rates in the same group) be designed?

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.

B. *Points for further study for the completion of Recommendation X.40*

1) Frequency spectrum of the transmitted signals [1].

2) Numbering scheme of frequencies and multiplex [2].

3) System parameters regarding transmission quality.

4) Possibility of equalization of delay distortion introduced by through-group filters.

5) Alarm control system capable of satisfactory operation in the presence of noise under bearer failure conditions.

ANNEX

(to Question 29/IX)

Frequency division multiplex systems in the primary group of carrier systems

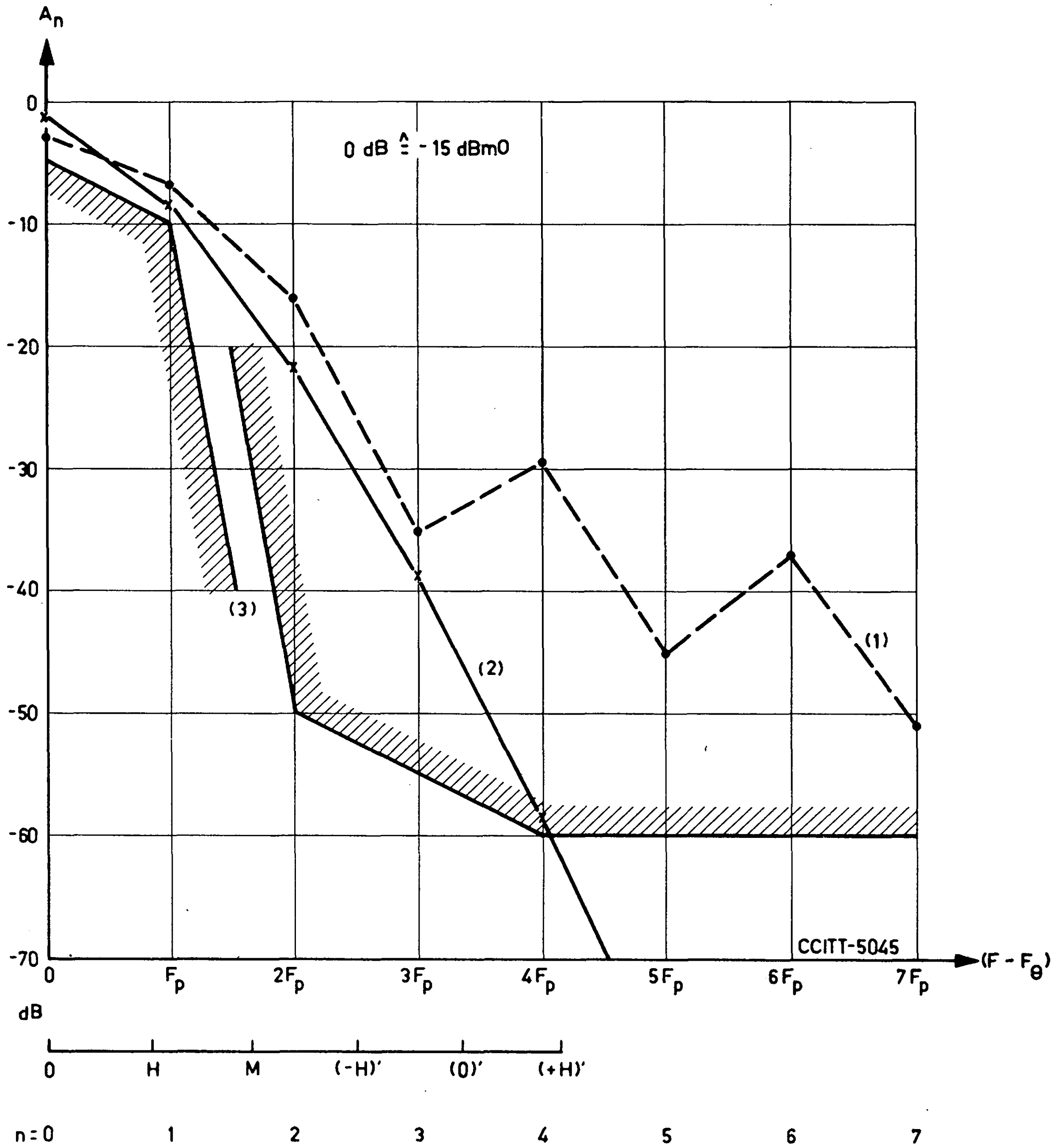
Extract from Contribution COM IX—No. 43 (Siemens)

3. *Frequency spectra*

The enclosed Figures 1 and 2 have been drawn analogous to the respective Figure 1 of the Recommendations R.35, R.37, R.38 A. The figures indicate the frequency spectra for 1:1 test reversals and a modulation index of 0.833 for 2.4 kBd, . . . and 9.6 kBd systems . . . . Adjacent to the curve for square-keyed signals, a curve showing the spectral distribution with sinusoidal frequency modulation is drawn. The proposed limits of spectral distribution are also entered. These limits ensure, on the basis of a send level of −15 dBm0 for the 2400-baud channels and of −7 dBm0 for the 9600-baud channels, that the crosstalk conditions required by carrier equipment are met in the adjacent frequency ranges, which may include speech channels of neighbouring groups. The most stringent requirement in connection with these periodically modulated data channels is that sinusoidal residues may not exceed −73 dBm0p (Recommendation G.232, Annex 1, page 10 of the *White Book*).

Note 1. — The frequency spectra, shown in the annex to the question, may serve as a basis for further study.

Note 2. — The numbering scheme should be established in accordance with the plan shown in Recommendation 70 *bis*, page 104, bearing in mind that the bandwidths of channels 1 and 12 can only be used for subdivision into 50, 100 and 200 baud channels.



Modulation index $m = \dfrac{H}{F_p} = 0.833$

(1) Square keying

$$A_n = \frac{2}{\pi}\left|\frac{m \times \sin\frac{\pi}{2} m}{n^2 - m^2}\right| \quad \text{for } n = 0, 2, 4, \ldots$$

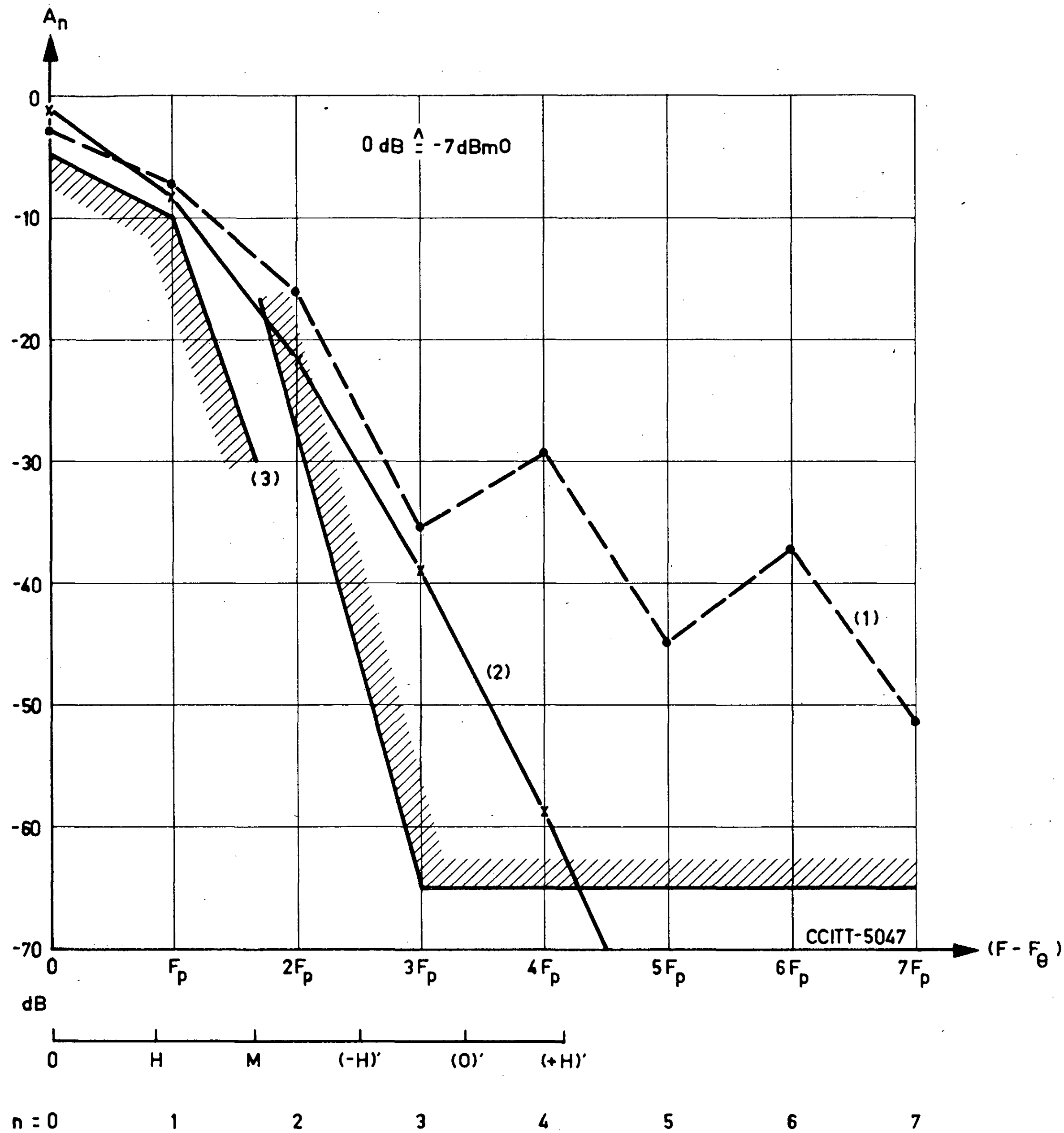
$$A_n = \frac{2}{\pi}\left|\frac{m \times \cos\frac{\pi}{2} m}{n^2 - m^2}\right| \quad \text{for } n = 1, 3, 5, \ldots$$

(2) Sinusoidal keying

$A_n = J_n\,(m)$ (Bessel function)

(3) Tolerance limits

FIGURE 1. — **Spectrum for 1:1 FM keying/2.4 kBd**



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$$A_n = \frac{2}{\pi}\left|\frac{m \times \sin\frac{\pi}{2}m}{n^2 - m^2}\right| \quad \text{for } n = 0, 2, 4\ldots$$

$$A_n = \frac{2}{\pi}\left|\frac{m \times \cos\frac{\pi}{2}m}{n^2 - m^2}\right| \quad \text{for } n = 1, 3, 5\ldots$$

(2) Sinusoidal keying

$A_n = J_n(m)$ (Bessel function)

(3) Tolerance limits

FIGURE 2. — **Spectrum for 1:1 FM keying /9.6 kBd**

Question 31/IX* — Time division of a PCM system and of a primary group for telegraphy and data transmission

(Geneva 1972, formed from parts of former Questions 30/IX and 31/IX)

1) It is desirable to standardize on a TDM system which can be used on the PCM voice channel time slot and on a primary group to obtain:

a) less expensive telegraph channels than with existing VF methods,

b) channels dedicated to data transmission for a range of data signalling rates, priority being given to those as given in draft Recommendation X.1.

2) Would it be desirable to standardize the use of a complete PCM link for telegraph and data transmission purposes?

Note. — See Supplements Nos. 1, 2, 3, 4 and 5 to the present volume.

ANNEX

(to Question 31/IX)

Extract from the Report of Study Group IX — Geneva, 1972

1. *Use of a PCM channel time slot or a primary group*

1.1 The Study Group was of the opinion that it would be desirable from the economic point of view to standardize one type of multiplex system for use on primary groups and PCM voice channel time slots. It was decided that study should be concentrated on the use of a channel time slot of 64 kbit/s. It was noted that a bit rate of 65 kbit/s should be standardized for international links.

In the case of using a primary group it was agreed to use a modem and a data signalling rate, which are, or will be, standardized by Special Study Group A.

1.2 Initially, Study Group IX has confined its study to the time subdivision of a PCM channel time slot to derive asynchronous telegraph and data channels; the question of synchronous channels will remain open for further study.

1.3 It considered that the following two methods for multiplexing asychronous channels should be studied:

— uncoded multiple sampling,

— coded multiple sampling.

1.4 Both methods have a linear relationship between modulation rate and isochronous distortion. The frequency of sampling can, to keep within the limits of tolerable distortion, be changed to permit a higher range of modulation rates.

A theoretical study showed that the cumulative effect of the distortion of telegraph channels in tandem may be much less than the linear addition of the distortion of individual channels. The probability of a character being affected by a start-stop distortion corresponding to linear addition of distortion decreases rapidly as the number of channels in tandem increases.

A limit of the order of 5% should be placed on the degree of isochronous distortion to be tolerated at 50 bauds.

1.5 The uncoded system is simpler than the coded system and has less limitations as regards the maximum modulation rate which can be transmitted over a derived channel. The inherent protection against bit errors on the line is high, therefore no error correction appears to be required for that purpose.

1.6 The coded system, on the other hand, would be more efficient in providing a greater number of derived asynchronous channels. However, because of the reduced redundancy, a bit error on the PCM link has more influence on the error rate and on the distortion of the demultiplexed telegraph signal. With certain codes this effect can be strongly reduced with a penalty on the efficiency. Therefore the code to be adopted would need to be examined carefully. In particular, a bit error occurring in the transmission over the PCM system should not result in continuous reversing of the demultiplexed telegraph signal leading to false clearing or calling on telex lines. The opinion was expressed that the decreasing cost per bit on PCM channels would not tend to justify complicated and expensive coded systems to derive a maximum number of telegraph channels.

1.7 It appears that the uncoded multiplex system may be more economical for short to medium distances while the coded system may prove to be more attractive on longer trunk routes.

In submitting future contributions on this aspect, cost comparison studies should be based on the VF telegraph channel as the unit cost and should take account of savings in equipments obtained in each application.

1.8 The following relationship exists for the multiplex systems considered:

$$100\ \frac{m}{d} \times n = S \times K$$

where m = modulation rate per telegraph channel (in bauds),
d = degree of isochronous distortion (in per cent),
n = number of telegraph channels,
S = aggregate data signalling rate of the multiplexed channels (in bit/s),
K = coding efficiency factor (for the uncoded system $K = 1$; for the coded system: $K > 1$).

2. *List of points for further study concerning the use of a PCM voice channel time slot*

2.1 *Range of modulation rates*

Study Group IX noted the user bit rates proposed for new data networks and the proposed Recommendation for the standardization of 64 kbit/s for the international links.

2.2 *Coding*

Comparison of advantages and disadvantages of the uncoded and coded systems from an economical as well as a technical point of view.

2.3 *Restrictions on signals at the entry to a transmission link*

In the case of multiplex systems the smallest unit for entry into the international PCM digital network will be by means of a channel time slot having a binary bit rate of 64 kbit/s. Any restrictions to be imposed on the Special signals resulting from such multiplexing to ensure the proper operation of the digital network will be decided by Special Study Group D.

2.4 *Minimum signal duration at the entry*

Care should be taken on the influence of the minimum signal element duration due to predistortion on the coded system to be adopted.

2.5 *Channel framing*

The occurrence of a simulated framing pattern caused by information bits should be expressed in terms of probability figures.

The time to phase should be as short as possible and should in any case not result in a false telex calling or clearing signal.

2.6 *Unequipped channels*

The signals to be transmitted when a channel is not in use or is unequipped, is a point for further study.

2.7 *Interface*

The meeting has decided that the interface arrangements between PCM and TDM equipment could with advantage be standardized.

2.8 *Error rate*

The error rate depends upon the system used, e.g. systems without coding are less sensitive than those with coding. The study of this question should be pursued with the aim of providing for an error probability not higher than that to be achieved on analogue bearer circuits. As regards the occurrence of slips, Study Group Special D should furnish further information.

QUESTIONS TO BE STUDIED BY STUDY GROUP X: TELEGRAPH SWITCHING

Chairman: Mr. A. JANSEN (Netherlands)
Vice-Chairman: Mr. D. FAUGERAS (France)

Question 1/X — Automatic originating and answering of calls in the telex network

(continuation of point F of Question 1/A 1964-1968, amended at Mar del Plata, 1968, and transferred to Study Group X at Geneva, 1972)

Apart from the case standardized in Recommendation V.11 (Automatic calling and/or answering on the telex network), the following cases should be examined:

a) keyboard selection system;

b) system of a simpler interface.

Question 2/X — Further standardization of telex and gentex signalling in accordance with Recommendation U.1 (type A and type B) and Recommendation U.20

(Geneva, 1972)

Points to be stressed in the study:

i) all aspects of transit working via one transit centre only (see Supplement No. 7),

ii) to permit automatic restoration of service on the clearance of a fault which has caused the circuit to be made unavailable for outgoing traffic,

iii) further standardization of printed service signals.

Question 3/X* — Continuation of the study of the terminal and transit control signalling system for telex and similar services according to Recommendation U.12 (type D)

(Geneva, 1972)

In Recommendation U.12 itself, several points for further study are mentioned. These are included in the following points which should be stressed in the study:

1. Transit working, in particular:

   i) interworking with signalling systems types A, B and C,

   ii) time-out feature in type D transit centres (see section 2.11 of Recommendation U.12),

   iii) responsibility for tripping of the answer-back in a complete type D environment (see note to section 2.13 of Recommendation U.12).

2. Subscriber identification, in particular identification of the called subscriber.

3. Automatic re-test signal, in particular:

i) consequences of long propagation delays, e.g. on two-hop satellite links,

ii) regulation of the use of 30 seconds and 36 seconds start polarity periods,

iii) dephasing of re-test signals sent from the same exchange.

4. Action to be taken if a parity error is detected (see section 2.17 of Recommendation U.12). Different actions may be required depending on the stage in the setting-up process or on the error appearance on forward or backward path.

5. Allocation of reserve positions in Table 3 of Recommendation U.12 for either national or international use.

6. Specification of the start of the time-out period of 15 seconds mentioned in section 2.6 of Recommendation U.12.

7. Extension of Appendix 1 to Recommendation U.12 with a general sequence diagram for network selection signals.

Note. — In the study of this question, possible amendments of Recommendation X.70 resulting from the study of Question 1/VII—point I should be taken into account in order to keep Recommendation U.12 in line with Recommendation X.70 as far as possible.

Question 5/X* — What technical problems should be considered in introducing new service requirements for telex ?

(Geneva, 1972)

Points to be stressed in this study:

i) the introduction of store and forward facilities, for example multi-address and deferred delivery

ii) the introduction of switching facilities, for example, camp-on, automatic re-try, re-call and redirection of calls,

iii) safeguards in connection with automatic calling equipment, for example excessive call attempts (see also Question 1/X),

iv) the introduction of information services.

Question 8/X* — Further standardization of telex and gentex intercontinental transit signalling in accordance with Recommendation U.11 (type C) on the basis of experience gained

(continuation of Question 8/X, 1964-1968, amended at Mar del Plata, 1968, and Geneva, 1972)

Points to be stressed in this study:

i) extended service codes, in particular for transit failure (cf. Recommendation U.1, section B.9a),

ii) action of the first outgoing intercontinental centre on receipt of the transit failure signal,

iii) clarification of stipulations regarding re-call, re-test and release of the intercontinental circuit.

Question 10/X — Signal transfer delay in the telex network

(Geneva, 1972)

Considering

1. that the transfer delay for transmission through an exchange using space switches is negligible and that the same delay of a frequency-division multiplex system with characteristics per Recommendation R.35 is typically in the range 22 to 30 milliseconds, depending on the design of the equipment; the variation from one channel to another in a particular design being approximately 2 milliseconds;

2. that, by comparison, the transfer delay associated with each time-division switch and with each time-division multiplex equipment in the telex system is of the order of 170 milliseconds for character-interleaved operation and 60 milliseconds with element-interleaved operation;

3. that the use of time-division equipment and systems in the telex network will probably increase in the future, thereby introducing significant additional transfer delays, to the extent that these may equal or exceed the component of overall path delay associated with operation via a telecommunications satellite;

4. that the overall transfer delay can be minimized by using interleaved elements rather than interleaved characters, by optimizing the design of the switching and multiplexing equipment and by coordination in the design and operation of time-division switches and multiplexing systems wherever they happen to interface with one another;

a) what should be the allowable transfer delay characteristics of time-division switching and multiplexing equipments in the telex network, and

b) what considerations or changes to existing recommendations should be applied to minimize the impact of possible greater transfer delays should the use of time-division switching and multiplexing equipments increase in the future?

Question 11/X — Automatic maintenance tests of telegraph circuits

(continuation of Question 11/X = 22/IX, 1964-1968, amended at Mar del Plata, 1968, and Geneva, 1972; concerns Study Groups IX and X; to be studied by Joint Working Party 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);

3. How automatic testing methods could be employed on circuits which may include regeneration, to check:

   a) the margin of regenerative repeaters or the start-stop channel input of the time division multiplex equipment,

   b) the start-stop output signals from such equipment (e.g., degree of distortion some 2-3%).

Note. — See Annex to Question 11/X in Volume VII of the *White Book*, Mar del Plata, 1968.

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QUESTIONS TO BE STUDIED BY STUDY GROUP XIV: APPARATUS AND TRANSMISSION FOR FACSIMILE TELEGRAPHY

Chairman : Mr. M. Stephenson (United Kingdom Post Office)

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 a new Recommendation X.40: Standardization of frequency shift modulated transmission systems for the provision of telegraph and data channels by frequency division of a primary group, prepared by Study Group IX has been approved by the Vth Plenary Assembly (see *Green Book*, Vol. VIII).

It was also informed that, as to facsimile service on new data networks, Joint Working Party NRD (now designated Study Group VII) had expressed its view that as far as facsimile transmission in digital form is concerned, it would readily be acceptable to a new data network, because an item on " bit sequence independence " has been listed in the user facilities. As for analogue facsimile transmission it would be admitted to users as long as they were prepared to provide analogue/digital conversion, if necessary.

Study Group XIV considered that these points informed by other Study Groups would serve as a basis for continuation of this study.

Question 2/XIV — Digital facsimile equipments over various transmission facilities

(Geneva, 1972)

1. *Transmission facility considerations*

a) Are there any particular requirements for digital facsimile transmission?

b) Digital transmission parameters, e.g., are the standardized data signalling rates recommended for new data networks suitable for digital facsimile transmission? (see Note).

c) Consideration of possible new features planned for communications network, e.g. conference call facility (see Note).

Note. — These points should be studied in conjunction with Study Group VII. See also Comment 2 to Question 1/XIV.

2. *Equipment characteristics*

a) Consideration of standardization of synchronous and/or non-synchronous equipment, e.g. picture element rate.

b) Consideration of interfaces between the equipment and the transmission facilities.

c) What are the effects in the case of unattended equipment, e.g. station identification?

d) Consideration of encoding and decoding methods, e.g. redundancy removal and the use of digital equipments over analogue facilities.

e) Call set-up procedures.

Question 3/XIV — Increase in transmission 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)
(results to be transmitted to the Joint Working Party LTG)

What means might be considered to increase the operating speed of facsimile apparatus in the international service?

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 1. — The influence of attenuation distortion in the transmission channel on a symmetric sideband operation must also be investigated.

Note 2. — See Supplements Nos. 14 to 17 of the *Green Book*, Volume VIII.

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 using frequency modulation or double sideband amplitude modulation. Vestigial sideband transmission is also dealt with in Annex 3.

ANNEX 2

(to Question 3/XIV)

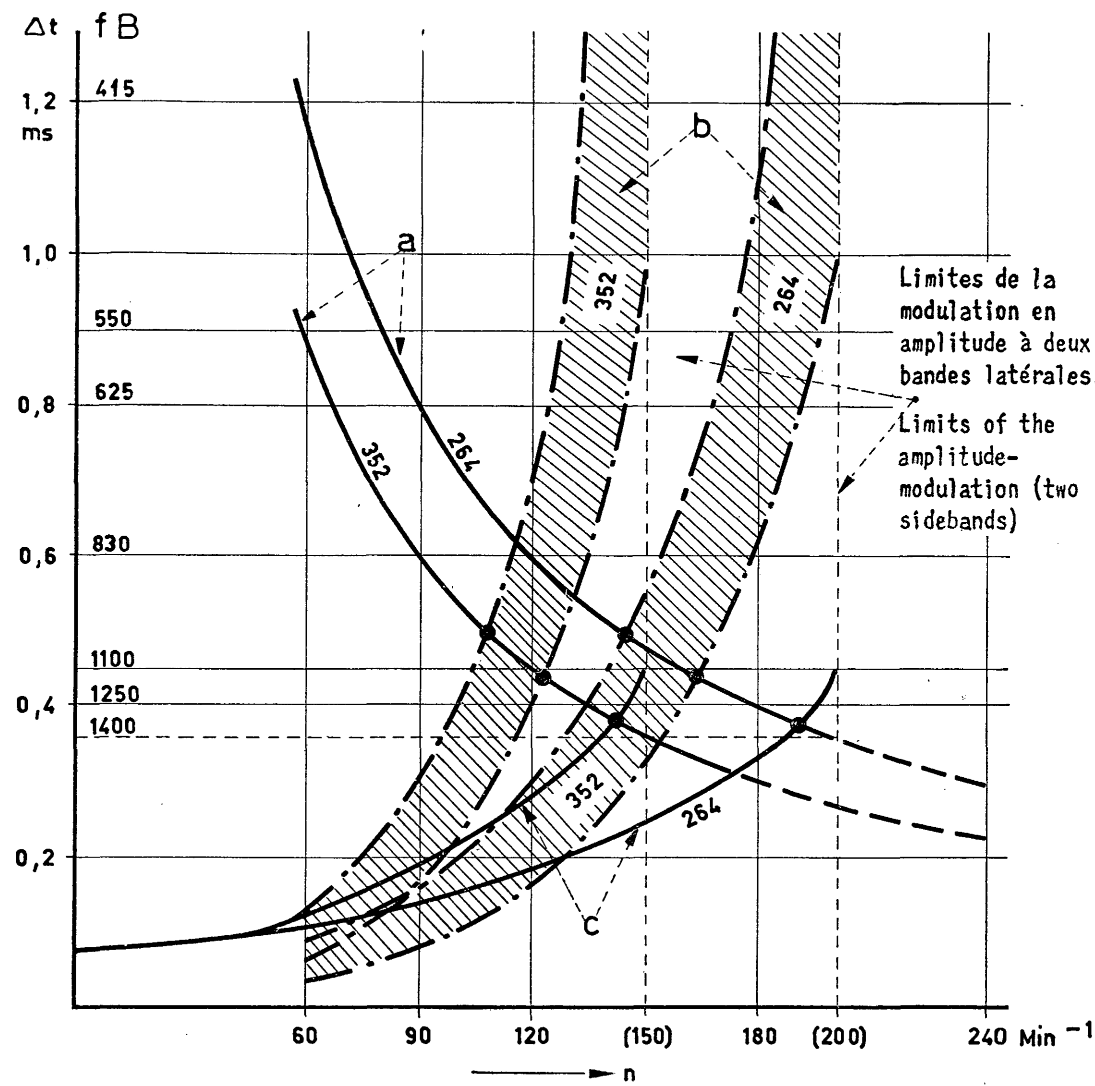
Extract from the contribution of the Federal Republic of Germany

(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 ot 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 ± 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 standardized correctors is doubtful, because dispersions are added thereto statistically. And in international service, we have to reckon with a wider range of dispersion.



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.

FIGURE 1

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 " could apply to the two methods shown in Figures 1 and 2. It should be clearly understood that in this question it is the method shown in Figure 1 which is concerned, and which in the C.C.I.F. was for many years 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 " vestigial sideband " occurs in connection with this question it should be understood to mean the case of Figure 1.

The results obtained in the U.S.S.R. with vestigial 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.

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 Republic of Germany.

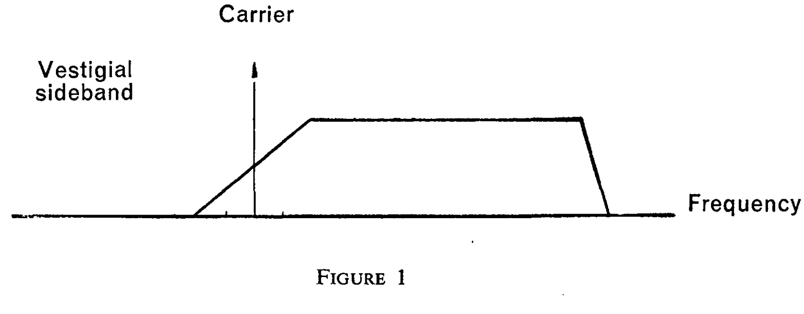


FIGURE 1

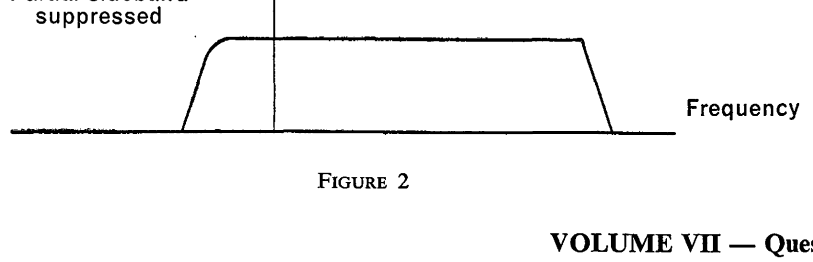


FIGURE 2

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 (AGDE) 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 basic consists of a group of cascade-connected 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 basic from the maximum

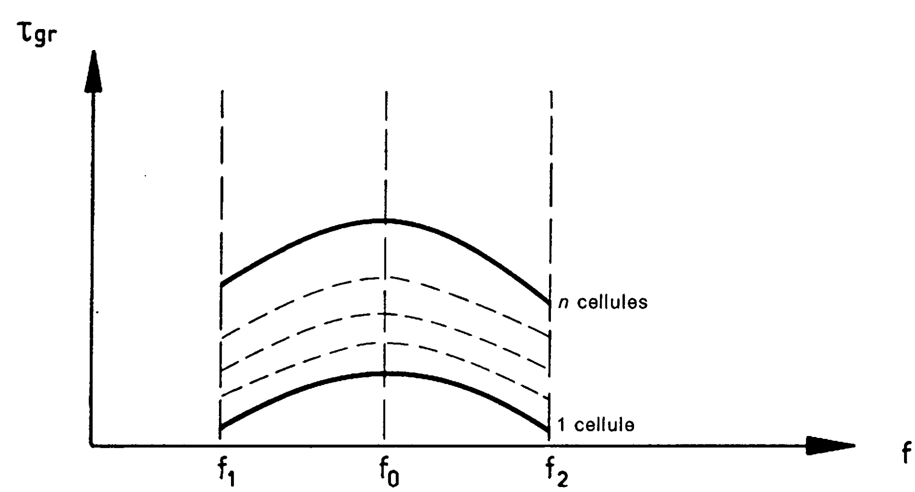
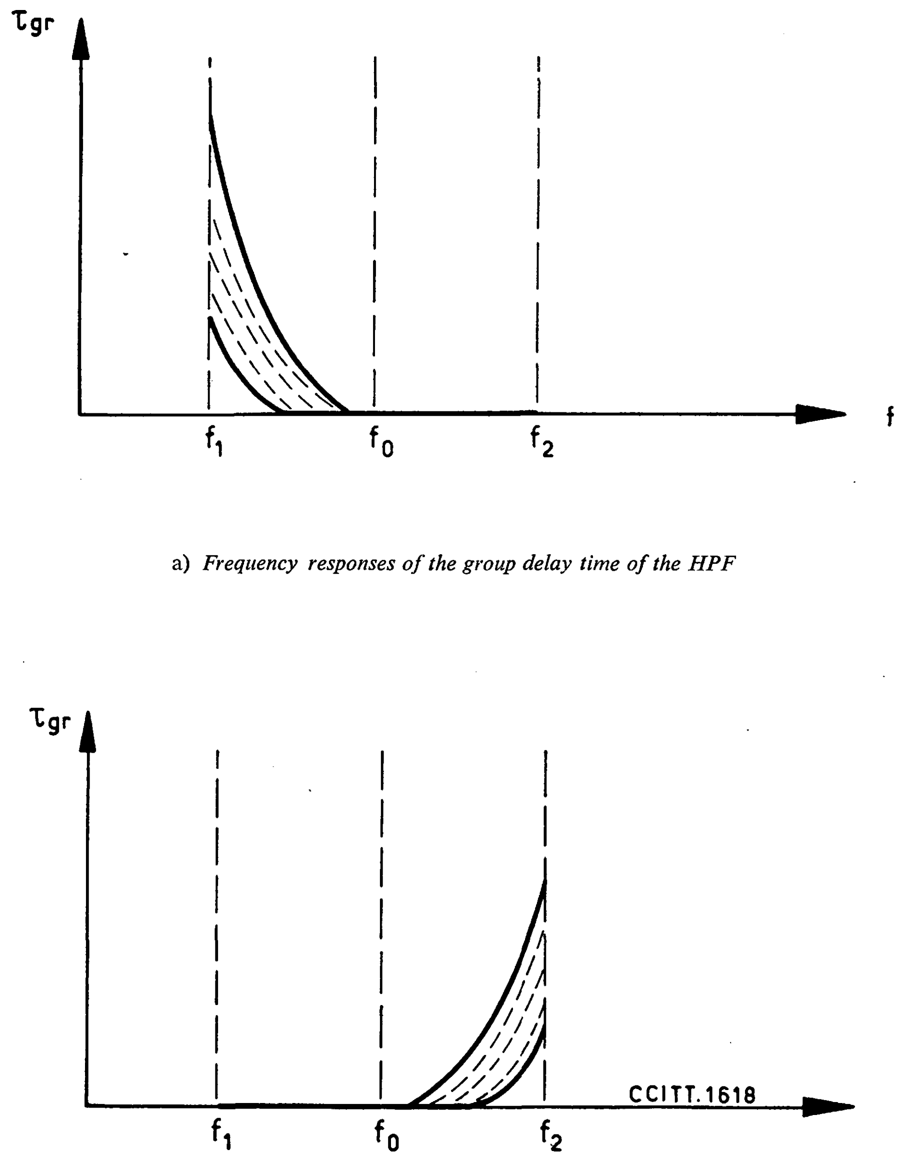


FIGURE 1. — **Frequency responses of the phase link of the CN basic**

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 Tgr = constant (Figure 2b).

Tuning is made by comparison of the GD at the frequencies f_1, f_0 and f_2 ($T\text{gr}_1$, $T\text{gr}_0$ and $T\text{gr}_2$).

The Nyquist method is used for measuring Tgr. 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 $\Delta f = 12.5$ Hz. The tuning signal in the receiver passes through the CN bas. and CN aux. and gets to the analysis circuit, which compares $T\text{gr}_1$ and $T\text{gr}_2$ with $T\text{gr}_0$. The connection of the phase links of the CN basic to the route by means of selectors is taking place up to the time when the conditions of $T\text{gr}_1 < T\text{gr}_0$ and $T\text{gr}_2 < T\text{gr}_0$ exist.



a) *Frequency responses of the group delay time of the HPF*

b) *Frequency responses of the group delay time of the LPF*

FIGURE 2. — **Frequency responses of the CN auxiliary**

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;

— the equivalent variation does not exceed ± 4.3 dB at the period of tuning;

— interference level (white noise, random pulse noise) does not exceed -26 dB 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 -8.7 dB 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.

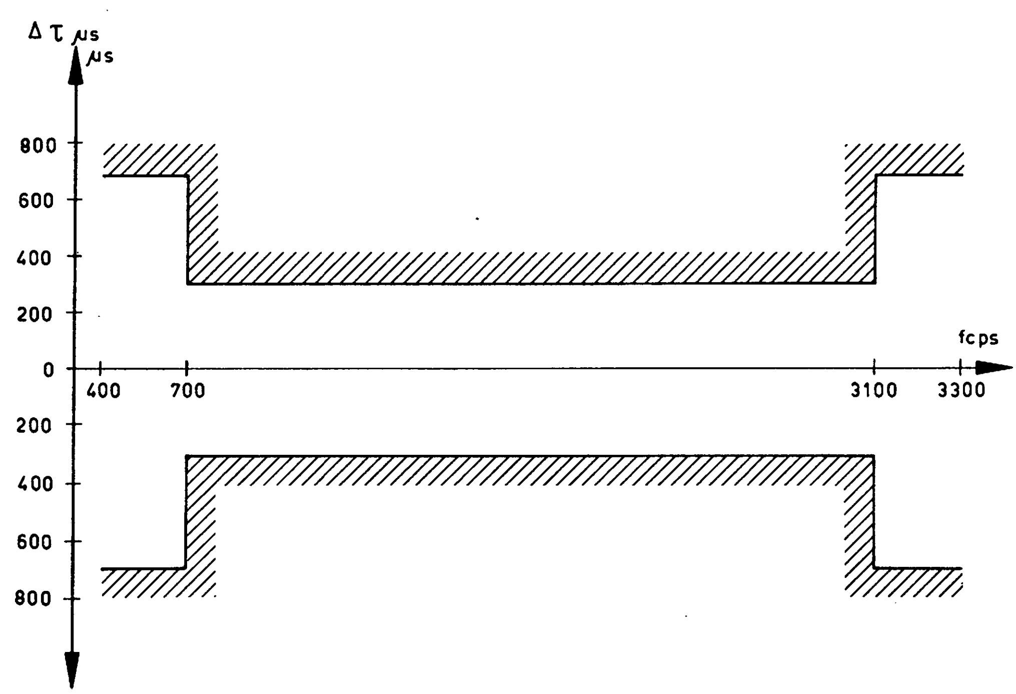


FIGURE 3

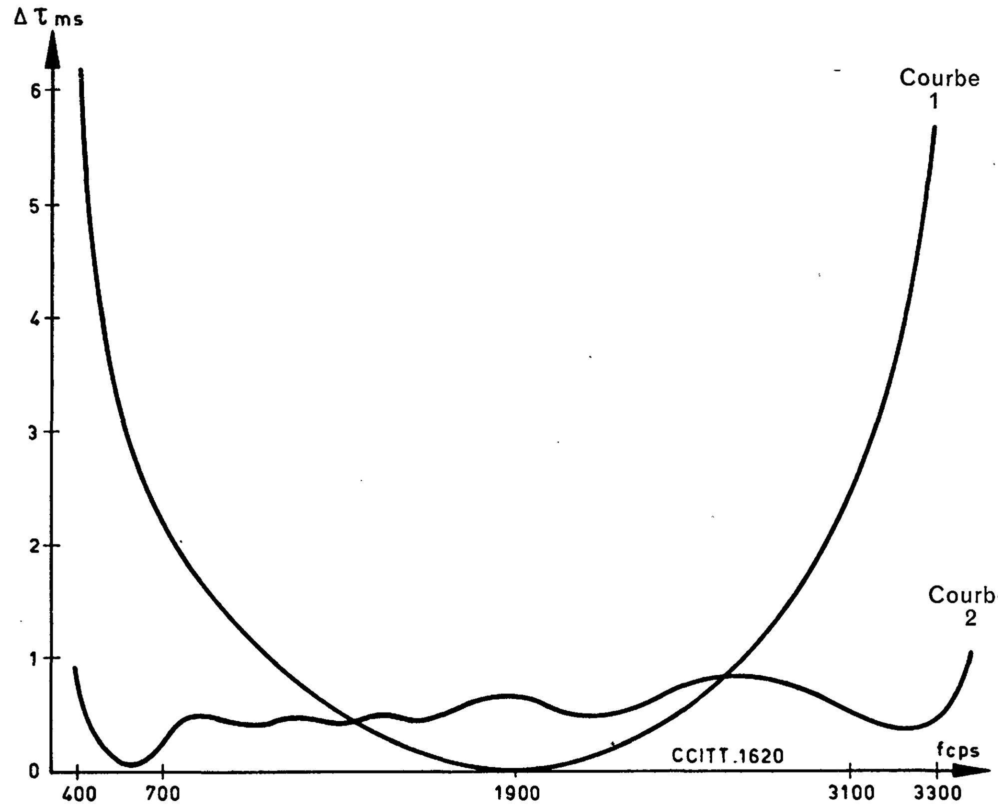


FIGURE 4

Question 5/XIV* — Permissible power levels in facsimile transmission on telephone-type circuits

(Geneva, 1972)
(Results to be transmitted to the Joint Working Party LTG; see Question 27/XV)

a) Should the permissible levels for phototelegraph signals, as indicated in Recommendation T.11 (H.41), be modified?

Note. — In particular, one should consider whether it is possible to lower the level of the frequency modulated signal from −10 dBm0 to −15 dBm0. As concerns amplitude modulated phototelegraphy, the Annex below describes tests carried out by the I.P.T.C. and gives the opinion of this Organization.

b) Should the permissible levels for black-and-white facsimile signals, as indicated in Recommendations T.10 and T.10 *bis*, be modified?

ANNEX

(to Question 5/XIV)

Peak power for phototelegraph signals

(International Press Telecommunications Council—June 1972)

1. In October 1970 a Working Party of Study Group XIV considered proposals for reducing the signal power used for phototelegraphy and agreed that " the point of prime importance is to ensure the quality of facsimile transmission ".

The Working Party therefore proposed that Administrations should make tests with various values of peak power and compare the results by means of the C.C.I.T.T. test chart. In November 1970 this proposal was considered by LTG which decided that the tests should be made with peak powers of −3 dBm0 and −6 dBm0.

2. Tests made by Administrations over their point-to-point phototelegraph services cannot, however, provide a reliable measure of the effect which reductions would have on the multi-destination networks used to supply newspapers with news photographs. These networks consist of omnibus circuits between Press Agency offices from which the transmissions pass to subscribing newspapers over leased lines in the national networks.

To determine the effect which peak power reductions would have on these multi-destination networks, the I.P.T.C. invited the Associated Press to make tests over its European system.

3. These tests were made from London during the morning busy hour on 4 May 1972 by simultaneous transmissions over the leased 4-wire circuits to:

a) Copenhagen, Malmö and Oslo,

b) Paris, Brussels, Amsterdam and Frankfurt,

c) Rome.

The U.K. Post Office cooperated in the test to the extent of checking the signal levels and confirming that the circuits were correctly lined up in London. The peak powers were measured at the circuit terminals in the Associated Press office, which is the zero level reference point, and included the power of the telegraph channels in the circuits. No other checks were made on the circuits which were used " as found ", i.e. in representative but not necessarily correct adjustment.

The tests were made with peak powers of 0, −3, −6 and −9 dBm0.

4. Although Study Group XIV had suggested the use of the C.C.I.T.T. test chart, it seemed doubtful whether this would show the full effect of reducing the signal power of phototelegraphy. The test chart is not itself a photograph but a printed card and its dynamic range (as measured by comparing the signal powers produced when scanning the lightest and the darkest parts of the chart) was less than that of many photographs or of the phototelegraph equipment specification (30-35 dB).

It was therefore decided to make the tests with an actual photograph. The one selected was of a man wearing a black dinner jacket, black watered-silk waistcoat and a white, frilled shirt. These contrasting black and white areas contained shade variations and possessed a dynamic range of 34 dB.

5. Both negative and positive copies of the photograph were made at the Associated Press offices listed in paragraph 3 and positive copies were made by two Danish newspapers, *Ahtvelt* and *Syllandspesten*.

These photographs showed clearly that decreasing the signal power results in:

a) loss of tone scale in the highlights,

b) loss of tone scale in the dark areas,

c) increased pattern interference,

d) increased white-spot interference,

e) could prevent receivers from phasing correctly.

Exceptionally, however, it was found that at Amsterdam and Brussels, and to a lesser extent also at Frankfurt, reducing the peak power from 0 dBm0 to −3 dBm0 improved the tone scale of the highlights. This showed that there was some compression of the modulation at the higher power, probably at Paris, which was a common point in the omnibus circuit to the three offices, but it is not possible to be more precise. This is the drawback of testing the network " as found ", for there is no certainty that all parts will be correctly lined up; indeed the likelihood is to the contrary. On the other hand tests of a correctly lined-up system would be little use as a guide to normal conditions.

Apart from the exceptions mentioned in the preceding paragraph the tests showed that the quality of phototelegraph transmission decreased perceptibly when the peak power was reduced to −3 dBm0 and again when it was reduced to −6 dBm0, at which level the photograph received at Oslo was unusable because of lack of tone scale and pattern interference. That received at Malmö was almost as bad.

At −9 dBm0, the deterioration had become so severe that only three photographs were usable, those at Paris, Amsterdam and Rome and of these, the Amsterdam photograph had poor tone scale and the Rome photograph suffered from pattern interference.

6. Bearing in mind that:

a) the world-wide Press Photo networks were designed to operate at a peak power of 0 dBm0 and that any reduction in this design parameter is likely to result in loss of quality of the transmitted photographs;

b) over longer distances and less well-developed telecommunication systems and to newspapers more remote from the distribution offices, the loss of quality may be more severe than that revealed by these tests;

c) the ability to receive news photographs of printable quality is an essential element in the distribution of information;

d) it is in the interest of both users and Administrations that any service should possess an adequate margin of safety,

the I.P.T.C. considers that any reduction of the permitted peak power of phototelegraphy is undesirable but that, if a reduction is essential in the common interest, it should be limited to a decrease of 3 dB and should be subject to review in the light of experience.

Question 6/XIV — Use of leased telephone-type circuit for the simultaneous transmission of signals of 1) facsimile and telegraph, 2) facsimile and speech and 3) facsimile and data

(Mar del Plata, 1968, amended at Geneva, 1972)

(to be studied by the Joint Working Party LTG)

For the most efficient use to be made of a leased international telephone-type circuit, it is in many cases desirable simultaneously to carry facsimile and telegraph signals. In some cases it may also be desirable to carry facsimile and speech simultaneously, and possibly facsimile and data signals.

In such cases 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 other 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 1. — See Recommendation H.34.

Note 2. — This question has a bearing on Question 1/A, point J, and Question 24/XV.

Question 7/XIV* — Facsimile service between subscribers

(continuation of Question 7/XIV, 1964-1968, amended at Mar del Plata, 1968, and at Geneva, 1972)

Study of points arising from the implementation of Recommendations T.2 and T.4.

1. *Points for further study in respect of Recommendation T.2*

1) the modulation and demodulation equipments, specified in Recommendation T.2, particularly:

a) the frequency which should correspond to black and the frequency which should correspond to white;

b) the modulation to apply when switched connections are involved;

2) the scanning line frequency permitted when switched connections are involved;

3) standardization of other characteristics of machines such as:

a) band compression;

b) reduced redundancy with or without band compression.

2. *Points for further study in respect of Recommendation T.4*

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?

Note. — This Question also interests Study Groups I and II.

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?

ANNEX

(to Question 8/XIV)

Use of phototelegraphy for transmitting news phototographs in colour

(Contribution COM XIV—No. 25, June 1972: International Press Telecommunications Council)

After studying the replies to a questionnaire sent to Newspaper Publishers and News Agencies, the I.P.T.C. has reached the following conclusions:

a) The amount of colour material transmitted by wire, although very small at present, is growing: in about 5 years 10% of all news photographs may be in colour.

b) Most colour photographs will originate as 35-mm transparencies (diapositives). Transmitters capable of handling this size and type of photograph will reduce processing time, an important consideration with colour work.

c) The replies showed a strong preference for colour photographs to be received in the form of separations, i.e. monochrome photographs showing the intensity of the primary colours. The Council concurs in this view which accords with the principle that material should reach newspaper offices in a form which minimizes processing.

d) A strong preference was also expressed for the separations to be transmitted simultaneously rather than sequentially. The Council considers that this view has been based on a possible reduction in transmission time and pays insufficient regard to the wider bandwidth required for simultaneous transmission of separations or to the preponderance of monochrome material.

e) The Council believes that, at least for Agency networks, separations will continue to be sent sequentially until the proportion of colour photographs makes this course no longer practicable. At that stage consideration will need to be given to all means of increasing the flow of news photographs, including the simultaneous transmission of separations.

Question 9/XIV — High-speed facsimile transmission on wide-band circuits

(Mar del Plata, 1968)
(Results to be transmitted to the Joint Working Party LTG)

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 1. — This Question has a bearing on Question 1/A, point Z.

Note 2. — See Recommendations H.14 and H.15 (*Green Book*, Volume III).

Question 10/XIV — Definitions for facsimile telegraphy

(continuation of Question 10/XIV, 1964-1968)

Revision of the definitions for facsimile telegraphy 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) were entirely revised and have been published in the part of *Definitions* of this Volume VII.

Question 11/XIV — Facsimile transmission over earth satellites

(Mar del Plata, 1968)
(to be studied in cooperation 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).

Note 2. — See Supplement Nos. 24 and 25 of Volume VIII of the *Green Book*.

SUPPLEMENTS TO RECOMMENDATIONS AND QUESTIONS CONCERNING TELEGRAPH TECHNIQUE

Contributions received during the 1968-1972 study period which are published on account of their special interest

Supplement number	Source	Title	Relevant question	Page
		Supplements to Series R Recommendations (Telegraph transmission)		
1	France	Considerations on a system for telegraph transmission by time division of a primary group or a PCM time-slot	31/IX	313
2	Netherlands	Telegraphy and anisochronous data transmission with time multiplexing	31/IX	316
3	Federal Republic of Germany	Encoding methods for asynchronous telegraph and data transmission over PCM systems	31/IX	320
4	N.T.T.	Digital encoding method for non-synchronous data	31/IX	326
5	N.T.T.	Report on field tests of data transmission by PCM system	31/IX	331
6	USSR	The effect on telegraph distortion of sudden changes of level	12/IX	333
		Supplements to Series U Recommendations (Telegraph switching)		
7	France	International transit with existing telex networks	2/X	335
8	Australia	Application of Recommendation U.4—Telex signalling diagram		346
9	C.C.I.T.T. Secretariat	World-wide telex and gentex routing plan	–	348

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Supplement No. 1

FRANCE *(COM IX—No. 23—October 1970)*

CONSIDERATIONS ON A SYSTEM FOR TELEGRAPH TRANSMISSION BY TIME DIVISION OF A PRIMARY GROUP OR A PCM TIME-SLOT

1. *General considerations*

The French P.T.T. Administration considers that the time subdivision of a telephone channel to set up telegraph or data transmission links is not economically attractive for the time being, especially for general purpose channels (transparent systems). However, time subdivision of a primary group or of a PCM telephone channel time-slot could well produce economically viable systems. The two questions should be treated together.

The coexistence of the analogue and digital telephone networks means that telegraph transmission systems must be compatible with both types. The question of compatibility with the two transmission networks is examined below in the case of a primary group and a PCM time-slot; it requires:

— the same capacity of multiplex telegraph channels,

— a data signalling rate of the multiplex signal which if not identical is at least appropriate to the primary group and the PCM time-slot.

2. *Selection of the data signalling rate*

2.1 *Multiplex signal*

The data signalling rate of the telegraph multiplex may be

a) *in the case of the primary group*, the rate selected for the modem [1]: 48 kbit/s, or a rate that might be selected for future modems, 72 kbit/s [2] for example.

b) *in the case of PCM*

— 64 kbit/s, with 8 bits in the time-slot.

— 56 kbit/s, with 7 bits in the time-slot.

A data signalling rate of 64 kbit/s or 56 kbit/s permits direct synchronization of the telegraph multiplex by the PCM system. It also permits transmission of the multiplex on an analogue network, either using a 72-kbit/s primary group modem with stuffing bits added to the multiplex output, or using a 64-or 56-kbit/s primary group modem.

2.2 *Telegraph channel*

The data signalling rate of the telegraph multiplex should be compatible with the standardized data channel rates [3]. The data channel rate which results in the best use of the 64-kbit/s multiplex is $N \times 500$ bit/s, where $1 \leqslant N \leqslant 128$. This unit data signalling rate is set by the binary element rate, the TS (time-slot) rate and the PCM frame rate within the superframe.

3. *Capacity of the telegraph multiplex*

A distinction must be made between asynchronous and synchronous telegraph channels.

3.1 *Asynchronous telegraph channels*

The principle generally used to convert asynchronous into synchronous signals is to encode the conditions and transitions of the asynchronous signals. Two methods have been described:

— the Bell System " Sliding Index " method [4]

— the C.I.T. (Compagnie Industrielle des Télécommunications) CODEST method [5].

The efficiency of these methods is about 10 bit/baud for a telegraph distortion of less than 4%. Following these methods, a multiplex signal with a data signalling rate of 64 kbit/s allows the regrouping of about 128×50-baud channels with a distortion of less than 4% or 13×1200-baud channels with a distortion of less than 10%.

3.2 *Synchronous telegraph channels*

Basic synchronization is distributed to subscribers from the multiplexer. Subscribers are connected to the multiplex telegraph system by modems or baseband transceivers. The telegraph multiplexing efficiency is $(1-\varepsilon)$, where ε is a small quantity; when the multiplex consists of a single channel only, $\varepsilon = 0$. When the multiplex consists of several data channels, the method for synchronizing the multiplex frame depends on the efficiency required and the permissible resynchronization time.

For example, in the case of a multiplex with a data signalling rate of 64 kbit/s, made up of N 2 kbit/s channels, method No. 1 permits recovery of the frame synchronization, but on the first frame of the multiplex the bit/baud efficiency is mediocre. Method No. 2 produces an efficiency of 1 and the synchronization time is that of the PCM when the multiplex signal is transmitted on PCM. When the multiplex signal is transmitted on a 72-kbit/s group modem, the synchronization time may be about the same as that of the PCM. The synchronization characters are transmitted in the stuffing bits.

Method No. 1

The frame is made up of 32 bits divided into four time groups (gr) of eight. The eighth bit of each group is always a 1, except in group No. 1 in which the eighth bit is a zero. The first group (gr0) is occupied by a 7-bit frame-start character (Figure 1) consisting of seven zeros.

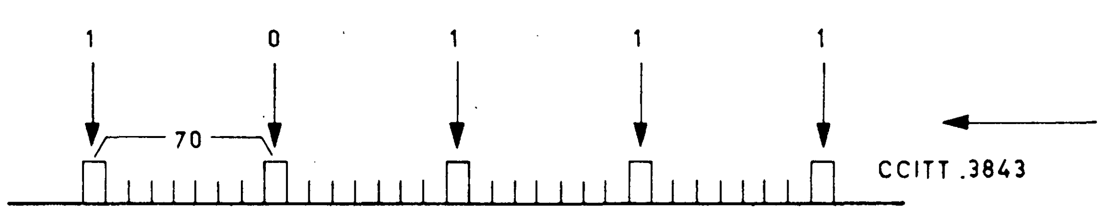


FIGURE 1

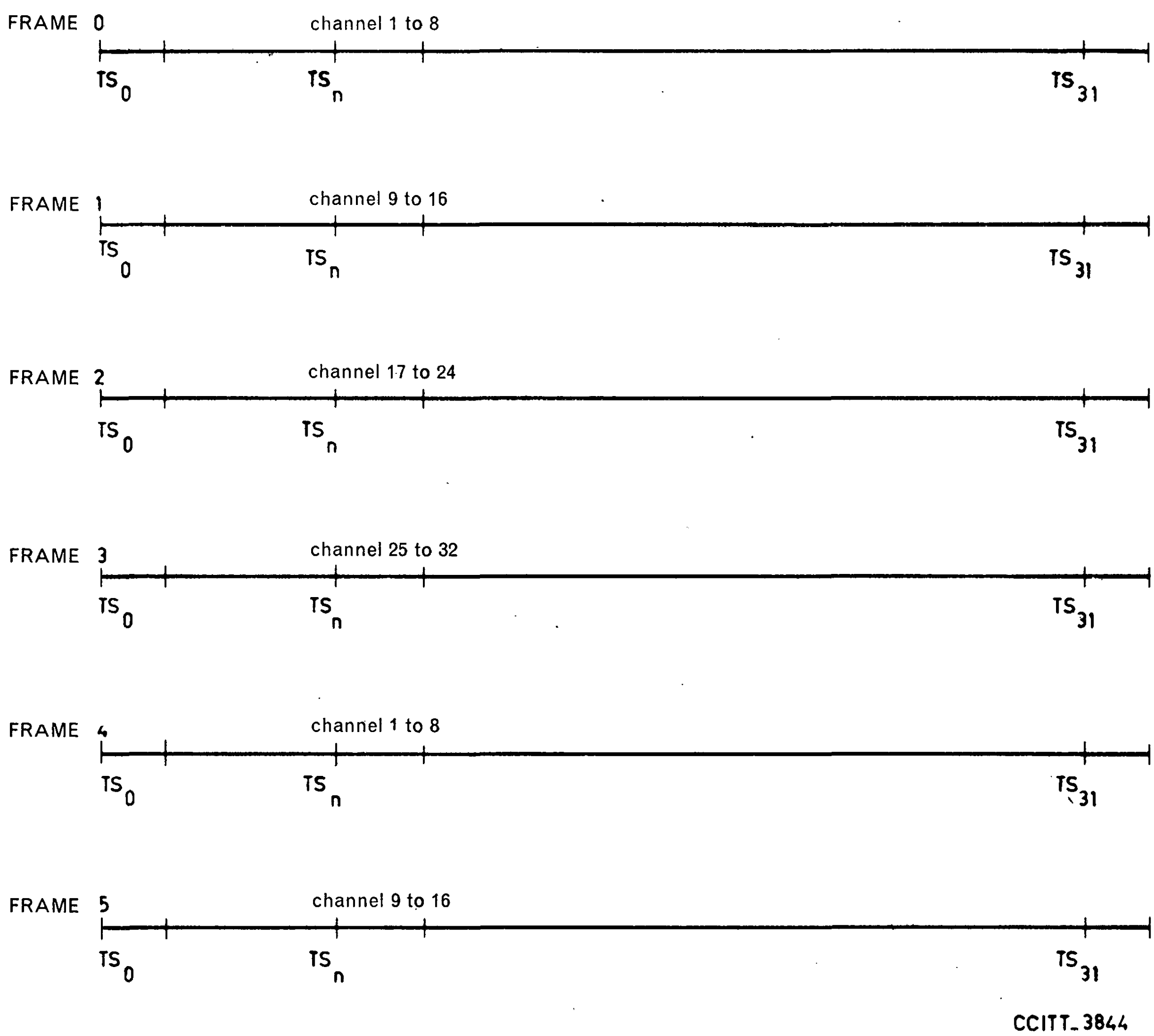
By this method we obtain 21 synchronous 2 kbit/s data channels with a multiplex signal of 64 kbit/s.

The efficiency of the system is then 0.65, i.e. $\frac{3}{4} \times \frac{7}{8}$.

This multiplex signal may be transmitted on a primary group at a rate identical to that of the PCM but in this case " stuffing " bits are not used, as the multiplex has its own frame information. When the multiplex signal is transmitted by PCM, the synchronization time of the multiplex signal is at the most that of the PCM plus a maximum of one telegraph frame, i.e. 500 μs.

Method No. 2

The multiplex telegraph signal occupies a PCM time-slot. Multiplexing and demultiplexing are done by means of the frame-start and the superframe information as shown in Figure 2. The efficiency of the multiplex in this instance is 1. The synchronization time is that of the PCM.



(TS = time-slot)

FIGURE 2

On the primary group it is necessary to use a faster data signalling rate than that of the PCM in order to insert the frame synchronization information. This would bring the rate to about 72 kbit/s. The synchronization method may be very similar to that used for the PCM system and the synchronization times may also be about the same.

4. *Flexibility of the multiplex telegraph system*

4.1 *Synchronous data channels*

In a multiplex made up of synchronous data channels, the channel data signalling rates which offer the greatest flexibility for a minimum equipment cost are multiples of 500 bit per second. In view of the fact that there is a lot of data-processing equipment with rates in multiples of 600, it is desirable for the multiplex signal to be able to transmit these channels also with the greatest flexibility. One method would be to set up data channels with faster data signalling rates and multiples of 500. The differences would be eliminated by " stuffing ".

4.2 *Asynchronous data channels*

Asynchronous data channels are transformed into synchronous channels by one of the techniques mentioned in 3.1 above.

REFERENCES

[1] C.C.I.T.T., *White Book*, Vol. VIII, Recommendation V.35.

[2] C.C.I.T.T., *White Book*, Vol. VIII, Question 1/A, point Z.

[3] C.C.I.T.T., *White Book*, Vol. VIII, Question 1/A, point N.

[4] L. F. TRAVIS and R. E. YAEGER: Wideband Data on Tl Carrier, *Bell System Technical Journal*, October 1965, pp. 1567-1604.

[5] J. OSWALD: CODEST, a new PCM system for transmitting telegraph signals and digital data (Un nouveau système par impulsions et codage des signaux télégraphiques et des données numériques), *Câbles et Transmissions* No. 2, 1970, pp. 179-185.

Supplement No. 2

NETHERLANDS *(based on Contribution COM IX—No. 42—June 1972)*

TELEGRAPHY AND ANISOCHRONOUS DATA TRANSMISSION WITH TIME MULTIPLEXING

1. *Introduction*

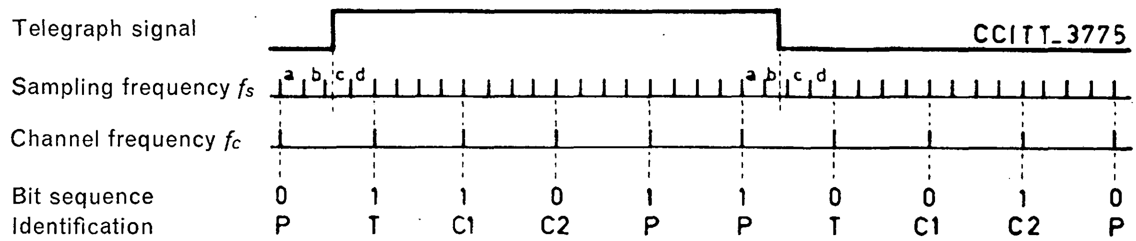
The Netherlands Administration pursued, in cooperation with the Philips company, the study of the time subdivision possibilities of primary group circuits and PCM time-slots for telegraphy and data transmission. According to the opinion of the study group that from the economic point of view it would be desirable to standardize one type of multiplex system, a structure is proposed for use on PCM voice channel time-slots and on primary group circuits. In the latter case the number of anisochronous channels will be lower or the isochronous distortion will be higher.

2. *Multiple sampling and coding*

The simplest method of multiplexing anisochronous telegraph or low-speed data signals is multiple sampling of the elements. By means of a data signalling rate of the multiplexed signal of 64 kbit/s and a sampling frequency of 1 kHz, 64 anisochronous channels of 50 bauds can be realized with an isochronous distortion of 5%.

A more efficient method of multiplexing anisochronous signals is multiple sampling followed by sliding index coding. The channel frequency of the proposed variant of this method is four times lower than the sampling frequency. When a transition occurs, one bit T indicates the direction of the transition (figure 1).

FIGURE 1



It is followed by two code bits (*C1* and *C2*), containing information about the position of that transition (e.g. positions *a*, *b*, *c* and *d* correspond with 00, 01, 10 and 11). If there is no transition, the bits *P* indicate the actual polarity of the anisochronous channel. With this coding method a bit error does not result in a continuous reversing of the demultiplexed signal, thus preventing the occurrence of false calling and false clearing signals. Considering once more a data signalling rate of 64 kbit/s and a sampling frequency of 1 kHz, the channel frequency becomes 250 Hz, and 256 anisochronous channels can be realized with an isochronous distortion of 5%.

It appears that the latter method has a four times higher efficiency than the former one.

Although such a coding method increases theoretically the system sensitivity to errors introduced during transmission, comparable error rates have been measured practically on channels with and without coding. Moreover, coding and decoding can be very economically achieved by using a common device for all the channels of the whole system. Finally, among all the presently known processes, used under similar conditions with respect to isochronous distortion and maximum modulation rate, the described coding method shows the highest efficiency. By giving a four times higher number of channels, this method allows important savings in the cost of the channel terminals with respect to the simple multiple sampling method.

The Netherlands Administration proposes therefore to generalize the application of the described sliding index coding method, for all the input signals.

3. *Maximum modulation rate and minimum signal element duration*

In the proposed sliding index process, the correct restitution of the input signal elements implies that their duration has to be greater than the duration of the three bits (*T-C1-C2*, Figure 1) which form a code character in the isochronous signal. As a result the maximum modulation rate of the input signal is limited to one-third of the bit rate of the corresponding isochronous channel.

The duration of the element which corresponds to the maximum modulation rate does not represent, however, the minimum duration of the signal element which is tolerated for the system. Every element having a duration greater than one bit of the isochronous signal is still accepted but is restored with a duration greater than 2 bits of the isochronous signal.

4. *Multiplex system structure*

The study has shown that a rate of at least 500 bit/s for the isochronous channels allows the greatest flexibility for the multiplex system structure and the optimum use of the 64 kbit/s rate of a PCM time-slot.

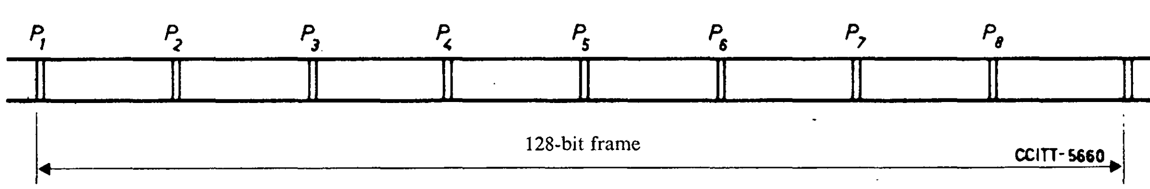
The maximum number of channels is then 128 and the multiplex signal frame is 128 bits. In this frame, 8 bits have been set aside for frame synchronization (cf. paragraph 5) and 120 bits remain for information transfer. Each information bit within the frame belongs thus to an isochronous channel of which the 500 bit/s rate allows the transmission of 50-baud telegraph signals with 2.5% distortion or 100-baud signals with 5% distortion.

When using sub-frames with 64, 32 and 16 bits, isochronous channels at 1, 2 and 4 kbit/s are formed in order to allow the transmission of anisochronous signals at 200 or 300, 600 and 1200 bauds. The table

CHARACTERISTICS FOR 64 AND 48 KBIT/S OF THE PROPOSED SYSTEME

Binary rate of the line signals (S) Frame (F)	Frame or sub-frame f bits	Nominal modulation rate m bauds	Sampling frequency $4 \cdot \left(\frac{S}{f}\right)$ bit/s	Binary rate per isochronous channel $\left(\frac{S}{f}\right)$ bit/s	Number of channels $\left(\frac{F-8}{F}\right) \cdot f$	Isochronous distortion $\frac{m}{4 \cdot \frac{S}{f}} \cdot 100$ %	Maximum modulation rate * $\left(\frac{1}{3}\right) \cdot \left(\frac{S}{f}\right)$ bauds
	128	50	2000	500	120	2.5	167
	128	100	2000	500	120	5	167
$S = 64\,000$ bit/s	64	200	4000	1000	60	5	333
$F = (120+8)$ bits	64	300	4000	1000	60	7.5	333
	32	600	8000	2000	30	7.5	667
	16	1200	16000	4000	15	7.5	1333
	96	50	2000	500	88	2.5	167
	96	100	2000	500	88	5	167
$S = 48\,000$ bit/s	48	200	4000	1000	44	5	333
$F = (88+8)$ bits	48	300	4000	1000	44	7.5	333
	24	600	8000	2000	22	7.5	667
	12	1200	16000	4000	11	7.5	1333
	128	50	1500	375	120	3.3	125
	128	100	1500	375	120	6.6	125
$S = 48\,000$ bit/s	64	200	3000	750	60	6.6	250
$F = (120+8)$ bits	32	300	6000	1500	30	5	500
	16	600	12000	3000	15	5	1000

* With an isochronous distortion of 8.3%.



P_i = synchronization and parity bits

given in the appendix shows various characteristics of the system; each configuration using an identical bit rate for all the channels. These characteristics remain unchanged for all mixed systems obtained by combination of channels with different bit rates.

The table also gives the characteristics obtained when a 48-kbit/s synchronous modem is used on a primary group. In this case, a reduced frame of 96 bits produces the same characteristics as a 128-bit frame with a 64-kbit/s bit rate, but the number of channels is reduced in proportion to the bit rate. Another possibility is to maintain the 128-bit frame allowing the same number of channels for 50, 100 and 200 baud signals but with some derating in the distortion figures and in the maximum modulation rate.

Thus the table shows clearly the great flexibility given by a multiplex system using two different frames of 96 and 128 bits. The choice between frames makes the system suitable for a large range of speeds (48, 56, 64 or 72 kbit/s), which may be needed for the transmission on a primary group or in a PCM time-slot, while maintaining very attractive characteristics with respect to distortion, number of channels and modulation rates. Furthermore, the adaptation to a particular bit rate does not imply any modification in the multiplex equipment because the clock signals are not generated in this equipment but are delivered to it either by the PCM equipment or by the synchronous modem. The same multiplex equipment can therefore be used for the transmission on a primary group with various modem types as well as for a PCM time-slot with 56 or 64 kbit/s.

5. *Frame synchronization*

In the proposed system, an 8-bit group is used in the 128- or 96-bit frames in order to ensure frame synchronization at the receiver. Furthermore these 8 bits (P_i) are symmetrically placed in the frame as indicated on the figure given in the appendix.

The number of bits and their position in the frame correspond to an isochronous channel with the highest bit rate. This configuration ensures the highest flexibility for the multiplex system and allows a symmetrical distribution for the sampling instants, which are needed for the common coding and decoding device.

The choice of an 8-bit group for the frame synchronization pattern also allows the introduction of a simple device used for the correction of transmission errors. For this purpose, the value of the 8 bits is derived from the 120 or 88 information bits, according to a Hamming code. This code allows one erroneous bit per frame to be corrected while protecting the frame synchronization pattern against simulation.

Loss of frame synchronization is detected as soon as three incorrect consecutive frames are received, i.e. within about 6 ms. Inversely synchronization is recovered after three correct consecutive frames.

6. *Field trial measurements*

A field trial was carried out with sliding index coded 200-baud signals. Only some of the channels made use of the device correcting one erroneous bit per frame.

The transmission medium used was primary group No. 4 of a secondary group, in which the other primary groups were used for telephone traffic. The length of the transmission link was about 120 km.

After a 2. months measuring period, the following average error rate figures have been registered.

	Modem transmitting level	
Error rate	−17 dBm0	−23 dBm0
— without error correction	0.9×10^{-7}	5×10^{-7}
— with error correction	0.8×10^{-7}	2.5×10^{-7}

The table shows that the measured error rate figures are very good in spite of the low transmitting level of −17 dBm0 used for the modem, while the authorized C.C.I.T.T. level for a synchronous data modem is −5 dBm0. Moreover, it has been measured that with the same transmitting level no errors are introduced on the received signals, in the presence of white noise corresponding to a fictitious reference circuit of 833 km.

It has to be noted that the single-error-correcting device only brings an improved error rate when the line signal is very low.

Supplement No. 3

FEDERAL REPUBLIC OF GERMANY *(Contribution COM IX—No. 44—June 1972)*

ENCODING METHODS FOR ASYNCHRONOUS TELEGRAPH AND DATA TRANSMISSION OVER PCM SYSTEMS

Sliding index encoding methods [1] may be employed for asynchronous transmission of telegraph and data signals over PCM systems. These methods are economical and utilize PCM bit stream efficiently. Compared with uncoded transmission, however, their disadvantage is, due to reduced redundancy, that bit errors on the PCM line have an appreciable influence on the bit error rate and the distortion of the recovered data signal. According to Supplement No. 4, the recovered data signal error rate is about four times that of the PCM circuit error rate. Additionally the telegraph distortion of the recovered data signal, introduced by impairments in the PCM circuit, is likely to assume any value.

By choosing a suitable encoding method the existing redundancy in the encoded data signal could be utilized for error detection and correction and a reasonable compromise could be achieved between tolerable telegraph distortion and error rate of the recorded data signal. Regarding transmission quality and redundancy these methods range between pure sampling and sliding index encoding with only one index bit [1].

In connection with question 31/IX it appears to be necessary to study error-correcting methods which may be adopted in encoding and decoding of the polarity transitions of the telegraph and data signals in the next study period.

Annex 1 shows examples of protected encoding and redundancy-utilizing decoding methods. These encoding and decoding methods may also be extended so that a sufficient number of transitions is provided in the transmitted data signal during a continuous sequence of ZEROS or ONES to maintain synchronization. A corresponding example is given in Annex 2.

ANNEX 1

Error rate and telegraph distortion of the recovered signal caused by impairments in the PCM circuit in the case of asynchronous telegraph and data transmission

1. *Introduction*

The significant instant of the data signal, in this case, is communicated to the receiving station by a code character which consists of two parts, namely the

— start criterion, used to indicate *that* a polarity transition did occur a moment ago, and the

— sampling criterion, used to indicate precisely *when* this transition did occur.

Previous suggestions aiming at a practical realization have the disadvantage that the start criterion, initiating the decoding process at the receiving end, consists of one bit only. This involves errors and distortions in the recovered data signal if this bit is disturbed. Methods protecting the start criterion from being affected during transmission over the PCM circuit are therefore proposed.

[1] TRAVIS, YAEGER: Wideband Data on T1 Carrier, *Bell System Technical Journal*, 44 (1965) 8, page 1572.

2. *Encoding methods*

Figure 1 is a block schematic showing the encoding and multiplexing of 4800-baud, 2400-baud and 1200-baud data channels in place of a single PCM voice channel. Employing this method, a maximum of two 4800-baud channels, four 2400-baud channels or eight 1200-baud channels can be multiplexed. Figure 2 shows the associated

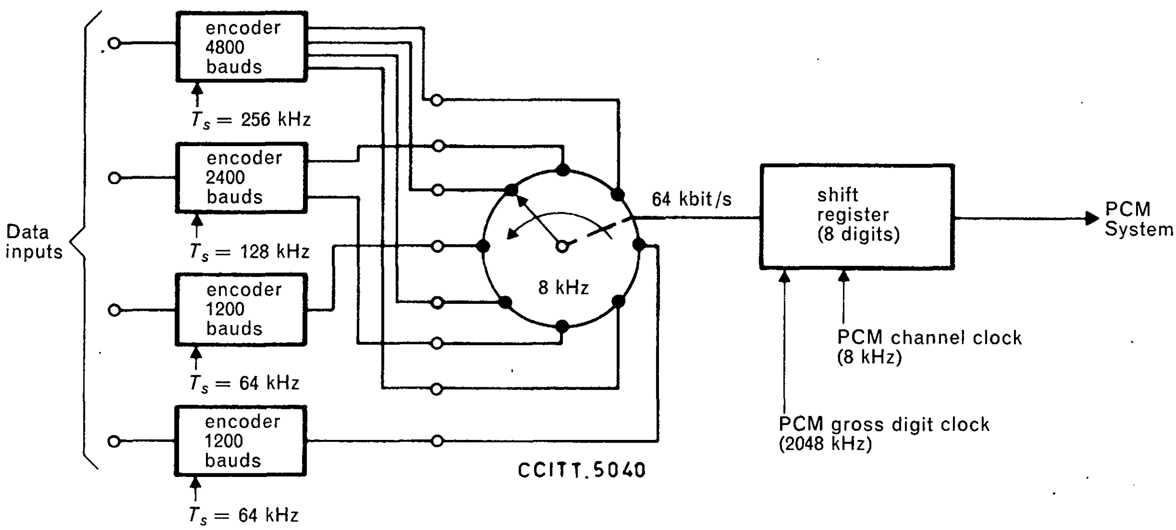


FIGURE 1. — **Asynchronous data transmission over PCM systems for 4800-, 2400- and 1200-baud data channels (transmitting end)**

pulse diagram. A data signal (1), applied to the input, is sampled in the encoder with the aid of the sampling pulse (2). Sampling pulse and multiplex pulse (3) are synchronized. If a polarity transition has occurred in the data signal, the start criterion of the code character is transmitted with the next following multiplex clock pulse. With *encoding method 1* (4) the start criterion consists of three identical bits, with *encoding method 2* it consists of five bits, four bits of one polarity and one bit (e.g. the 4th bit) of the other polarity (5). Moreover, in both encoding methods the start criterion also includes information regarding the polarity of the data signal sampled. In encoding method 1 the sampling criterion is ONE if the polarity of the data signal is ONE and ZERO in the opposite case. In encoding method 2 the polarity of data signal is represented by the polarity of the four identical bits of the start criterion.

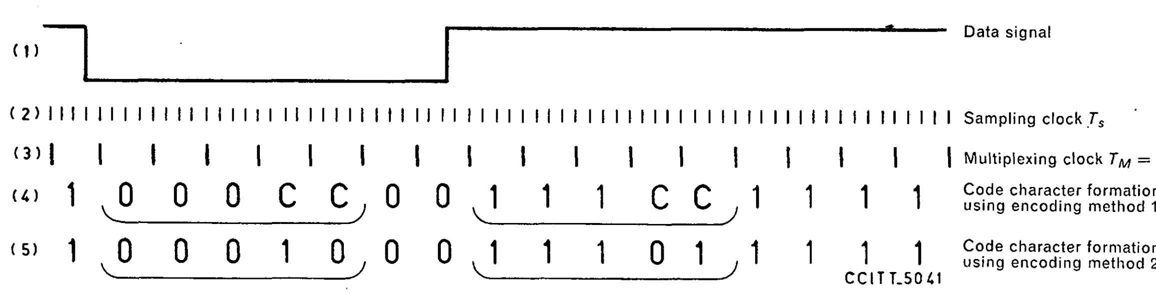


FIGURE 2. — **Pulse diagram of code character formation by means of encoding methods 1 and 2 for a data channel**

The start criterion is followed by the sampling criterion which marks the significant instant between two multiplex clock pulses. In encoding method 1 the sampling criterion consists of two bits. The system-inherent isochronous telegraph distortion is in this case $\leqq 3.8\%$. In encoding method 2 the start criterion is also used as sampling criterion. In this case the system-inherent telegraph distortion amounts to $\leqq 15\%$. Outside the code character, i.e. during the period up to the next following start criterion, polarity ONE prevails if the data signal is ONE. Otherwise polarity ZERO is transmitted.

The code characters are formed for all of the data inputs (Figure 1, left) in the manner described, multiplexed and injected into the PCM system in place of a single speech channel. In view of their low inherent distortion, systems employing encoding method 1 can be operated over a number of independent line sections. Systems based on encoding method 2 may be used on point-to-point circuits and also on multi-point connections if the signals are regenerated after each line section. It may be mentioned, in addition, that the method depicted in Figure 1 permits the formation of sub-systems and master systems operating at telegraph and data transmission speeds ranging from 50 bauds to 9.6 kbauds.

3. *Decoding method*

In the case of encoding method 1, the decision at the receiving end that the character is a code character is made if two of the three bits of the start criterion are of the same polarity. After this decision decoding of code character can be carried out. Employing encoding method 2, the decoding process is initiated if at least four of the five bits of the start criterion have been found to be correct. The significant instant of the data signal is obtained by decoding the sampling criterion.

4. *Error rate and telegraph distortion of the recovered data signal*

The data transmission system described together with the noise source of the PCM line have been simulated on a digital computer. Data messages are transmitted in the PCM circuit in such a way that, between two consecutive bits of a code character, a large number of bits belonging to other channels are transmitted. Therefore noise bursts on the PCM circuit will in most cases not result in the same effects as bursts in a single data channel. A random noise source has therefore been used.

Simulation on a computer yielded the following results:

Errors in the recovered data signals cannot occur unless two bits of the start criterion are affected or, with encoding method 1, if a start criterion is accidentally produced as the result of " double errors " in the PCM circuit. Figure 3 shows the error rate p_D of the recovered data signal as a function of the error rate p_M on the PCM circuit. It shows that code characters formed in accordance with encoding method 2 will be less affected since this method also permits " double errors " to be corrected. To compare the two encoding methods with an encoding method employing a single bit as the start criterion, the p_D of the latter method is also shown in Figure 3.

If the bits of a code character are disturbed on the PCM circuit, *additional distortion* occurs in the recovered data signal (independently of the system-inherent telegraph distortion). Figure 4 shows the distribution of the ratio of these additional distortions to the error rate on the PCM circuit. The major part of this additional distortion has the same values as the system-inherent distortion: 3.8% with encoding method 1 and 15% with encoding method 2. Values up to 41% (early individual distortion) are possible with encoding method 1, although this probability is rather low.

The individual distortion of *predistorted data signals* will never be increased but in many cases it will be decreased.

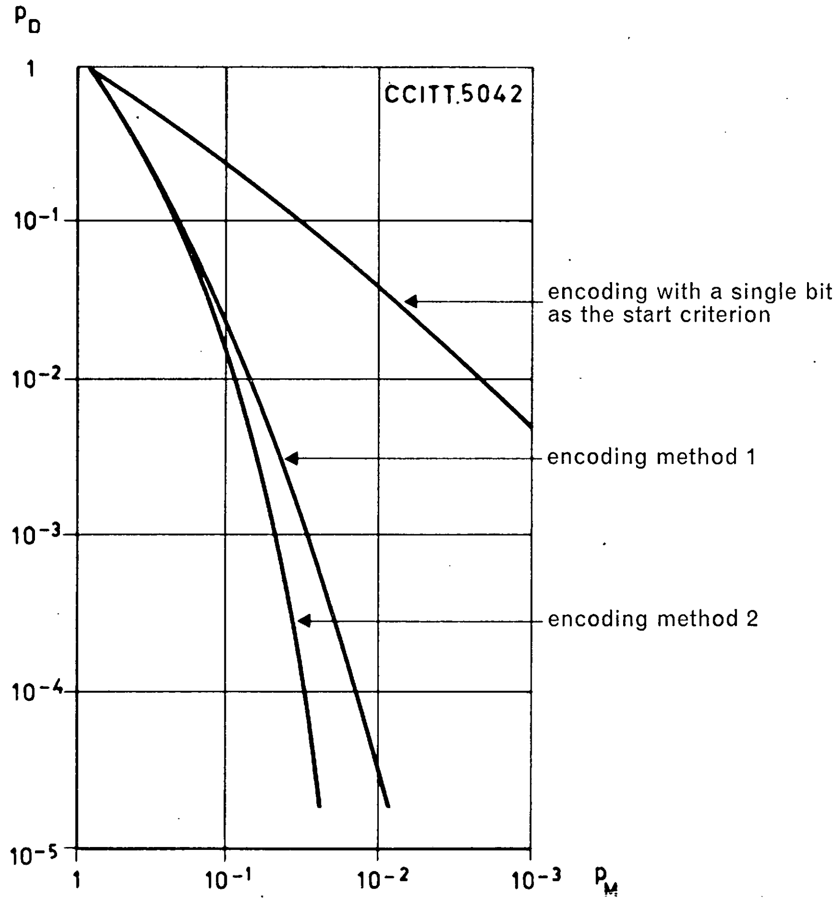


FIGURE 3. — **Error rate p_D of the recovered data signal as a function of the error rate p_M on the PCM circuit**

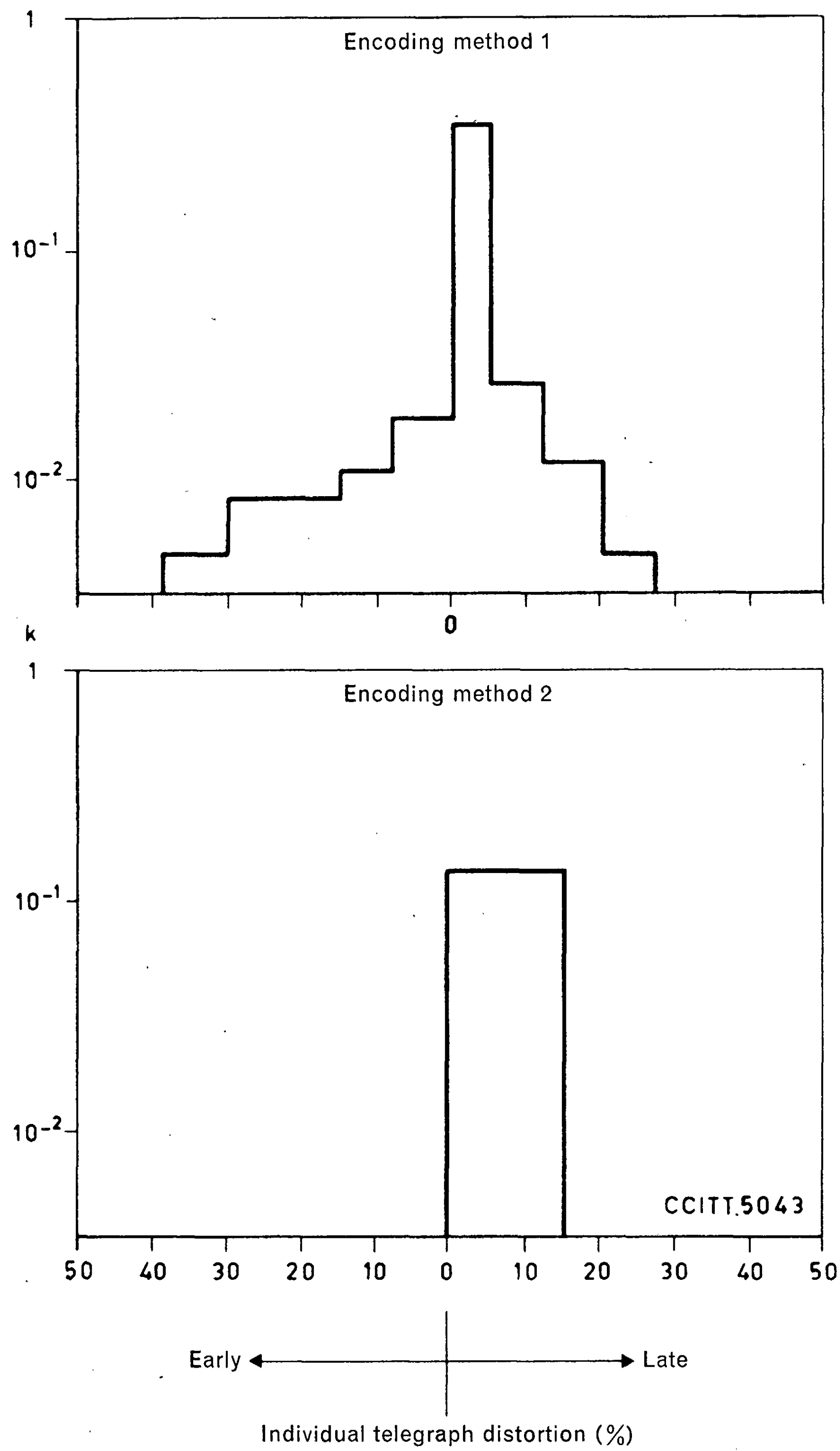


FIGURE 4. — **Distribution of the ratio (k) of additional distortion values to the error rate on the PCM circuit in the recovered data signal**

ANNEX 2

Transmission of synchronizing information during a continuous sequence of ZEROS or ONES in the telegraph or data channel

Using the encoding methods mentioned in Annex 1, identical bits are transmitted between two code characters. This offers the advantage that the polarity of the data signal is always clearly marked. The disadvantage, however, is that no synchronizing information is transmitted during these intervals.

Supplement No. 4 therefore suggests a method providing for the marking of intervals of the same data signal polarity by criteria such as alternations 1010 . . . or 0101 . . . (dual mode encoding method). In this way timing information is transmitted together with information marking the signal polarity. The disadvantage is that these two criteria differ only by their phase and, if synchronization gets lost (slip by one bit due to a fault) there will be no difference between these two criteria.

A solution is therefore suggested which provides for the marking of the two polarities of the data signal by the criteria 110110 . . . and 001001 . . . This prevents merging of the two criteria in the event of a phase displacement and ensures the transmission of adequate synchronizing information. Figure 1 below shows the application of this principle in connection with encoding method 1 (see Annex 1) on a single data channel. The code character (4) obtained with encoding method 1 is subjected to a second encoding excepting the two code bits denoted by *C*. The code character (4) switches, depending on its condition, to the *S1-state* (5) or to the *S0-state* (6) to form the new code character (7). The code character resulting from encoding method 2 (see Annex 1) can be transformed in the same way.

The code characters are generated in this way for all data inputs (see Annex 1, Figure 1), multiplexed and injected into the PCM system in place of a single speech channel.

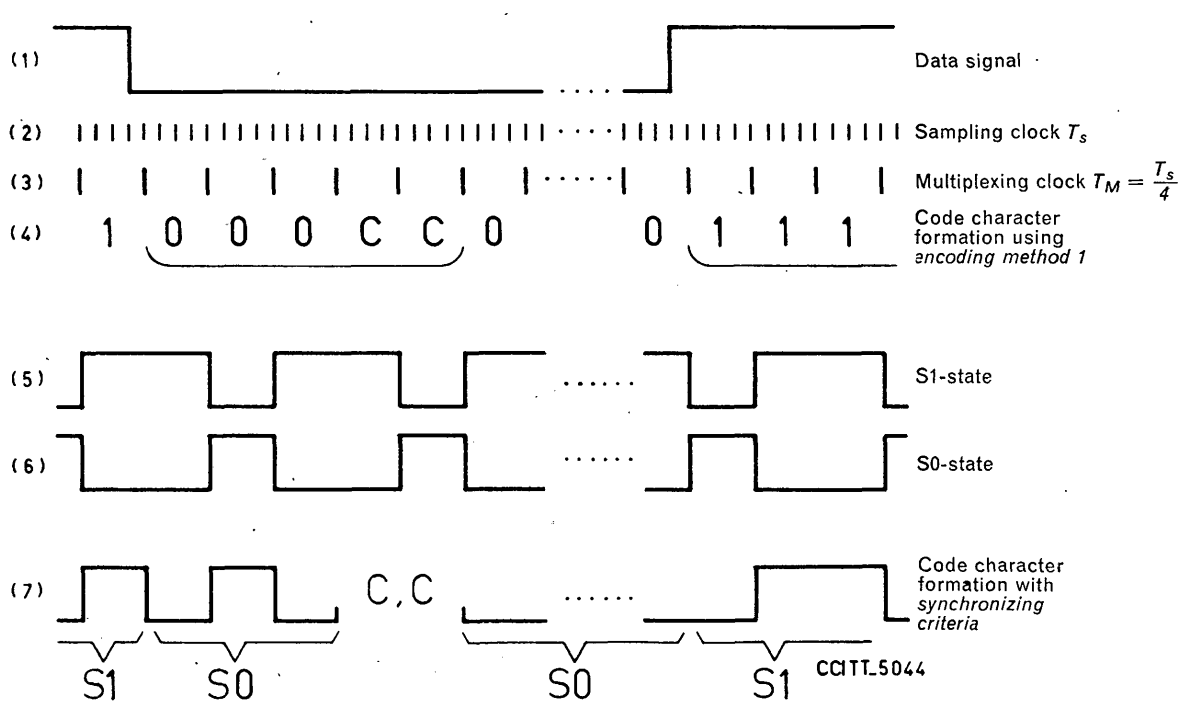


FIGURE 1. — **Pulse diagram of code character formation with synchronizing criteria by means of encoding method 1 for one data channel**

Supplement No. 4

NIPPON TELEGRAPH AND TELEPHONE PUBLIC CORPORATION *(Contribution COM IX —No. 51—June 1972)*

DIGITAL ENCODING METHOD FOR NON-SYNCHRONOUS DATA

1. *Introduction*

A digital system, such as PCM, has many attractive characteristics for transmission of digital signals, including data and two-level facsimile signals. When a PCM system is synchronized with a data system, the present PCM can transmit 64 kbit/s data signals, using one voice channel, since the PCM system has 64 kbit/s transmission capability per voice channel. However, appropriate digital encoding is required for data transmission over a digital system because, in general, the data transmission system is not synchronized with the digital system.

Figure 1 shows block diagrams of a data transmission system over a PCM facility. Figure 1 a) shows a data transmission system used for data signal only, while Figures 1 b) and c) show a hybrid system which provides mixed voice-data service over a PCM line.

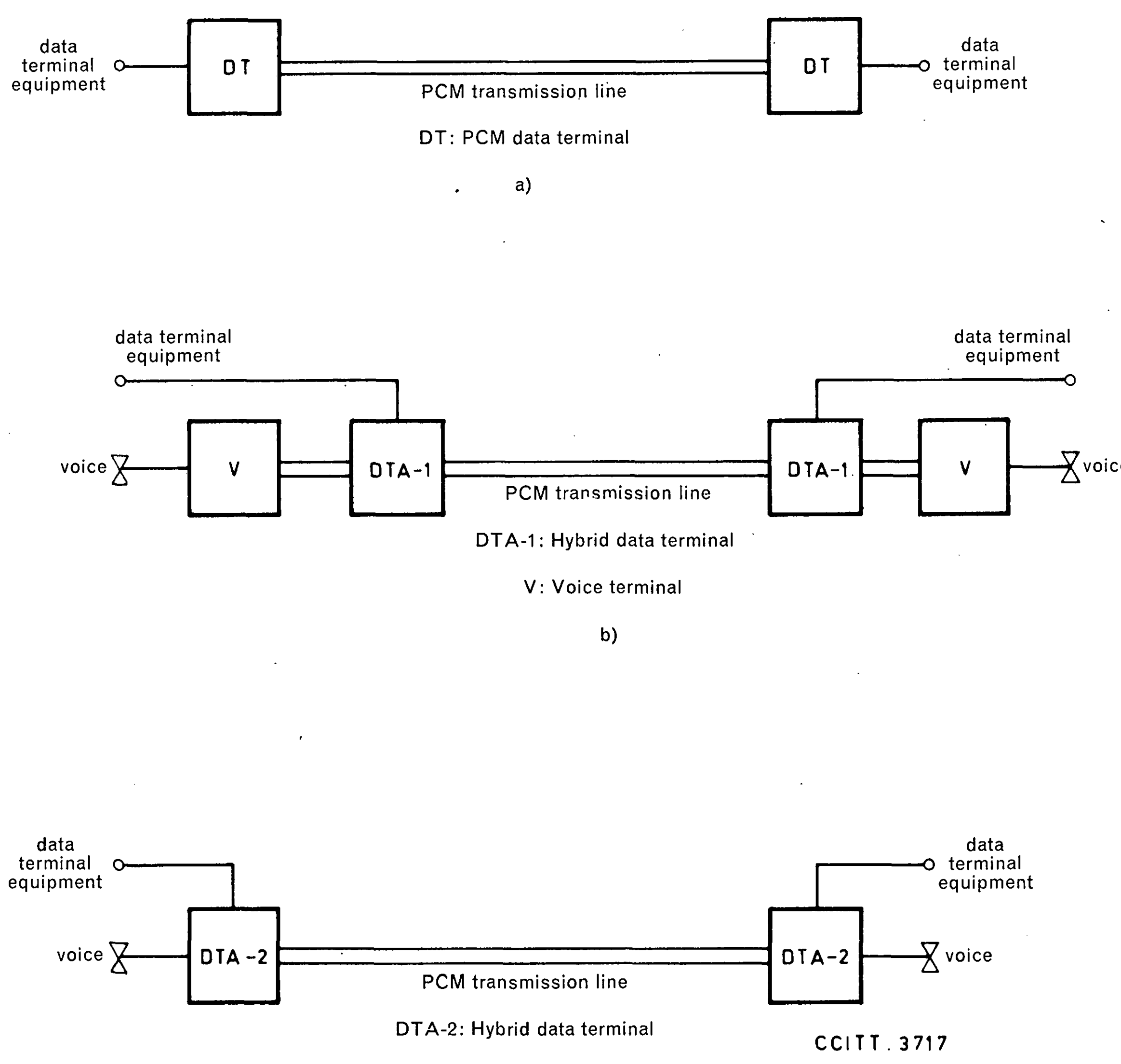


FIGURE 1. — **Data transmission over PCM system**

In encoding a data signal for transmission over PCM lines, the factors which must be considered include:

1) high coding efficiency;

2) small time quantizing error;

3) small line error effects on data error;

4) simple configuration of coder and decoder.

The purpose of this contribution is to report an efficient and convenient encoding method for non-synchronous data transmission over digital lines.

2. *Description*

2.1 *Dual mode encoding method*

An efficient encoding method for non-synchronous data signals, called dual mode method, is described. In this method, the ZERO mode pulse train or ONE mode pulse train, corresponding to ZERO state or ONE state of the data, is transmitted. The ONE mode pulse train is represented by a (1010 . . . . .) sequence and the ZERO mode pulse train is represented by a (0101 . . . . .) sequence, starting with a framing pulse. When a data transition occurs, the mode of the pulse train changes from the mode showing ONE state to the mode showing ZERO state, or vice versa.

The pulse immediately after the transition pulse is used to designate whether the transition occurred in the early half of the interval between successive pulses or in the latter half. This second pulse giving transition time is required to reduce the quantizing error for transition time. Thus, the dual mode method requires only two PCM bits for each data bit, allowing operation at a theoretical data transmission rate equal to half the sampling pulse rate.

Since the minimum interval between data transitions then must be no less than two pulse intervals, and since the transition is quantized to within one-half of one pulse interval, the maximum time quantizing error is $\pm 12.5\%$ of the minimum data transition interval.

If three bits are used to encode a transition, the resultant time quantizing error is reduced because transition time can be characterized as early-early, early-late, late-early, and late-late. Reduced quantizing error allows high-quality data transmission and is especially beneficial when multilink transmission is required. Dual mode three-bit encoding process is shown in Figure 2. Input data signal (1) is applied to the sampling circuit to obtain pulse (3). The sampling pulse (2), which is derived from clock and timing circuits, is synchronous with a PCM pulse. In the absence of a transition of data state, the coder output (6) provides a ONE mode (4) or a ZERO mode (5) pulse train, corresponding to ONE state or ZERO state of the data.

When a data transition occurs, the time quantizing pulses which indicate the transition time are inserted into the next available time slots following the transition. As shown in Figure 2, each sampling period is divided into four sections and the time quantizing pulses identify the section in which a transition has occurred.

The decoder compares the mode of the received pulse train (equal to (6)) with the reference mode (ONE mode or ZERO mode), and detects the change of the mode of the received pulse train and time quantizing pulses. The decoder logic resolves this information into a data transition occurring within one-quarter of one sampling period. This permits synthesis of a delayed low-distortion replica (7) of the input data signal.

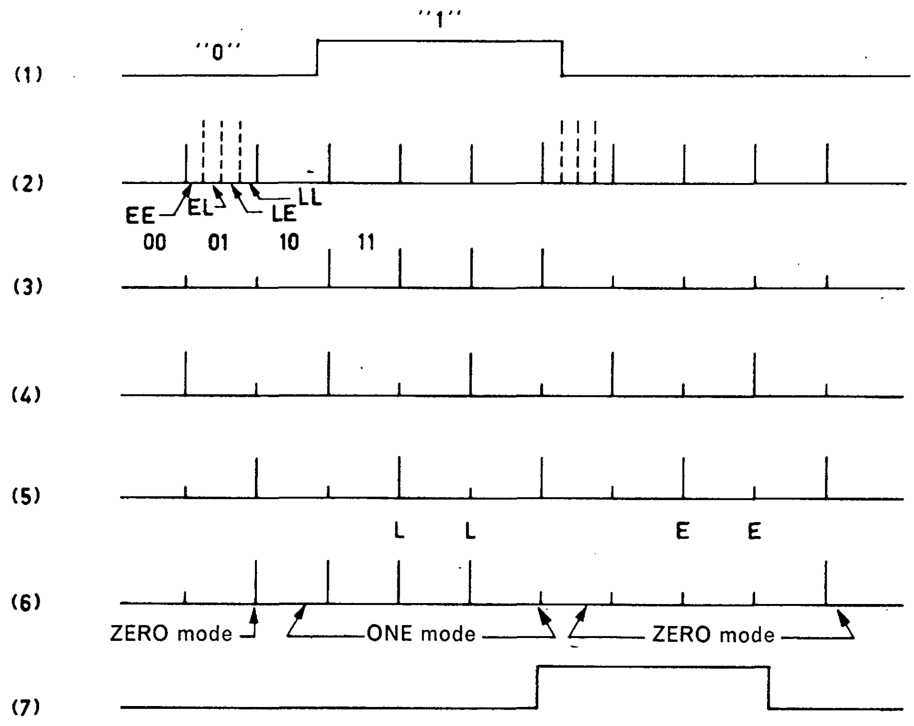


FIGURE 2. — **Timing diagram for dual mode three-bit encoding**

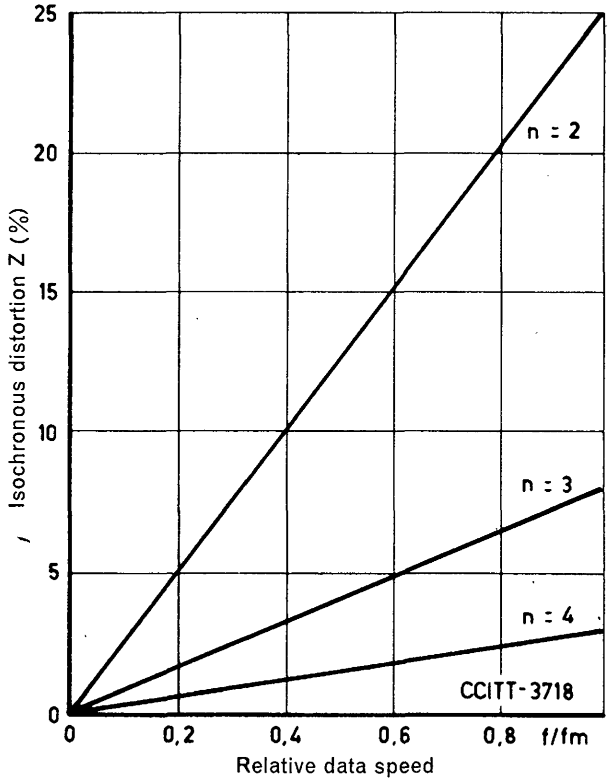


FIGURE 3. — **Isochronous distortion**

Note. — Delay of framing bit is not included.

A reference mode pulse train, either ONE mode or ZERO mode, must be provided in the receiver decoder to enable recovery of information from the received pulse train. The PCM framing pulse provides the information needed to reproduce the reference mode pulse train.

2.2 *Time quantizing error*

The maximum isochronous distortion Z_m due to time quantizing is given by Equation (1). Where "n" is the number of encoding pulses.

$$Z_m = \frac{1}{n \cdot 2^{n-1}} \qquad (1)$$

Maximum data rate f_m is given by Equation (2):

$$f_m = \frac{f_0}{n} \qquad (2)$$

where f_0 is sampling pulse rate.

Figure 3 shows the relationship of isochronous distortion Z and data rate f. When three bits are used for transmission by dual mode method, the resultant maximum quantizing error is $\pm 4.2\%$ of the minimum data transmission interval. Maximum data rate then becomes one-third of the PCM pulse rate.

2.3 *Line error effects*

The correlation between line error rate and data error rate depends upon the data statistics, the terminal coding arrangement and the distribution of the line error rate. Computer simulation and experimental results show that the data error rate is from 2 to 4 times the line error rate.

3. *Multiplexing*

A number of data signals can be multiplexed by the time division technique. Two arrangements for multiplexing are considered: one is multiplexing data only, as is shown in Figure 4, the other is a hybrid system which multiplexes voice and data signals, as shown in Figure 5.

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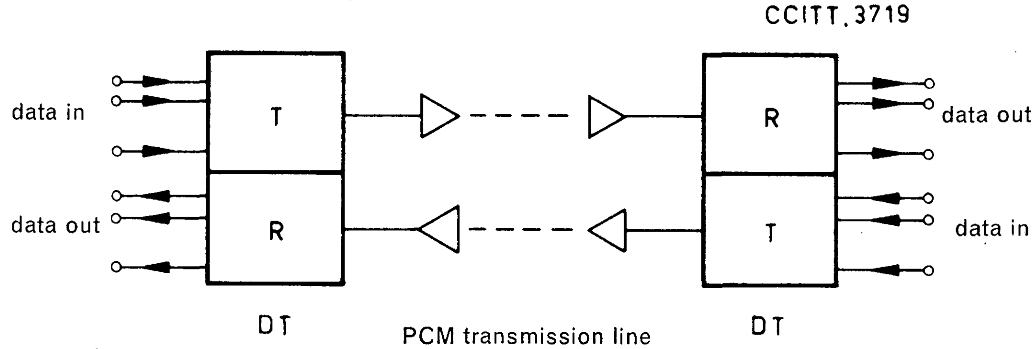


FIGURE 4. — **Block diagram for all-data transmission over digital system**

In Figure 5 a), PCM terminal *(V)* and data terminal *(DTA-1)* are synchronized. This approach features the PCM voice terminal (V) being a standard unit which is already installed for commercial service, and the data terminal (DTA-1) being added for encoding and decoding data signal only. An alternative scheme for multiplexing voice and data signals is shown in Figure 5 b). The hybrid data terminal (DTA-2) encodes and decodes both data and voice signals by common timing circuit.

4. *Conclusion*

Considering the various advantages of the dual mode method as described above, NTT proposes that the dual mode method be used for data transmission over various digital systems, including existing PCM systems. We also suggest the use of three-bit encoding for high-quality data transmission over digital systems, although the two-bit encoding method can be used in the case of one-link transmission.

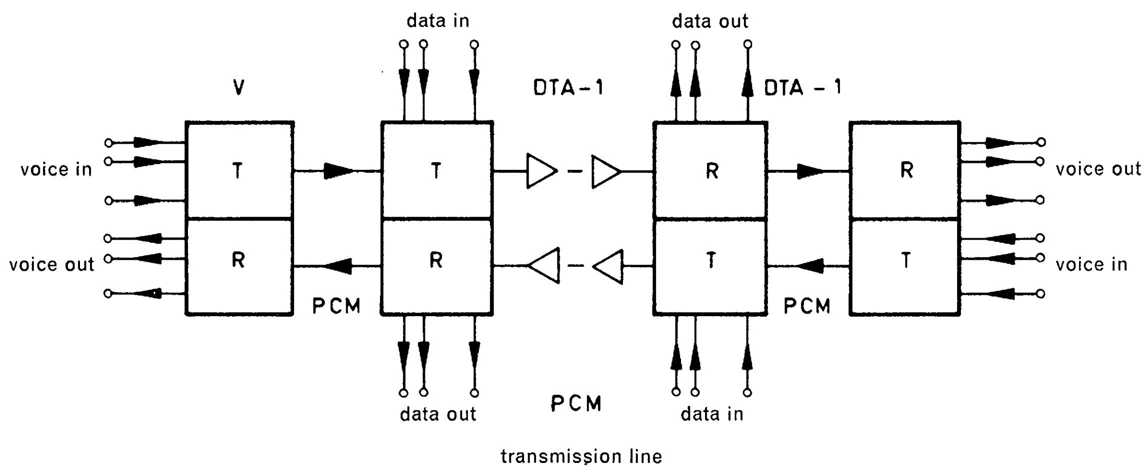


FIGURE 5 a)

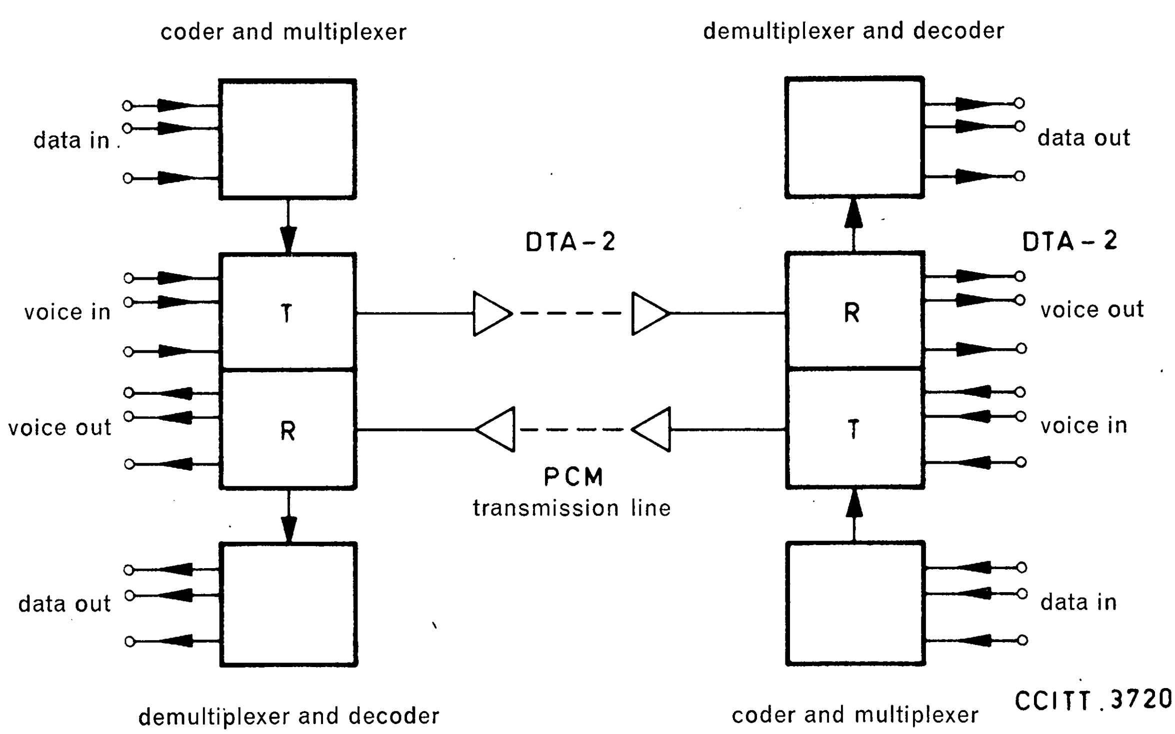


FIGURE 5 b)

FIGURE 5. — **Block diagram for hybrid data transmission over digital system**

Supplement No. 5

NIPPON TELEGRAPH AND TELEPHONE PUBLIC CORPORATION *(Contribution COM IX —No. 55—August 1972)*

REPORT ON FIELD TESTS OF DATA TRANSMISSION BY PCM SYSTEM

1. *Introduction*

It was proposed in Supplement No. 4 that the dual mode encoding method would provide an efficient way of transition encoding of data signals. However, bit errors on a PCM line have an appreciable influence on bit error rate of received data signals. According to that Supplement the received data error rate is about two to four times the PCM line error rate. A field test of data transmission by PCM system was carried out using the dual mode 3-bit encoding method described in the above document and the test results show a number of interesting suggestions for data transmission over PCM lines.

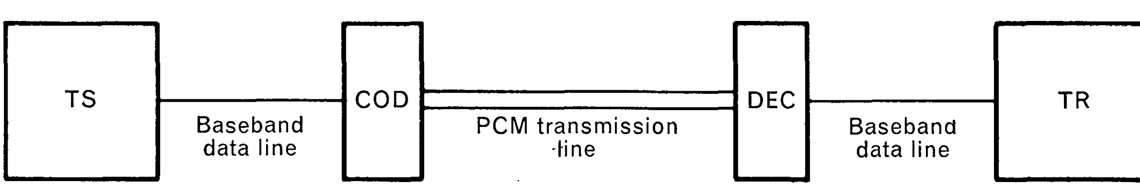
2. *Outlines of data terminal used in the field test*

The dual mode 3-bit encoding method was employed in experimental terminal equipments for data transmission over existing PCM-24 lines operating at a line bit rate of 1544 kbit/s. With this method, two channels of 9600 bit/s data, four channels of 4800 bit/s data or eight channels of 2400 bit/s data can be multiplexed, respectively, in a single PCM voice channel, or one channel of 48 bit/s data in three PCM voice channels. For a higher data rate, eight channels of 48 kbit/s data signal, two channels of 240 kbit/s data signal or one channel of 480 kbit/s data signal can be multiplexed in a single 1544 kbit/s PCM-24 line.

A frame alignment signal is carried on every 193 bits, as in the PCM-24 system. Other fundamental parameters of the data terminal are identical with those of PCM voice terminals, so that the terminal can be applicable to the existing PCM lines.

3. *Measurements*

The 511-bit test pattern recommended in V.52 was used to measure data error rate of received data signals. A block diagram of the measurement system is shown in Figure 1, where the length of the PCM transmission line is approximately 100 km.



TS = Transmitting part of measuring apparatus
TR = Receiving part of measuring apparatus
COD = Coding part of dual mode data terminal equipment
DEC = Decoding part of dual mode data terminal equipment

FIGURE 1. — **Measurement system block diagram**

4. *Data error rate*

Data transmission by transition encoding methods would suffer appreciably from PCM line errors compared with ordinary sampling methods. Table 1 shows the error rate P_d of the received data signal and the error rate P_e on the PCM line. In order to save the time required for the error rate measurement, the error rate of the PCM line was adjusted to the order of 10^{-6} by applying Gaussian noise to the line, because the error rate of the existing PCM line is in the order of 10^{-8} or less, as will be mentioned later. Table 1 includes the field test results of various data rates together with the digital computer simulation results for comparison.

The digital computer simulation has been conducted under the condition that input data signals applied to the dual mode 3-bit encoder would take a random pattern and that bit errors on the PCM line would occur at random. According to the simulation results, the received data signal error rate is about 4 times the PCM line error rate. However, field test results indicate that data error rate is markedly affected by line error characteristics, data statistics and adjacent data channel conditions.

TABLE 1

BIT ERROR RATE

Data rate	Simulation		Measurement	
	P_d/P_e	P_d	P_e	P_d/P_e
2400 bit/s	4.3	6.0×10^{-6}	1.3×10^{-6}	4.6
4800 bit/s	4.3	8.9×10^{-6}	1.4×10^{-6}	6.4
9600 bit/s	4.3	7.0×10^{-6}	1.4×10^{-6}	5.0
48 kbit/s	4.4	4.1×10^{-6}	1.4×10^{-6}	2.9
240 kbit/s	4.2	5.0×10^{-6}	1.3×10^{-6}	3.8

Note 1. — P_d: Data error rate; P_e: PCM line error rate.
Note 2. — Refer to Sec. 4 for the bit error rate measurement values.

Field test results are satisfactory for data transmission over the PCM system, because the results have indicated that a line error rate in the order of 10^{-8} or less is expected for the existing PCM-24 lines. As a result, a data error rate in the order of 10^{-7} or less can be expected for data transmission over the PCM-24 system using the dual mode encoding method. It would be concluded that the dual mode encoding method provides a highly efficient use of PCM channels, ensuring high-quality data transmission.

5. *Operating performance*

In the dual mode encoding method, the data signal polarity, positive or negative, is marked by mode pulse sequence such as alternating 1010 - - - format or 0101 - - - format. It has been suggested that these two kinds of mode pulse sequences differ only in their phase and, if synchronization be lost, namely slip by one bit due to a fault, there would be no difference between these two kinds of mode-pulse sequences. This would happen if no synchronizing information were sent to detect the phase of these two sequences. This problem is eliminated by using framing bits inserted in every frame in the line signal as a reference of the phase of these two sequences. Once the synchronization is lost, for example, by bit errors on the PCM line, the framing bit is able to recover the synchronization and to immediately correct the phase of the sequences.

Field tests showed there was no synchronization loss under various error rate conditions and the system proved to be reliable and satisfactory.

6. *Conclusion*

The experimental PCM data terminal equipment showed satisfactory characteristics throughout the field tests. It has been confirmed that the dual mode encoding method described in Supplement No. 4 can be effectively applied to actual data services.

Supplement No. 6

U.S.S.R. *(Contribution COM IX—No. 58—August 1972)*

THE EFFECT ON TELEGRAPH DISTORTION OF SUDDEN CHANGES OF LEVEL

In connection with Question 12/IX, the U.S.S.R. Telecommunication Administration has carried out measurements to determine the impact of the duration and magnitude of sudden changes in level on the degree of isochronous distortion.

The measurements were made on single voice frequency FM telegraphy channels. During the measurements all the VF telegraphy channels but the one tested were out of service.

The source of the short-term reductions in level and the source of the test signals were designed as independent units. The short-term sudden reductions in level thus occurred at random and were not correlated with the occurrence of the significant instants of the test signal restitution.

A fairly wide interval was chosen between two consecutive reductions in level (exceeding the total duration of 20 signal elements). This made it possible to exclude the influence of the interaction of transient processes due to consecutive reductions in level on the degree of distortion.

The distortion measurements were made with an instrument of discrete type designed to measure isochronous distortion, which was able to determine the maximum values of individual distortions.

The inaccuracy of the measurement error did not exceed:

0.25% in the range up to 12%
0.5% in the range up to 24%
1% in the range up to 48%.

The observation period for each tested value was chosen in accordance with Recommendation R.5. The degree of isochronous distortion in the tested VF telegraphy channels was equal to 1.25% under normal conditions (in the absence of reductions in level).

The test signals sent over the measured channels were signal elements of the 1:1 and 4:4 type. The measurement results were the same for both types.

Figure 1 shows the curve of the short-term level reduction. The time of transition from the normal to the reduced level and vice versa was negligibly small in comparison with the period (T) during which the reduced level was maintained.

Figure 2 shows the dependence of the degree of isochronous distortion (δ) on the relative duration $\left(\frac{T}{T_0}\right)$ and the amount of level reduction ($\Delta\alpha$).

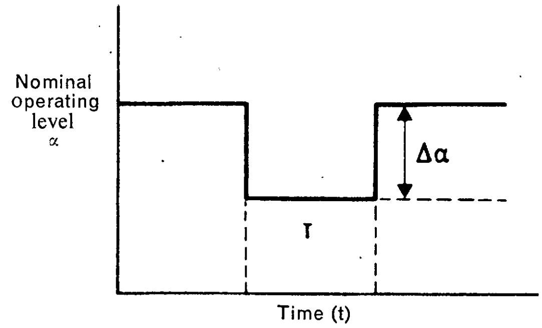


FIGURE 1. — **Curve showing short-term sudden reduction in level**

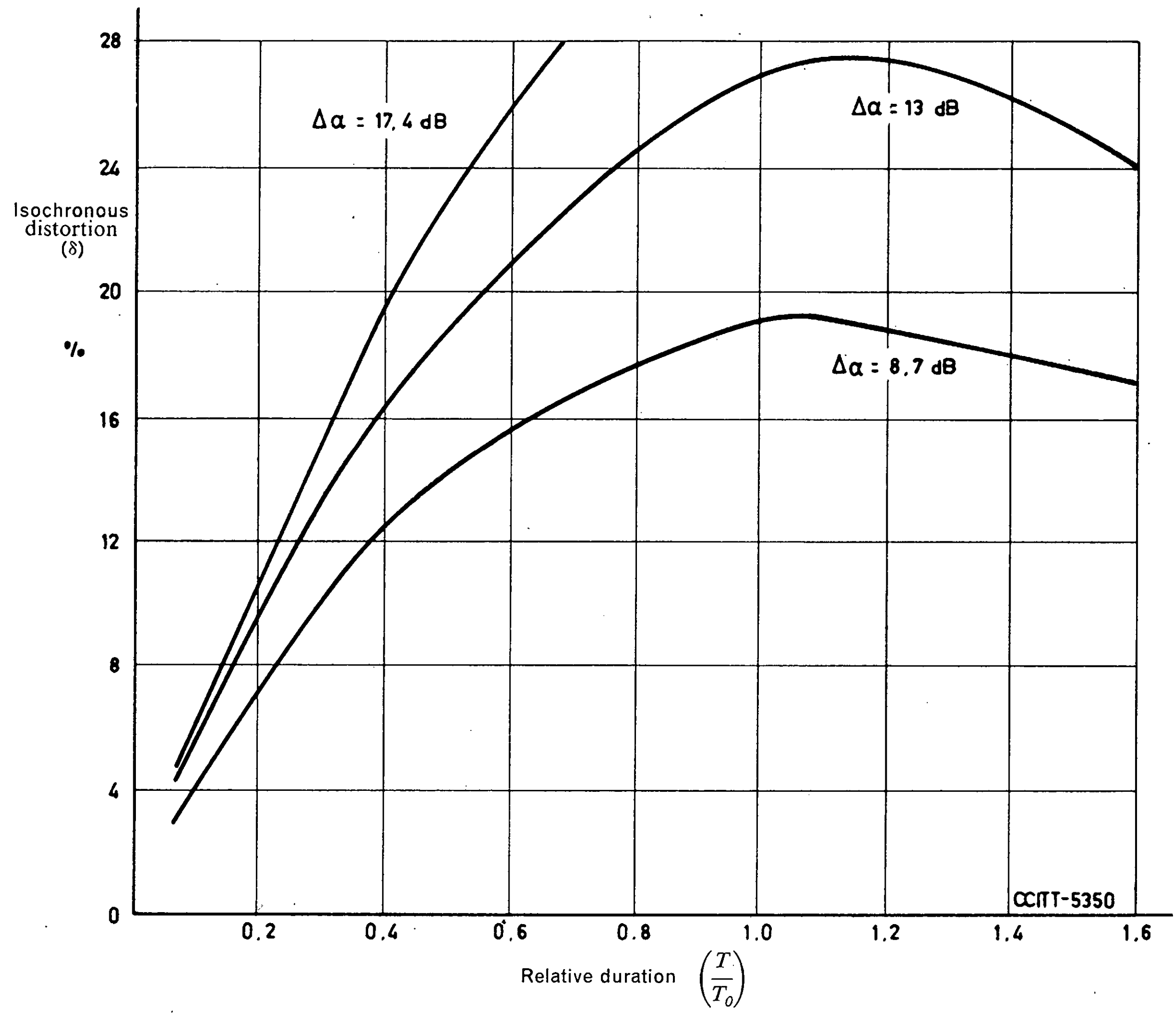


FIGURE 2. — **Degree of isochronous distortion versus relative duration and amount of reduction in level**

The measurements show that the degree of isochronous distortion in VF telegraphy channels increases steadily as the duration of the abrupt reduction in level increases from $0.1T_0$ to T_0 (where T_0 is the test signal element duration).

The degree of distortion remains practically constant if the duration of the level reduction is greater than this duration.

Supplement No. 7

INTERNATIONAL TRANSIT WITH EXISTING TELEX NETWORKS

FRANCE *(Contribution COM X—No. 37—January 1972)*

1. *Introductory comments on former Recommendation U.8*

The text of Recommendation U.8 (see *White Book*, Volume VII) dated from the New Delhi Plenary Assembly in 1960 when the study of a world plan for telex destination codes was initiated under " new " Question 8/1 = 8/X of the *Red Book*. The wording of the recommendation shows that little hope was seen for a rapid solution of the problem. The world plan for telex destination codes originated with Recommendation F.69 in 1964 which, apart from a few minor changes, is the present Recommendation in Volume II-B.

No doubt it was initially thought wise to restrict the application of Recommendation F.69 to automatic transit selection on " intercontinental " circuits. The world plan thus seems linked with the development of networks operating with the type C signalling system in Recommendation U.11, also published in 1964. The new system at least offered the advantage of not actually being in operation at the time, which lessened the problems of modifying installations already in service.

For these networks already in service, it was a question of not changing users' dialling habits too abruptly nor of overwhelming type A and B exchanges, because at that time automation of the most important international relations was expanding very rapidly, particularly in Europe. However, the situation has since evolved considerably and former Recommendation U.8 no longer corresponds to existing circumstances.

1.1 *Intercontinental or international relations ?*

With the development of satellite links, and particularly submarine cables, numerous international relations—intercontinental or otherwise—have in recent years been able to use new direct circuits with similar characteristics to those of the customary land circuits. The possible drawbacks of slightly longer propagation times are not serious for telegraph operation and switching with 50-baud circuits.

With the availability of these new channels a considerable number of relations previously operated with semi-automatic transit facilities are now equipped with direct circuits, thus allowing terminal traffic between remote countries to be fully automatic.

1.2 *Automation limited to terminal traffic*

As was formerly the case for interconnection between networks in the same continent, this automation followed the principles of Recommendation U.1, with most of the permitted variants in types A and B signalling. The practical problems of adapting equipment in the originating network to the signalling system in the destination network were already solved for each type of switching system by well-proven technical equipment.

In the absence of international coordination of national telex numbering plans, automation of international traffic is more or less restricted to the terminal traffic of networks which are interconnected without switching in any intermediate country. Even if subscribers knew, for each case, the prefixes giving access to the international outlets of the other networks, it would not be desirable to allow them complete freedom of choice in routing their transit calls.

Given these conditions, the resulting tendency is for groups of direct channels to multiply in relations where the volume of traffic does not always justify them, whenever there is a requirement to abandon semi-automatic operation with its disadvantages.

2. *Examination of the possibilities of partial coordination*

The introduction of type C signalling (Recommendation U.11) in a network implies the adoption of the destination codes in Recommendation F. 69, with a numbering scheme following a well-defined pattern. Fortunately, the converse is not compulsory. Since the publication of Recommendation F.69, in cases where this had not already been done, a fair number of Administrations have rearranged their national numbering plans to incorporate the C.C.I.T.T. destination codes into their prefixes giving access to the international outlets of their networks. These modifications have affected not only the numbers to be selected by their own subscribers for outgoing calls, but also for transit calls offered to outgoing semi-automatic positions in other countries.

Whether there will eventually be some uniformity in this field is of course not known. There is a clearly defined tendency to align numbering plans in recently automated networks; in others it is clear that such modifications can only be envisaged if extensive equipment replacements become necessary in the switching centres as a result of wear or limited expansibility.

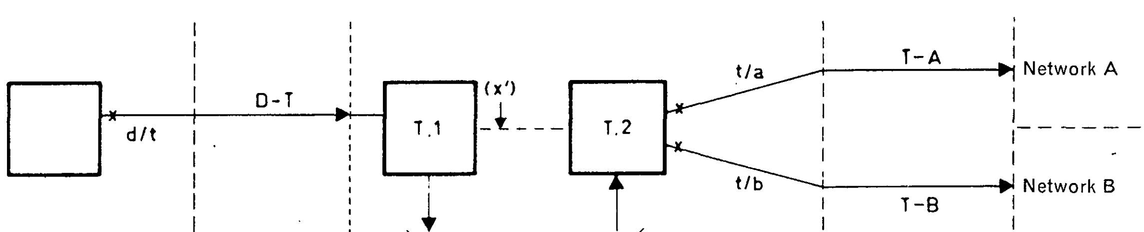
Considering this fact objectively, the search for a partial solution for automatic transit on existing systems should nevertheless meet with some success if it is confined to examining the additional conditions which must be satisfied if semi-automatic operation is to be eliminated *on international circuits which are already fully automatic for terminal traffic between the countries concerned,* if possible without modifying the method of operation, including numbering, in force for the automatic terminal traffic of each section.

2.1 *Conditions already satisfied*

For the sake of brevity we shall assume that terminal traffic is automatic:

— between originating subscribers in country *D* and subscribers in transit country *T*,

— and between the latter and subscribers in terminal countries *A*, *B*, . . . etc.



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For the direction of traffic flow considered, e.g. from *D* to *T*, circuits *D-T* can be split between various outlets of the *D* network and/or several inlets in the *T* network. The considerations below are in no way affected if, for the sake of simplicity, we confine ourselves to the case in which all the circuits *D-T* arrive at the same incoming exchange *T.1* in the *T* network. Similarly, circuits *T-A*, *T-B*, etc. will be assumed to be international outlets of a single exchange *T.2* which is the outgoing exchange for subscribers in network *T*.

Regardless of the geographical or physical configuration of the circuits or the way in which their traffic directions are assigned, we see that, in conformity with Recommendation U.1, the signalling on the *D-T* path is that of the *T* network. In the same way, arrangements are made (" x " in the diagram) in exchange *T.2*, or at its outlets, to adapt the signals exchanged on paths *T-A*, *T-B*, etc. to the signalling standards in networks *A*, *B*, etc. respectively.

At the outlets from each network there are devices capable of transmitting in the required direction not only the calling, call-confirmation, proceed-to-select, call-connected and clearing signals, but also of converting digits from keyboard code to dial code and vice versa when this is necessary. If at least one of the switching systems is based on keyboard selection the same equipment permits recognition of cases where the complementary signals prepare-for-digits, class-of-traffic and end-of-selection admitted by Recommendation U.1 (paragraphs 5 c and d) have to be added, suppressed, modified or re-located in the numbering sequence. These converters could moreover interpret the service sequences corresponding to calls which are unsuccessful in the incoming network and send them back to the caller, at least in a form suited to the signalling of the originating network.

In short, these problems of adapting the form of every signal exchanged on the circuit are resolved by the fact that the passage from one network to the next is already automated.

2.2 *Routing conditions and charging at point of origin*

One might ignore cases where there are two separate groups of *D-T* circuits, one reserved for automatic terminal traffic to subscribers of network *T* and the other, leaving *D*, for semi-automatic positions to set up calls transiting *T*. Such cases should be considered, however, because this situation is only justified if the originating Administration can neither bar nor charge correctly calls transiting *T*, which may be set up directly by subscribers in its own network. In these circumstances, which are covered by paragraph 3 of Recommendation U.6, the transit country enforces the barring of facilities when it can, i.e. when it has in its *T.1* exchange special selectors which do not offer access to the outgoing exchange *T.2* to serve circuits *D-T* reserved exclusively for incoming terminal traffic at *T*. In this case it is essential that the national numbering plan of the originating network should have a prefix for access to the automatic *D-T* channels which differs from that (or those) used to direct other international calls to manual or semi-automatic positions. This example clearly shows the advantage of including in each national numbering plan at least as many numbers or series of numbers as there are direct or transit international relations when automatic subscriber-to-subscriber operations are possible on the latter.

Obviously, if there is fully automated traffic *D-A* or *D-B* using outgoing channels *D-T* and taking advantage of the transit facilities offered by the traversed network, there can be no restrictions on access at the selectors associated with the circuits entering exchange *T.1*. Except in quite exceptional arrangements, the transit Administration should be freed from all responsibility in the way of barring, as this is the concern of the originating Administration.

The latter can, after taking due account of its national numbering plan and switching system, select the numbers or first digits of the complete numbering sequence to identify each particular international relation as it prefers. For selection *by the caller*, there is nothing to prevent a general prefix from being applied for access to the automatic international service, separate or not from the prefix giving access to the manual positions, or again a prefix specifying the outgoing route. It is not essential for subscriber-selected destination codes to conform strictly to those in Recommendation F.69. The main point is that the Administration of origin must be able to recognize by means of this number the destination network to which the called subscriber is actually connected.

If this basic condition is met by the national numbering plan in the originating network, the routing of the call, charging of the calling subscriber and the sending of a number acceptable to the switching system in the transit country are purely technical questions which can be answered in all cases. Provision of the necessary technical facilities would appear to be the responsibility of the originating Administration since it benefits from the saving of equipment and staff needed for semi-automatic operation.

In accounting between Administrations, which is the task of the originating Administration, a difficulty arises in networks where a meter is used for each outgoing circuit, in accordance with Recommendation F.67, paragraph 2 b. A switching device will have to be inserted to evaluate the charged minutes on a given *D-T* circuit depending on whether the call set up is of the type terminal *D-T*, *D-A* or *D-B* with transit via *T*. Although each terminal network is more often than not considered a single charging zone as far as subscribers in the network of origin are concerned, the accounting rates per minute are obviously not the same as between all the Administrations concerned.

Since a meter directly assigned to the outgoing circuit is no longer satisfactory, it will no doubt be useful to make use of totalizing devices attached individually to every possible type of relation, *D-T*, *D-A* or *D-B* in the example chosen. The connection of the *D-T* circuit to the appropriate metering totalizer during the charged duration of each call may be prepared by carrying out a single translation during the selection phase. This again assumes that the number sent by the caller is sufficient to identify unambiguously the actual destination network to which the called correspondent belongs.

In the absence of an ideal solution which would seem to be strongly advocated by the preliminary considerations in Recommendation F.67, the recommendation itself mentions facilities flexible enough to produce an approximate solution which might be considered satisfactory, regardless of the way in which these charged minutes are evaluated for entry into the international accounts. With the method described in 2 a of Recommendation F.67, which is currently used in France, the introduction of an automatic transit service does not give rise to any new problems, either for charging the caller or for preparing international accounts.

3. *Signalling conditions for automatic transit*

For the Administration responsible for transit network *T*, the use on the *D-T* circuits of signalling which corresponds strictly to its own national switching system only rarely resolves all the difficulties arising on the incoming side of its network. These difficulties are caused mainly by the absence of standardization, which causes some uncertainty in three different phases during selection:

— the number format, which must almost always consist of a variable number of digits to comply with the numbering adopted in the various destination networks,

— the responsibility of connecting the calling and called subscriber due to the fact that the call-connected signal, depending on the particular case, may or may not be followed by such telegraph signals as answer-backs, date and time, etc.,

— the presence or absence of service signals which are only optional for unsuccessful calls.

The main question is certainly that of the numbering method to be recommended to traverse the transit network.

3.1 *Format of the numbering*

It has already been said that 5 e of Recommendation U.1 effectively imposed a closed numbering plan for keyboard selection networks because, with a dial selection system, signalling can only be adapted if it is known when (i.e. after how many digits) the end-of-selection signal (Combination No. 26 (+) of start-stop code No. 2) should be sent *to a system which requires it*. The usefulness of such a requirement for the successful functioning of a national keyboard system is open to question but the main trouble is that the uniformity rule for the number of digits was not extended to dial selection systems as well as to keyboard systems not requiring emission of the " + ". A major drawback caused by this particular provision in Recommendation U.1 is described below.

In practice the major difficulty is not caused so much by this limited uniformity; problems also arise on many international circuits connected to the incoming side of networks with register-controlled exchanges irrespective of whether the registers are designed to receive dial or keyboard signals with or without an end-of-selection " + ". The very reasonable desire for economy dictates that these registers, which generally only serve incoming calls, should have their capacity strictly limited to that needed to reach all subscribers in network *T*, considered here as an incoming terminal network.

The uniformity of the number of digits both for handling domestic and external traffic has produced some side-effects. The opportunity has been taken in a number of register-controlled networks to limit the number and dispersion of high-capacity registers since they are really only useful for obtaining subscribers in other countries. These special registers are thus often placed, as in France, only in type *T.2* exchanges which are mainly or entirely confined to international outgoing traffic.

This arrangement offsets the advantage gained by the fundamental principle in Recommendation U.1 of adapting signalling on the *D-T* circuits to that of the destination network's switching system.

3.1.1 Single or multiple stage selection

Limited register capacity in the national exchanges of a network implies selection in two stages for a subscriber in network *T* who wishes to correspond with country *A* or *B*. In other words, transit through *T* networks organized in this way would require two-stage selection as for outgoing traffic, if any modification to the existing *T.1* and *T.2* exchanges' structures is to be avoided.

It is appropriate here to examine in greater detail whether such a selection procedure is desirable. To give an example, the two numbering sequences prescribed for a telex subscriber or gentex station for an international call from the French network have the following features:

— The first group of signals corresponds to the uniform number of digits in the national numbering plan. It is used to route the call to a high-capacity register, providing it with the category of the caller and establishing the class of traffic of the call and the destination network. By the middle of 1971 the latter information conformed with the destination codes in Recommendation F.69 for 19 of the 28 fully automatic relations. Alignment of all these destination codes is planned.

— After being invited, by reception of a short sequence of backward path signals (GA), the caller continues selection by transmitting the national number of the called party directly to the international register, in accordance with the destination network's directory. As *the number of digits may vary considerably*, the second stage in the selection process *must finish with the + sign* to indicate end of selection.

The three basic functions of the international register for dealing with this selection process, are detailed below:

a) Checking of the request and possible rejection of calls which should be barred, e.g. in a relation not yet automatic for subscribers, an attempt to connect telex with gentex or vice versa, an unauthorized transit, etc.,

b) Selection of an outgoing international circuit as a function, not only of the destination code contained in the first sequence, but also of the first significant digit in the second sequence, as well as the caller's category. The destination telex network may in fact be separate from the gentex network or may have several inputs (cf. Recommendation U.7),

c) Re-transmission of the digits in the second sequence on the international circuit, in accordance with the appropriate signalling code (keyboard or dial), with, if necessary, class-of-traffic signals coded and placed as required by the Administration of the destination country.

As each network has its own numbering peculiarities, especially for outgoing prefixes, registers like those in the Paris *T.2* exchange must be able to deal with all possible types of relation. To do so it must call on a common device called the " route marker ". At the moment this device contains about 20 different programmes even though this international exchange has no charging functions. The latter are transferred to the subscriber's exchange which derives sufficient data from the first numbering sequence to process them.

In practice two-stage dialling at the outgoing side of the network has never caused subscribers any significant difficulty. From traffic observations, this method is of considerable service to operators in foreign semi-automatic positions, who rapidly familiarize themselves with the first sequences in the French numbering plan, for obtaining other networks in automatic transit, or for normal or stand-by routing.

To the extent to which its network is available, in the *T* transit position, the French Administration may allow another network's subscribers direct access to the high-capacity registers in a *T.2* exchange. This facility has been available in one relation since the end of 1969 and will no doubt be extended in the near future to facilitate the flow of outgoing traffic from other networks. This presupposes that such networks have a numbering scheme which lends itself easily to the sending, along the first section of the international route, of a first sequence which is exactly the same as the one chosen in France for outgoing traffic.

Such coordination between origin and transit countries is seldom achieved. Furthermore, the two-stage selection procedure imposed by the arrangement of certain register networks may be a source of trouble for subscribers in networks designed for step-by-step selection, as they would be used to a single selection process. Its advantages are even debatable if register-controlled networks are considered in the outgoing position.

If the principle of two-stage selection comes into general use, perhaps no changes need be made in the French type *T.1* incoming exchanges. But if advantage is to be taken—as an outgoing network—of the transit possibilities offered in this way by other networks, the way in which outgoing traffic is handled within each network traversed must be considered. Networks often have greatly differing numbering schemes with varying numbers of digits for access to international outlets. In particular, it may be necessary for the high-capacity registers in the *T.2* exchanges to translate the first numbering sequence according to a correspondence table and a format depending on the network transited by each call. If all the organizational details of the other networks were known in the originating Administration, it should be possible in theory to find a technical solution to this problem. The preceding description of the functions performed by the registers in the French *T.2* exchanges demonstrates the complexity of the programmes for handling outgoing traffic. This complexity might be compounded by the number of selection methods to be considered for transit, and above all the system would be compromised by the slightest change decided upon by another Administration.

In view of these considerations, preference must be given to a single-stage selection process, with a minimum of common prerequisites, for calls transited via an existing network. For a network organized like that in France, with two-stage selection at the outgoing international side, this would have important consequences:

a) to offer transit through its own network:

— In the incoming *T.1* exchanges, high-capacity registers would have to be introduced at least on the equipment for handling incoming international calls. These registers would have to be capable of detecting a call for a national subscriber, as at present (i.e. with a number with a limited and uniform number of digits) and a number which is generally, but not necessarily, longer for a call automatically transited via a third network.

— In the incoming *T.1* exchanges, or at their outlets towards *T.2*, a device (indicated as *(x')* on the diagram) would have to be introduced to convert the standardized transit numbering to the two-stage numbering format which is the only one acceptable to *T.2*. This format conversion is purely a matter of internal organization on the part of the responsible transit network.

b) to take advantage of analogue transit, which might be offered by other networks:

— A new programme would have to be inserted in the *T.2* exchanges for transmitting a single sequence selection to other networks accepting automatic transit with the new standardized format. As it is unique, this additional programme may no doubt make it possible to do away with several others set up especially for minor terminal relations, which could be more economically operated with automatic transit.

3.1.2 Standardization principle for transit selection

Given that this standardization should not change any of the provisions in force for routing terminal traffic between the originating network *D* and the transit network *T*, calls on a *D-T* circuit fall into one of two types of numbering schemes:

— the present number which gives, without any other indication, the significant digits of the called subscriber's national number in network *T*;

— a complete transit number containing, before the national number of the called party, the destination code specifying a network for which automatic routing is possible.

The co-existence of these two types of numbers would not allow strict adherence to the numbering format in Recommendation U.11 for two main reasons. Firstly, both dial and keyboard selection would have to be possible, as some transit countries may be equipped with exchanges which cannot operate otherwise. Above all the incoming *T.1* exchange in the transit network must know whether the call has to be treated as transit or as incoming terminal traffic. When the first significant digits are received, there must be no confusion between a simple national number in network *T* and a destination code starting a transit numbering sequence.

In view of the composition of the national numbering schemes which it is aware of, the French Administration considers that the best way of meeting this difficulty is to standardize the figure ZERO *as first significant digit* in the transit numbering sequence. In submitting this proposal, it points out:

— that this standardization would not run counter to the provisions of paragraph 4 in Recommendation U.7, as the digit " 0 " mentioned in brackets in this text has nothing to do with the number transmitted on an international circuit;

— that it is not in disagreement with the stipulation in Recommendation F.69 prohibiting the use of this first digit zero for *composing* destination codes, but on the contrary justifies this prohibition and can only facilitate interconnection between existing type A and B signalling systems with the type C signalling system;

— that it is perfectly compatible with the few national networks where access to international outlets is obtained by using a first digit other than zero.

On the other hand for a network offering transit possibilities, it requires that no national subscriber number should be accessible from an incoming international circuit by means of this first digit zero. There seem to be very few networks which do not satisfy this condition. The corresponding Administrations would not, however, be obliged to renumber their zero series subscribers if they were not interested in having their network used for automatic transit.

Paragraph 1 of former Recommendation U.8 stated that the prefix should characterize the called country from the calling country. This could only be a directive aimed at the structure of national plans and numbering from the user's point of view, along the lines set out in 2.2 above. But, to standardize this information, which has to be inserted in the selection sequence sent on the international circuit, the only acceptable possibility is found to be the destination code given in the table annexed to Recommendation F.69.

Consequently, to obtain a subscriber in destination network A having a national number made up of the digits N1, N2 . . . . Nn, the numbering sequence should be basically the series of significant digits:

— 0 — Xa — Ya — N1 — N2 — . . . — N*n*

if the destination code is restricted to the two digits Xa and Ya.

Similarly the transit exchange *T.1* must receive the series:

— 0 — Xb — Yb — Zb — N1 — N2 — . . . — N*p*

when a caller in the originating country wishes to obtain a correspondent numbered N1, N2 . . . N*p* in the directory of the network of arrival *B* whose destination code is fixed by the three digits Xb, Yb and Zb in Recommendation F.69.

3.1.3 Modes of transmission on the *D-T* circuit

When the transit network makes dial selection compulsory, the sequence can only be the series of pulse trains corresponding to the significant digits alone. Recommendation U.2 therefore applies. However a very short time must be imposed for the interval between two trains of pulses. The point here is not merely to gain time on the transmission of the complete sequence, but to be sure of recognizing the end of selection. In the case of a destination network with keyboard selection complying with the terms of paragraph 5 e of Recommendation U.1, knowledge of the destination code enables the total number of digits to be known both in the originating and transit networks. This will not be the case when the call terminates in a network which has a numbering scheme with a variable number of digits. This uncertainty is a fairly serious disadvantage for exchanges in the transit system even if, finally, forward selection is performed by mere re-transmission in dial code of the national number of the called party to the destination network.

A maximum delay of five seconds is allowed in paragraph 5 f of Recommendation U.1 for this interval between two dial pulse trains, but the purpose of this provision is to permit automatic clearing, which is quite a different matter. Given this limit, a delay of about two seconds would no doubt be an acceptable means of detecting the end of selection in dial code. This might be reduced to one second if steps were taken to ensure that, on the incoming side of the transit network, the complete numbering sequence were only transmitted directly by the calling subscriber on the *D-T* circuit in very exceptional cases.

The same problem must be resolved in the originating network when the number has to be sent on the *D-T* circuit—this time with keyboard selection; especially if the destination network uses dial selection or does not have a uniform number of digits in its numbering. In this case, the transit switching system almost always includes registers whose occupation time must be limited. Also, to avoid unnecessary occupation of international outgoing circuits, these devices are generally designed so that forward selection does not start until all the selection information has been received. The question, then, relates to selection towards other networks which have numbering schemes with widely varying numbers of digits, rather than to the national network of the transit country. To ensure satisfactory operation, it is essential that these registers receive the standard keyboard end-of-selection signal (combination no. 26 in the start-stop code).

Mention should also be made of the two signals used to complete the selection sequence by teleprinter:

- The " prepare-for-digits " signal. This is compulsory and normally consists of combination No. 30 of start-stop alphabet No. 2. However, in application of point 1, paragraph c of Recommendation U.30, some Administrations, including France, substitute for this a combination No. 21 to characterize gentex traffic routed on telex circuits used for both types of call. In this case a combination No. 30 becomes a specific indication that the call belongs in the telex category. It is up to the C.C.I.T.T. to decide whether this possible application of the pre-signal justifies being given a more explicit and official form in a recommendation.

- The " class-of-traffic " signal. The optional nature of this signal, its position in the numbering sequence and the different meanings assigned to the combinations in different networks are all factors which complicate the outgoing international selection programmes for other networks. While its usefulness is undeniable, this signal should be standardized in a more precise fashion than it is at present, by:

— at least giving preference to *one* well specified position, for example between the last significant digit of the number and the end-of-selection signal, or as a signal substituting for the latter in place of the + sign;

— strictly reserving the two combinations to be used when necessary for transit telex and transit gentex calls of the same type.

These additions to the recommendations should be made without affecting the principle that signalling on the *D-T* circuit should conform to that of the transit network. With regard to these complementary signals there is no need to worry about what might happen on arrival as the role of the transit exchanges is precisely to carry out all the necessary adaptations, and their task should thereby be simplified.

3.2 *Call-connected signal and connection of correspondents*

With internal traffic many systems automatically trigger the answer-back when connection is made. In order to avoid giving the subscriber an impression of poorer quality service for international traffic, many international outgoing exchanges also perform this function on establishing a connection between two correspondents.

With reference to the arrangement proposed at the beginning of this paper, the problem arises, in connection with the handling of transit calls by the outgoing *T.2* exchange in the intermediary network, of whether this exchange should operate as it has done up to now for its national callers. The fact that such a variety of signals is returned at this stage by the destination networks of arrival seems to indicate that this should not be so. When the call is successful, whether or not there are any telegraph signals from the destination network, it is the originating Administration which must decide how the two correspondents are to be brought together.

All the transit network has to do in this case is to re-transmit the call-connected signal in the return direction of the *D-T* circuit in its own form of signalling, as soon as it is received from the network of arrival and correctly detected. With a type A signalling transit system, this amounts to saying that the 150-ms start polarity pulse, followed immediately by the connection in tandem of two international circuits sections, should suffice. With type B signalling the changeover to permanent stop polarity in the direction *T-D*, must be carried out with connection in tandem after a 2-second delay while it is perfectly possible for a telegraph modulation to be returned at this instant from the destination network .

The adoption of unified criteria for the call-connected signal and its re-transmission in each of the A and B signalling systems of the transit network, practically removes any point from the new " transit-connected " signal, which is fairly difficult to define since it must not start the charging device in the originating network. With some of the selection times observed at present in automatic international traffic, it might be considered that the emission of a few signals would at least result in making the calling subscriber wait. Backward signalling of this kind could only be introduced under the control of the originating country. If the transit network were to take the initiative for such an emission, it is probable that these waiting signals would either not reach the subscriber concerned or else cause confusion.

3.3 *Service signals for ineffective calls*

To avoid complications in transit systems, it is probably best to ask them to return on *D-T* type circuits the same signals as those sent to their national subscribers, when the latters' calls are unsuccessful in the various destination networks. This solution may have some minor disadvantages but it would be utopian to expect a transit system to give as exact and faithful an interpretation as possible of signals received from destination networks of very different design. The two examples which follow give some idea of the scope of these difficulties:

a) Originally the automatic telex exchanges of the French network gave the service sequences OCC, ABS, NA, etc., preceding them with the internal national prefix of the exchange, i.e. in principle the first two digits N1 and N2 of the called subscriber's national number. With a five-digit numbering scheme this internal prefix therefore corresponds to a thousand subscribers. It soon became necessary to bring into service exchanges in which the same registers serve several thousand subscribers, then nodal transit exchanges with no subscribers attached. The latter must be able to send some service signals, N1-N2-*NC* for instance, when a group of outgoing circuits is completely occupied. The result of this development is that the two digits N1-N2, which are still useful for the maintenance service, only rarely have an obvious meaning for the subscriber who is unfamiliar with the subtleties of this particular numbering.

b) Examination of Table 1 b annexed to Recommendation U.1 shows that a type B switching system is perfectly entitled to use the same criterion to signal the various busy, out-of-order, change of number or unobtainable number conditions. Several important networks operate in this way. If on the other hand a transit network is designed to give diverse service sequences, it could only send the sequence OCC to the calling network when the call fails in a type B destination network. The subscriber may then complain of receiving a false report on the actual situation of the correspondent he is calling in vain. However it is not the transit network which should be blamed for this inaccuracy.

Paragraph 9 a of Recommendation U.1 on the detailed composition of these service signals has now been amended, so that the code expression, with its maximum of three letters, must be immediately preceded by the letter shift and followed by combinations Nos. 27 and 28. Thus the service code should still print correctly when only the last *six* signals received from the destination network are re-transmitted onward. For the reception and retransmission of service sequences it is useful to have a shift register with a capacity limited to eight signals for economy. A simple procedure is to record the clearing signal also in the form of two combinations No. 32 which automatically trigger re-transmission of the six preceding combinations. This arrangement eliminates any characters in the sequence whose usefulness in the international service is doubtful, such as the digits N1-N2 mentioned above or date and time signals from the destination country.

This contribution is confined to the many aspects of the essential phases in automatic transit signalling. If this facility is to be progressively extended in existing systems, this is the time to introduce a minimum of uniformity. This would no doubt involve some additional equipment or modifications in the numbering of certain networks where it is desired to introduce transit facilities or take advantage of such facilities for outgoing traffic. These measures may be immediately applicable in some cases and require more or less lengthy delays in others. For its part, the French Administration is fully aware of the scope of the action it would have to take in its own national network if the above proposals were favourably received and eventually incorporated in a recommendation of the C.C.I.T.T. But it would not hesitate to take this action because it is convinced that even partial standardization in this field is preferable to local and scattered measures which would lead to mutually incompatible solutions.

In conclusion, it is suggested that the directives summarized below be used as a basis of discussion of Question 2/X:

1) The numbering plan in the originating network should be such that the number transmitted by the calling subscriber for an international call routed with automatic transit permits:

   a) identification of the destination network to the called subscriber,

   b) automatic routing of the call to a network capable of providing transit to the network of destination (see Recommendation U.7),

c) charging of the transit call in the originating country in accordance with the general principles in Recommendation F.67.

2) In conformity with Recommendation U.1, signalling on the international circuit connecting the originating network to the transit network should conform strictly to that used by the transit system for terminal calls to subscribers in its network.

For transit-routed calls to subscribers in the destination network, signalling should also be of the same A or B type, with dial or keyboard selection signals as appropriate, except for the following conditions:

a) the numbering sequence should be transmitted in its entirety and in a single process at the maximum rate permitted by the numbering code used by the transit network;

b) the significant digits making up this sequence should be successively:

— the first digit zero, characterizing a transit call;

— the two or three digits of the destination code in accordance with the list annexed to Recommendation F.69;

— the number of the called subscriber in his national network, in the same form as this would normally be sent for an automatic incoming terminal call originating in the transit network.

c) Administrations wishing to make their networks available for transit purposes should so arrange their numbering schemes that no subscriber is accessible in their national networks via a first digit zero emitted on an incoming international circuit,

d) to avoid wasteful occupation of international circuits and of switching equipment in the transit network, the end of the selection sequence should be interpreted in the transit system:

— by reception of a combination No. 26 (+), for teleprinter keyboard selection. Emission of this combination is compulsory regardless of the destination network's system;

— by an interval of 1 to 2 seconds of Z polarity following the emission of the last pulse train in dial selection.

3) As soon as connection with the called subscriber is established, the transit network should re-transmit the call-connected signal received from the network of arrival to the originating network in a form geared to the transit system's specific requirement, i.e.:

Type A system: A polarity pulse of 150 ms ($\pm$11 ms)

Type B system: Z condition for at least 2000 ms.

Tandem connection of the circuits should be effected in the transit network as soon as this call-connected signal is re-transmitted.

4) When the destination network transmits service signals for unsuccessful call attempts, the transit network may, and as far as possible should, only re-transmit to the originating network the last six combinations in the service sequence, immediately followed by the clearing signal.

Supplement No. 8

AUSTRALIA *(Contribution COM X—No. 47—June 1972)*

APPLICATION OF RECOMMENDATION U.4 — TELEX SIGNALLING DIAGRAM

In the *White 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 over the international circuit for incoming telex calls.

The following time sequence diagrams apply for international telex calls terminating in the Australian telex network.

Note 1 Australian subscriber's answerback in form:
L/S Combination No. 29
C/R 27
L/F 28
7 characters
Sp 31
A 1
A 1
F/S 30
5 digits
L/S 29

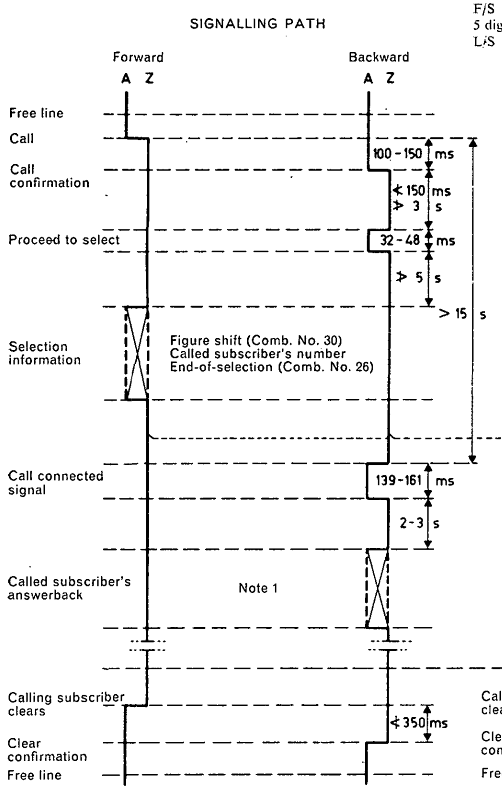
Note 2 (I) Call failed in international exchange service signal in form:
C/R Combination No. 27
L/F 28
L/S 29
X
Space 31
Y
C/R 27
L/F 28
where XY = NC, NP or NA

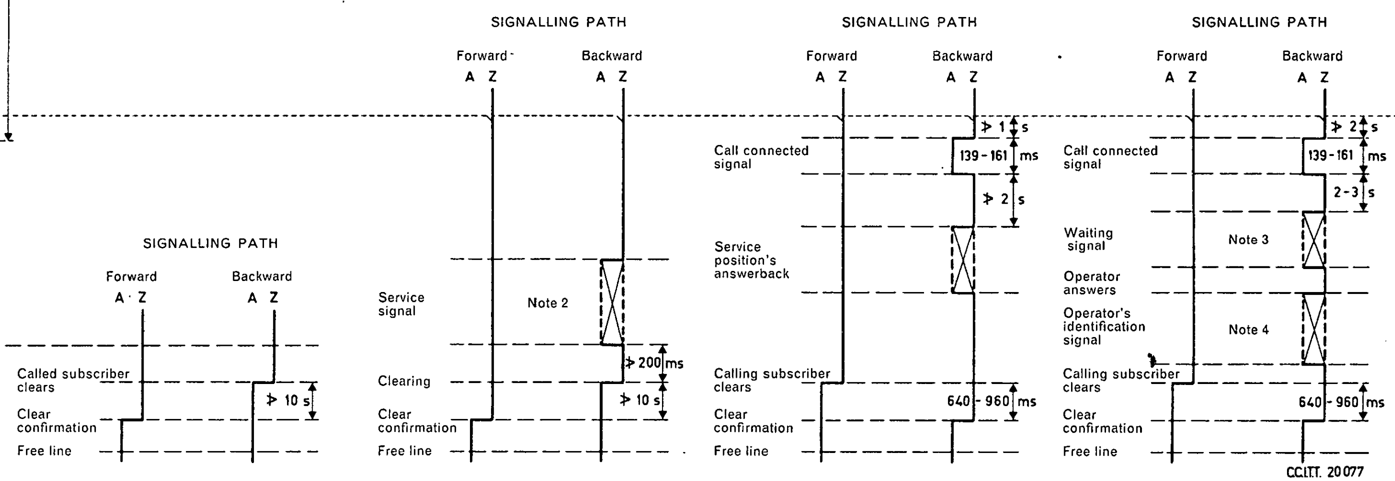
2 (II) Call failed in national trunk exchange service signal in form:
L/S Combination No. 29
X
C/R No. 27
L/F 28
L/S 29
Y
Z
L/F 28
where X = Letter identifying trunk exchange
YZ = NC, NP or NA

2 (III) Call failed in national terminal exchange service signals in form:
C/R Combination No. 27
L/F 28
L/S 29
X
Y
Z
C/R 27
L/F 28
where XYZ = OCC, DER, ABS or NCH

Note 3 Waiting signal in form:
C/R Combination No. 27
L/F 28
L/S 29
M 13
O 15
M 13
C/R 27
L/F 28

Note 4 International operator's identification signal in form:
C/R Combination No. 27
L/F 28
L/S 29
I 9
N 14
T 20
L 12
X 24
Space 31
S 19
Y 25
D 4
Space 31
F/S 30
Ø
Ø
where ØØ = 01 to 18
= Operator position number





SUCCESSFUL CALL

UNSUCCESSFUL CALL DUE TO FAILURE IN AN EXCHANGE

CALL TO SERVICE POSITION

CALL TO INTERNATIONAL OPERATOR

TIME SEQUENCE DIAGRAMS FOR INTERNATIONAL TELEX CALLS TERMINATING IN AUSTRALIA

Supplement No. 9

C.C.I.T.T. SECRETARIAT *(Contribution COM X—No. 53—September 1972)*

WORLD-WIDE TELEX AND GENTEX ROUTING PLAN

The IVth Plenary Assembly of the C.C.I.T.T. approved continuation of the study by Joint Working Party TGX on Questions 8/I and 8/X, as amended. A questionnaire, annexed to the question in the *White Book*, was drawn up for distribution to and completion by Administrations in two stages. The first part sought details on intercontinental transit centres established or to be established by Administrations in conformity with Recommendations F.68 and U.11. The second part of the questionnaire was aimed at completing the information required to set up a world routing plan.

The first part of the questionnaire was duly distributed in C.C.I.T.T. Circular letter No. 59 (12 January 1970). The resulting replies were subsequently published in Contribution GM TGX-No. 2. After examining this document, TGX decided that it was necessary to re-issue the first part of the questionnaire in order to seek more specific information on the intercontinental transit centres. The modified version is attached in Section A of the Annex, and was sent out in C.C.I.T.T. Circular letter No. 158 dated 11 June 1971. The replies were collated and distributed in C.C.I.T.T. Circular letter No. 186 of March 1972. This circular letter also sought answers to the second part of the questionnaire (refer Section B of the Annex).

In Section C of the Annex the list of intercontinental transit centres, giving the ready for testing and ready for service dates derived from the first parts of the questionnaire, is shown again for ease of reference, together with information on aggregate traffic and the type of operation proposed for various relations in the intercontinental transit network—this information being derived from the replies to the second part of the questionnaire. Section D of the Annex lists all the telex network identification codes which have been used to identify the various countries in Section C.

SECTION A

Text of the first part of Questionnaire on world-wide telex and gentex plan as published in Circular Letter No. 158

Question	Answer
Q.1 By what dates will an intercontinental transit centre conforming to Recommendations F.68 and U.11 be ready in your country a) for testing? b) for service? (It is pointed out that the 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.4 If your centre is the first transit centre of the intercontinental connection what signalling conditions would you offer to the calling network?	Type A . . . . [a] Type B . . . . Type C . . . .
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?	Type A . . . . [a] Type B . . . . Type C . . . .
Q.7 What methods of operation (semi-automatic or fully automatic) would be permitted between the calling networks and the intercontinental centre?	Semi-automatic . . . . [a] Fully automatic . . . .
Q.10 What telex network identification code(s) will you use for your register code?	[a]
Q.11 To what continental and intercontinental routes will you have direct connections from your intercontinental transit centre? What signalling conditions would you employ on each route?	*Route* [a] *Signalling condition*
Q.13 Will the circuits on the routes given in the answer to Q.11 be operated both-way or uni-directionally?	
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?	☐ Yes ☐ No (check box where applicable) If answer is no:

[a] Indicate the date of entry into service.

SECTION B

Text of the second part of the Questionnaire on the world-wide telex and gentex plan as published in Circular Letter No. 186

Question	Answer
Q.2 If in reply to Question 1 you do not intend to have an intercontinental transit centre conforming to Recommendations F.68 and U.11 in your country, do you intend to connect your network(s) to an intercontinental transit centre in another country?	Yes [a] ☐ No ☐
Q.3 Do you intend to use the intercontinental transit network to pass your gentex traffic?	Yes [a] ☐ No ☐
If so, will a separate route be provided to the intercontinental transit centre(s) for this purpose?	Yes [a] ☐ No ☐
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?	. . . .[a]
Q.8 Do you propose to adopt semi-automatic or fully automatic operation for intercontinental traffic originated from your network?	*semi-automatic* ☐ [a] *fully automatic* ☐ [a]
Q.9 What restrictions, if any, are there relating to incoming and outgoing gentex traffic?	
Q.12 Give details of your terminal traffic originating from your country and passing over the intercontinental transit network, as expected in 1972, 1975 and 1978. The details to be shown are: a) mean busy hour in the relation in G.M.T. b) traffic in erlangs at the busy hour c) busy hour to day rate: $\frac{\text{average traffic per busy hour}}{\text{average traffic per business day}}$	*1972* *1975* *1978* a) . . . . b) . . . . c) . . . .
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 a) to overflow or would you restore the route by: b) other circuits not employing ARQ radio channels; or c) other circuits using ARQ radio channels? d) others? What reduction in traffic capacity will result from these arrangements ?	a) . . . . b) . . . . c) . . . . d) . . . .

[a] Indicate the date of entry into service.

Section C — Table of information received on the intercontinental transit network

Country	Intercontinental transit centre F.68/U.11		Date of connection to intercontinental transit network (ITN)	Gentex			Date when call connected signal available	Type of operation proposed for originating traffic	Country
	Date ready for testing	Date ready for service		ITN to be used for gentex?	Separate route?	Restrictions on gentex?			
	Question 1		*Question 2*	*Question 3*	*Question 3*	*Question 9*	*Question 6*	*Question 8*	
A	1974	1974		N		NR	E	F	A
AA	—	1973		N		NA	E	F E	AA
AR	1974	1975					U 1/B E	F 1972	AR
B	1975	1976		1975	N	NR	E	S E, F E	B
BR	1973	1973							BR
CA	E	E		N		NA	E	F E	CA
CH	1975	1977		Y[5]	Y[5]	NR	E	S E, F 1977	CH
CL	1973	1973							CL
CO		E							CO
CY	E	1972		UC			U11 E[6]	S E, F 1975	CY
D	1973	1974		N[7]		NR[8]	E	F	D
ED	1973	1973							ED
F	E	UC[10]							F
FI	—	—	1972	N		NR	E	F	FI
G	1972	1972		N	N	11	E	F E	G
GR	1975	1975		Y[14]	N		1975	F L 1972	GR
H	1975	1976		1970	N	NR	1976	S 1970, F 1976	H
IA			E	UC			E	S E	IA
IG	E			E	Y	NR	E	F	IG
IN		1972		N			Oct. 1972	S Oct. 1972	IN
J	E	1975		N		NA	E	F E	J
KT			1971	N		NA	E	F E	KT
M			Y	1973	N	17	E	F E	M
N			Y[18]	Y[18]	N	—	E	S F[18]	N
NG	UC								NG
NL	1972	1973							NL
NP			1972	N	N			U C	NP
NZ			1972	N	N	NA	Sept. 1973	F E	NZ
P		E		N	N	NA	E	F 1972	P
PL	1974	1975							PL
PU	1973	1974				20			PU
RP	1974	1975		Y	Y		1974	F 1974[24]	RP
RS	1975	1975		N	N	NA	1974	F	RS
RW			Y	Y	N	NR	1974/1975	S	RW
S			E	Y	N	21	E	S E, F E	S
SA			1972	N		NR	E	F 1972	SA
TH	1972	1973		N		—	D 1973	F D 1973	TH
WB			1970	N	N	NA	1975	F 1975	WB
WG			E	N	N	NA	L 1976	S E	WG

Section C — Table of information received on the intercontinental transit network (*cont.*)

Country	Centre of mean busy hour (GMT)	Traffic (erlangs) in the mean busy hour			Mean busy hour to day rate (%)			Route breakdown		Country
		1972	1975	1978	1972	1975	1978	Action to divert traffic	Reduction in traffic capacity	
	Question 12	*Question 12*			*Question 12*			*Question 16*	*Question 16*	
A	1400	8	24	70	20	18	15	a	0	A
AA	0630	—	287[1]	593[1]	—	28[1]	28[1]	b[2]	0[2]	AA
AR	1400	6.98	11.9	17.5	20	20	20	a	20	AR
B					25	25	25	b[3]	?[4]	BR
BR										
CA								a		CA
CH	1530	20	26	32	20	20	20	a, b, c	0-20	CH
CL										CL
CO										CO
CY	0930	10	28	48	15	16	16	a	50	CY
D								b	0[9]	D
ED										ED
F										F
FI	0430	1	2.2	3.7	20	35	35			FI
G	1630[12]	694	1472	2528	23	24	24	a	0[13]	G
GR		?[15]						a and b		GR
H	1430	45	70	110	14	14	14			H
IA	0800	12.7	23.8	38.1	25	25	25	a		IA
IG	1530	45	80	130	17	17	17	d[16]	<20	IG
IN	1030	60	120	180	14	14	14	a		IN
J	T							b, c, d		J
KT	0900	7.1	17.7	32.7	11	15	20			KT
M	1030	0.1	0.152	0.21	14	23	32			M
N	1430	1.9	2.3	3.1	15	15	15			N
NG										NG
NL										NL
NP								c		NP
NZ	0430	28.0	77.7	117	11	11	11	b	0	NZ
P	1530	33.3	65	110	15	17	17	a, c[19]	0	P
PL										PL
PU										PU
RP	1130							c		RP
RS								a	0	RS
RW										RW
S	1430	20	42	69	20	20	20	d[22]		S
SA	1400	39	61	95	17	17	17	a, c	85[23]	SA
TH	0900	4.8						a		TH
WB	1630	0.3	0.4	0.6	20	20	20	b	0	WB
WG	1930	4.6	7.9	13.7	19	19	19	b		WG

Explanatory notes to the table of Section C

Abbreviations

For country identifications, see Section D, or I.T.U. *List of Telex Identification Codes.*

a = Option a in answer to Question 16, i.e. in the event of a breakdown of a route not normally employing ARQ radio channels, traffic would be diverted to overflow.

b = Option b in answer to Question 16, i.e. traffic would be diverted to other circuits not employing ARQ radio channels.

c = Option c in answer to Question 16, i.e. traffic would be diverted to other circuits using ARQ radio channels.

d = Option d in answer to Question 16, i.e. solutions other than a, b or c would be used.

D = Beginning of the year.

E = Existing, in service.

F = Fully automatic.

L = Late in the year.

N = No

NA = Not admitted.

NR = No restrictions.

S = Semi-automatic

Y = Yes

UC = Under consideration or study.

Footnotes

1. Values shown are for total traffic.
2. Restoration will wherever possible (i.e. for most routes) be effected by other circuits not employing ARQ radio channels and no reduction in traffic capacity would occur. Some minor routes may involve restoration by overflow which could involve transit to ARQ channels. Only routes employing ARQ radio as part of the normal circuit complement would be restored fully by ARQ radio channels.
3. B if possible.
4. Indeterminable.
5. If convenient.
6. Only type C call-connected signal is returned at present irrespective of type of signalling used, e.g. type A/U.20 or B. It is anticipated that in 1975 the respective call-connected signals will be returned for all types of signalling.
7. In the Federal Republic of Germany gentex exchanges and international gentex network are separated from those for telex.
8. No technical restrictions.
9. Normally no reduction.
10. But not before 1975.
11. No transit facilities, terminal only in European relationship.
12. 1530 in summer.
13. Most routes will have 100% restoration via satellites.
14. Only for routes without direct facilities. Separate route will not be provided.
15. Traffic other than on direct routes small.
16. All solutions will be used in order to minimize the reduction of traffic capacity.
17. Use of page-printers.
18. As soon as the intercontinental transit centre is ready for operation.
19. Other means from 1973.
20. Gentex via the Belgian network.
21. Incoming and outgoing gentex traffic can at present be exchanged with 30 telegraph offices in Sweden. An automatic telegram retransmission centre is planned to be brought into service during 1973, which will handle all international incoming and outgoing gentex traffic.
22. In the event of a breakdown all available traffic routes will be used independently of the means of transmission.
23. Up to 85%, depending upon the route affected.
24. Fully automatic Kinshasa, semi-automatic rest of the country.

SECTION D

List of countries' telex network identification codes

Code	*Country*	*Code*	*Country*
A	Austria	IN	India
AA	Australia	J	Japan
AR	Argentina	KT	Kuwait
B	Belgium	M	Morocco
BR	Brazil	N	Norway
CA	Canada	NG	Nigeria
CH	Switzerland	NL	Netherlands
CL	Chile	NP	Nepal
CO	Colombia	NZ	New Zealand
CY	Cyprus	P	Portugal
D	Federal Republic of Germany	PL	Poland
		PU	Peru
ED	Ecuador	RP	Zaire
F	France	RS	Singapore
FI	Fiji	RW	Rwanda
G	United Kingdom	S	Sweden
GR	Greece	SA	South Africa
H	Hungary	Th	Thailand
IA	Indonesia	WB	Barbados
IG	Italy	WG	Trinidad and Tobago