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SERIES Q: SWITCHING AND SIGNALLING

Specifications of Signalling System No. 5

ITU-T Recommendations Q.140-Q.180

(Formerly CCITT Recommendations)

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ITU-T Recommendations Q.140-Q.180

Specifications of Signalling System No. 5

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Source

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FOREWORD

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NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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SPECIFICATIONS OF SIGNALLING SYSTEM No. 5

INTRODUCTION

PRINCIPLES OF No. 5 SIGNALLING SYSTEM

General

System No. 5 is compatible with both TASI¹⁾ and non-TASI-equipped circuits and may be applied for automatic and semi-automatic operation and both-way working. It requires four-wire signalling and automatic access to the outgoing circuits.

The signalling equipment is in two parts:

- a) line signalling – for the so-called supervisory signals; and
- b) register signalling – for the numerical signals.

a) *Line signalling*

This is a link-by-link system using two in-band signalling frequencies 2400 Hz and 2600 Hz, two frequencies, instead of one frequency, being adopted for the following reasons:

- i) Automatic detection of double seizing on both-way working;
- ii) Frequency discrimination between signals, no time discrimination being incorporated.

Automatic detection of double seizing requires that the frequency of the proceed-to-send signal (2600 Hz) be different from that of the seizing signal (2400 Hz). The detection is achieved when one end transmits the outgoing seizing signal (2400 Hz) and at the same time receives the seizing signal (2400 Hz) from the other end and not the 2600 Hz proceed-to-send signal expected.

All signal recognition times are the same (125 ms) except for the seizing and proceed-to-send signals (40 ms). These two signals are not subject to signal imitation by speech and fast signalling is desired in particular to minimize double seizings.

To avoid, with this signalling system, relatively slow signalling in non-TASI applications and in lightly loaded conditions (the more usual) of TASI applications, all signals are the continuous compelled²⁾ type except the forward transfer signal. Continuous signals ensure TASI trunk/channel association during the actual time this function requires. (The alternative of TASI-prefix pulse type signals would, due to the 500-ms TASI prefix, introduce a slight risk of failure to associate a trunk with a channel, and would slow the signalling in terms of restoration of the transmission path after the signalling line splits under the more usual conditions of TASI loading and in non-TASI applications.) Only the forward-transfer signal is a TASI-prefixed pulse since for this signal a slight risk of failure can be accepted because it is operator-controlled and may be repeated at will.

¹⁾ See Supplement No. 2 in Orange Book, Volume VI.1 (1976).

²⁾ See for this term Recommendation Q.141, § 2.1.6

Except for the answer signal, all the compelled signals are normal compelled³⁾ type. For reasons of fast speed, the answer signal is overlap-compelled⁴⁾ at transit points. Fast answer signalling is desirable to minimize the risk of an abandoned call by either the called or calling party, should the verbal answer be lost due to the line splitting on answer signalling.

b) *Register signalling*

This is a link-by-link 2/6 multifrequency (m.f.) in-band en bloc⁴⁾ pulse signalling system, forward signalling only. The alternative, continuous compelled signalling, would be slow due to the long circuit propagation times in certain applications. The frequencies (700 Hz . . . 1700 Hz) are outside of the line signalling frequencies. The numerical information signalling is preceded by a KP signal (start-of-pulsing) and terminated by an ST signal (end-of-pulsing). En bloc non-overlap sending⁴⁾ applies at the outgoing international register, the seizing signal being sent, and thus the international circuit being taken as late as possible, namely when the ST condition is available in the outgoing international register. When sending, the outgoing register pulses out in a continuous sequence. The prior GO trunk/channel association due to the seizing signal is maintained by the TASI speech detector hangover during the interval between cessation of the seizing signal (on receipt of the proceed-to-send signal) and the start of the register pulse out, and during the intervals between successive m.f. signals.

En bloc overlap register signalling⁴⁾ applies at the international transit registers and at the incoming international register to minimize the post-dialling delay.

Compandors affect signalling, particularly short-pulse compound signalling (e.g. register signalling), due to distortion and the production of intermodulation frequencies. By virtue of the link-by-link signalling and the adopted duration of the m.f. pulses, system No. 5 functions correctly in the presence of compandors.

³⁾ See for these terms Recommendation Q.141, § 2.1.7.

⁴⁾ See for these terms footnote to Recommendation Q.151, § 3.1.1

CHAPTER I

DEFINITION AND FUNCTION OF SIGNALS

Recommendation Q.140

1. DEFINITION AND FUNCTION OF SIGNALS

1.1 seizing signal (sent in the forward direction)

This signal is transmitted at the beginning of a call to initiate circuit operation at the incoming end of an international circuit and to seize equipment for switching the call either to the national network of the incoming country or to another international exchange.

1.2 proceed-to-send signal (sent in the backward direction)

This signal is sent from the incoming end of an international circuit, following the receipt of a seizing signal, to indicate that the equipment is ready to receive the numerical signals.

1.3 start-of-pulsing signal, also called for system No. 5 "KP signal" (sent in the forward direction)

This numerical type signal is sent on receipt of a proceed-to-send signal and may be used to prepare the incoming international register for the receipt of the subsequent numerical signals.

Two different KP signals are provided to discriminate between terminal and transit calls:

- a) KP1, terminal; and
- b) KP2, transit.

1.4 numerical signal (sent in the forward direction)

This signal provides an element of information necessary to effect the switching of the call in the desired direction. There is always a succession of numerical signals sent.

1.5 end-of-pulsing signal, also called for system No. 5 "ST signal" (sent in the forward direction)

This numerical type signal is sent to show that there are no more numerical signals to follow. The signal is always sent in semi-automatic as well as in automatic working.

1.6 busy-flash signal (sent in the backward direction)

This signal, which is sent only after the proceed-to-send signal, is sent to the outgoing international exchange to show that either the route, or the called subscriber, is busy. The conditions of use of this signal are as follows:

- a) An international transit exchange *must* send this signal after register association, to indicate that there is congestion at that exchange or on the appropriate outgoing routes.

- b) An incoming international exchange *must* send this signal, after register association, if there is congestion at that exchange or on the outgoing routes directly connected to it, but sending the signal *is optional* when there is congestion beyond that exchange (when there is congestion at a point in the national network of the incoming country or when the called subscriber's line is busy). This signal is optional because there are several countries that do not send it from their national networks.

Note – The receipt of the busy-flash signal at the outgoing exchange will cause:

- an appropriate indication to be given to the outgoing operator or to the calling subscriber; and
- the sending of the clear-forward by the outgoing exchange to release the international connection (except when otherwise arranged, for example, in this case of observations on circuits).

1.7 **answer signal (sent in the backward direction)**

This signal is sent to the outgoing international exchange to show that the called party has answered the call¹⁾.

In semi-automatic working, the signal has a supervisory function.

In automatic working, it is used:

- to start metering the charge to the calling subscriber;
- to start the measurement of call duration for international accounting purposes.

1.8 **clear-back signal (sent in the backward direction)**

This signal is sent to the outgoing international exchange to indicate that the called party has cleared. In the semi-automatic service, it performs a supervisory function. It must not permanently open the speech path at the outgoing international exchange.

In automatic working, arrangements must be made to clear the international connection, stop the charging and stop the measurement of call duration if, between 1 and 2 minutes after receipt of the clear-back signal, the calling subscriber has not cleared. Clearing of the international connection should preferably be controlled from the point where the charging of the calling subscriber is carried out.

Notes on the answer and clear-back signals. – See the corresponding Notes in Recommendation Q.120.

1.9 **clear-forward signal (sent in the forward direction)**

This signal is sent in the forward direction at the end of a call when:

- a) in semi-automatic working, the operator at the outgoing international exchange withdraws her plug from the jack, or when an equivalent operation is performed;
- b) in automatic working, when the calling subscriber hangs up or otherwise clears (as in the case of a subscriber's installation with extension telephones).

This signal is also sent after receipt of a busy-flash signal by the outgoing international exchange, and when there is forced release of the connection (see Recommendation Q.118, §§ 4.3.1 and 4.3.2 for automatic working and § 4.3.1 for semi-automatic working). This signal may also be sent after an abnormal release of an outgoing register in the case indicated in Recommendation Q.156 under § 3.6.2 a) 1.

1.10 **release-guard signal (sent in the backward direction)**

This signal is sent in the backward direction in response to the clear-forward signal. It serves to protect an international circuit against subsequent seizure as long as the disconnection operations controlled by reception of the clear-forward signal have not been completed at its incoming end.

¹⁾ See Recommendation Q.27 for the action to be taken to ensure that answer signals, both national and international, are transmitted as quickly as possible.

1.11 **forward-transfer signal (sent the forward direction)**

This signal is sent to the incoming international exchange when the outgoing international exchange operator wants the help of an operator at the incoming international exchange.

The signal will normally serve to bring an assistance operator²⁾ into the circuit if the call is automatically set up at that exchange. When a call is completed via an operator (incoming or delay operator) at the incoming international exchange, the signal should preferably cause this operator to be recalled.

1.12 *Diagrams showing signal sequence*

The sequence of signals in semi-automatic and automatic working is shown in Tables 1 and 2 of Annex 1 to Signalling System No. 5 specifications.

A description of the various operations corresponding to the various normal and abnormal conditions which may arise in setting up a call are given in the tables of Annex 2 to Signalling System No. 5 specifications.

²⁾ See the definition of assistance operator in § 1.1.6 of Recommendation Q.101.

CHAPTER II

LINE SIGNALLING

Recommendation Q.141^{*)}

2.1 SIGNAL CODE FOR LINE SIGNALLING

(Geneva, 1964; modified at Helsinki, 1993)

2.1.1 General

The line-signal coding arrangement is based on the use of two frequencies f_1 (2400 Hz) and f_2 (2600 Hz) transmitted individually or in combination as shown in Table 1. The use of compound signalling for the clear-forward/release-guard sequence increases the immunity to false release by signal imitation.

By taking advantage of the fixed order of occurrence of specific signals, signals of the same frequency content are used to characterize different functions. For example, in the backward direction f_2 is used to indicate proceed-to-send, busy-flash and clear-back without conflict. The signalling equipment must operate in a sequential manner retaining memory of the preceding signalling states and the direction of signalling in order to differentiate between signals of the same frequency content. All signals except the forward-transfer signal are acknowledged in the compelled-type manner as indicated in Table 1. The order of transmission of backward signals is subject to the following restrictions:

- a) busy-flash signal: never after an answer signal and only after a proceed-to-send signal;
- b) answer signal: never after a busy-flash signal;
- c) clear-back signal: only after an answer signal.

NOTE – The receipt of the answer signal (f_1) permits discrimination between the busy-flash and the clear-back signals (both f_2).

A clear-forward signal, which must be acknowledged by a release-guard signal under all conditions of the equipment including the idle condition, may be sent from an outgoing end at any time to initiate the release of the circuit. The clear-forward signal is completely overriding and may break into any other signal sequence.

2.1.2 Transit working

In transit operation, the line equipment at the transit exchange shall be informed (e.g. by the register) that the condition is transit. This will facilitate the link-by-link transmission of line signals through the transit exchange without bringing about consequences appropriate to the terminal exchanges.

2.1.3 Sending duration of line signalling

2.1.3.1 The sending durations of the line signals are shown in Table 1. Additional requirements are:

- a) In the event of double seizing (due to both-way operation), the seizing signal transmitted from the end having detected double seizing should persist for at least 850 ± 200 ms to permit the other end to detect the double seizing.
- b) Should the called party flash his switch-hook at a faster rate than the equipment can transmit a succession of clear-back and answer signals, the correct indication of the final position of the switch-hook must always be given by the appropriate signal.

^{*)} The text of ITU-T Rec. Q.141 is as amended by WTSC in March 1993.

- c) Once the sending of a signal (pulse or compelled) has begun it should be completed (but see 2.1.1 in regard to the clear-forward signal releasing the circuit at any stage and in 2.1.7 in regard to the overlap answer signal at transit points). If two signals have to be sent one immediately after the other in the same direction, a silent interval of not less than 100 ms should separate the two successive signals. The silent interval should not be so long as to cause unreasonable delay in signalling.

Exceptionally

- 1) the intervals between successive signals may be less than 100 ms. However, the technique of complete signals with intervals of at least 100 ms is the preferred arrangement;
- 2) the forward-transfer signal may be ceased immediately if a backward signal is received. The acknowledgement of the backward signal is then sent.
- d) When sending a compound signal, the interval of time between the moments when each of the two frequencies is sent must not exceed 5 ms. The interval of time between the moments when each of the two frequencies ceases must not exceed 5 ms.

- e) *Time-out and alarm procedures*

- i) Should the transmission of any size, busy-flash, answer, clear-back or clear-forward signal persist beyond a maximum of 10 to 20 seconds, the signal shall be terminated.

NOTE 1 – 10 to 20 seconds time-out for the seizing signal allows reasonable time for association of a register in a distant centre.

- ii) Should the transmission of any proceed-to-send, release-guard or other acknowledgement signal persist beyond a maximum of 4 to 9 seconds, the signal shall be terminated.

NOTE 2 – The shorter time-out periods for secondary signals enable, under many conditions, detection of a fault at both ends of a circuit on a single call.

NOTE 3 – Time-out of the answer acknowledgement signal may cause charging without a satisfactory transmission path to the called party. If the occurrence of such time-outs should reach unacceptable levels, a delay in the transfer of the answer signal into the national network until the compelled answer signalling cycle is complete, may be justified.

- iii) Upon the occurrence of a time-out under the two above conditions, the attention of the maintenance personnel should be drawn to the fact that time-out has occurred.

NOTE 4 – An Administration may decide that on the time-out of an acknowledgement signal at the incoming end of the connection, when an automatic repeat clear-forward sequence is known to be provided at the outgoing end, no indication is given to the maintenance personnel, neither is the circuit taken out of service.

- iv) Upon the occurrence of a time-out, the circuit should automatically be removed from service after clear-down by the subscriber and blocked to outgoing calls. However, time-out of a seize signal may be excluded from this provision if time-out of that signal is followed by a clear-forward attempt.
- v) As a test procedure, Administrations may make repeated signalling attempts and restore the circuit to service if it is found to perform in a normal manner.
- vi) Each Administration shall make appropriate arrangements to ensure that a single fault will not cause removal from service of more than one circuit or of more than one register.

2.1.3.2 The duration of the forward-transfer signal is based on the possibility that TASI may clip a signal by up to 500 ms on rare occasions during heavy traffic periods, and on the need for establishing a recognition time that minimizes signal imitation.

2.1.4 Recognition times of line signals

Recognition time is defined as the minimum duration a direct-current signal, at the output of the signal receiver, must have in order to be recognized as a valid condition by the switching equipment. The recognition times are given in Table 1.

For equal immunity against signal imitation, the recognition time of compound signals such as the clear-forward/release-guard sequence could be less than that of the single-frequency signals liable to signal imitation. However, for convenient design arrangements, and to improve the immunity of the clear-forward/release-guard sequence, the recognition time of the compound signals is the same (125 ± 25 ms) as that of the single-frequency signals liable to signal imitation.

After signal recognition, interruptions of up to 15 ms in the primary or acknowledgement signals shall be ignored in the compelled signalling sequences. Interruptions of more than 40 ms must be recognized as the end of the appropriate signal in the compelled signalling sequences.

2.1.5 Line signal code of System No. 5

The line signal code is given in Table 1.

TABLE 1/Q.141

Line signal code

Signal	Direction ^{a)}	Frequency ^{b)}	Sending duration	Recognition time
Seizing – <i>Prise</i>	————→	<i>f</i> 1	Continuous	40 ± 10 ms
Proceed-to-send – <i>Invitation à transmettre</i>	←————	<i>f</i> 2	Continuous	40 ± 10 ms
Busy-flash – <i>Occupation</i>	←————	<i>f</i> 2	Continuous	125 ± 25 ms
Acknowledgement – <i>Accusé de réception</i>	————→	<i>f</i> 1	Continuous	125 ± 25 ms
Answer – <i>Réponse</i>	←————	<i>f</i> 1	Continuous	125 ± 25 ms
Acknowledgement – <i>Accusé de réception</i>	————→	<i>f</i> 1	Continuous	125 ± 25 ms
Clear-back – <i>Raccrochage du demandé</i>	←————	<i>f</i> 2	Continuous	125 ± 25 ms
Acknowledgement – <i>Accusé de réception</i>	————→	<i>f</i> 1	Continuous	125 ± 25 ms
Forward-transfer – <i>Signal d'intervention</i>	————→	<i>f</i> 2	850 ± 200 ms	125 ± 25 ms
Clear-forward – <i>Signal de fin</i>	————→	<i>f</i> 1 + <i>f</i> 2 (compound)	Continuous	125 ± 25 ms
Release-guard – <i>Libération de garde</i>	←————	<i>f</i> 1 + <i>f</i> 2 (compound)	Continuous	125 ± 25 ms
a) ———→ forward signals ←———— backward signals b) <i>f</i> 1 = 2400 Hz <i>f</i> 2 = 2600 Hz				

2.1.6 Further specification clauses relative to the signalling code

- a) The seizing signal continues until acknowledged by the proceed-to-send signal. The proceed-to-send signal is transmitted when an incoming register is associated and continues until acknowledged by the stopping of the seizing signal¹⁾.
- b) The clear-forward signal continues until acknowledged by the release-guard signal, which may be sent as described under 1) or 2) below:
 - 1) The release-guard signal is sent on recognition of the clear-forward signal and continues until acknowledged by the cessation of the clear-forward signal or until the relevant incoming equipment at the international exchange is released, whichever occurs later¹⁾.
 - 2) The release-guard signal is sent in response to the clear-forward signal to indicate that the latter has brought about the release of the relevant incoming equipment at the international exchange. The release-guard signal continues until cessation of the clear-forward signal is recognized¹⁾.

¹⁾ This type of signalling is called “continuous compelled”.

The outgoing access of the incoming end of the both-way circuit shall be maintained busy for 200 to 300 ms after the end of the transmission of the release-guard signal.

- c) With respect to the busy-flash, answer and clear-back signals the acknowledgement signal shall not be transmitted before the signal recognition time (125 ± 25 ms) of the primary signal has elapsed. The primary signal shall not be ceased until the signal recognition time (125 ± 25 ms) of the acknowledgement signal has elapsed²⁾ (see 2.1.7 with respect to the transmission of the answer signal at a transit point).
- d) The busy-flash will be transmitted if the call cannot be completed for any of the following reasons:
 - 1) congestion at an incoming international exchange;
 - 2) congestion at a transit international exchange;
 - 3) error detected in the receipt of the register signals;
 - 4) busy-flash (if received) from a subsequent international system (e.g. system No. 4) or from the national network;
 - 5) time-out of an incoming international register.
- e) Receipt of busy-flash at the outgoing international exchange will cause:
 - after signal recognition time (125 ± 25):
 - 1) the acknowledgement signal to be sent; and
 - 2) an appropriate audible indication to be transmitted to the operator or to the subscriber. When the preceding circuit provides for the transmission of busy-flash, this signal should be transmitted to that preceding circuit;
 - after the end of the compelled sequence, i.e. 100 ms after termination of the acknowledgement signal [see 2.1.3 c):
 - 3) a clear-forward signal to be transmitted from that exchange and the international circuit or chain of circuits to be released by the clear-forward/release-guard sequence.
- f) Receipt of busy-flash at a transit exchange will cause after signal recognition time:
 - 1) the acknowledgement signal to be sent; and
 - 2) the busy-flash signal to be sent on the preceding incoming circuit;
 - 3) the transit exchange and forward connection to be cleared.

NOTE 1– Where existing equipment is designed to allow clearing only from the outgoing international exchange, this need not be modified retrospectively.
- g) Upon receipt of the answer signal in the answer state or the clear-back signal in the clear-back state, the international exchange should, nevertheless, respond by sending the acknowledgement signal.

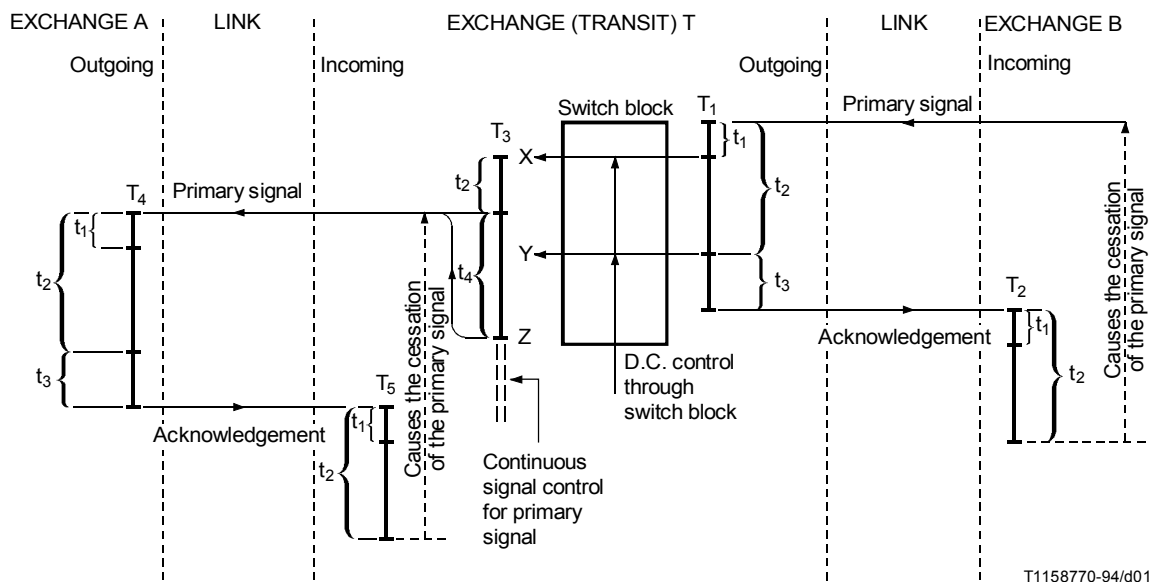
NOTE 2 – This procedure will be helpful to avoid unnecessary discontinuity of the compelled sequence when the international exchange receives answer (f 1) of clear-back (f 2) signal twice within a short interval.
- h) In order to prevent irregularities, Administrations should ensure that the sending time of the release guard signal has a minimum duration of 200 ms. The recognition of the release guard signal without prior sending of a clear forward signal should be regarded as an irregularity. Administrations should decide to react on detection of that irregularity by sending a clear forward signal and release through-connection in the international exchange. Depending on the capability of the signalling system on the preceding link, the international switching centre should initiate the release of this link.

2.1.7 Backward signals on multilink connections (consider as an example a connection A-T-B)

a) Normal compelled signalling for busy-flash and clear-back signals

With *normal compelled signalling* [see 2.1.6 c) above] at a transit point T, the transmission of the primary signal from T to A does not commence until the signal recognition time of the primary signal sent from B to T has elapsed. This technique is applied for the transmission of busy-flash and clear-back signals.

²⁾ This type of signalling is called “continuous compelled”.



T_1 , etc. = Time base

t_1 = Receiving end line split (35 ms max.)

t_2 = Signal recognition time (125 ± 25 ms)

t_3 = Sending end line split (40 ± 10 ms)

t_4 = 125 ± 25 ms typically

FIGURE 1/Q.141

Typical arrangement to illustrate the principle of overlap compelled signalling for the answer signal at transit points

Recommendation Q.142

2.2 DOUBLE SEIZING WITH BOTH-WAY OPERATION

2.2.1 Unguarded interval

Considering that on long international (intercontinental) circuits:

- the sending end splitting time may be 50 ms prior to signal transmission;
- TASI may occasionally clip the initial 500 ms of seizing signals;
- circuit propagation time may be relatively long;
- the signal receiver response time must be taken into account;
- the recognition time of seizing signals is 40 ± 10 ms;

the unguarded interval relative to double seizing in the extreme case approaches 600 ms plus the circuit propagation time and the signal receiver response time. The signalling system should therefore detect double seizing and take action as defined in § 2.2.2.

2.2.2 Detection of double seizing

In the event of double seizing, the same frequency (f_1) is received as is being transmitted at each terminal. This condition shall be detected by the signalling equipment and shall cause stoppage of the outgoing seizing signal at each end. An end having detected double seizing, and terminated the outgoing seizing signal 850 ± 200 ms after this signal has been transmitted, will maintain the circuit in the busy condition until the stoppage of the incoming seizing signal from the distant end. Each outgoing seizing signal maintained for at least 850 ± 200 ms will ensure that both ends of the circuit will detect the double seizing.

The signalling equipment will be released on termination of both the outgoing and incoming seizing signals and a clear-forward shall not be sent.

Either of the following arrangements may apply on detection of double seizing:

- a) an automatic repeat attempt to set up the call; or
- b) a re-order indication is given to the operator or to the subscriber and no automatic repeat attempt is made.

Method a) is the preferred arrangement (see Recommendation Q.108).

Method a) does not require the repeat attempt to be limited to the circuit used at the first attempt, but should the first circuit be seized again at the second attempt on the second search over the circuits, a minimum time of 100 ms shall elapse between the termination of the first attempt outgoing seizing signal (or the recognition of the cessation of the incoming seizing signal, whichever occurs later) and the commencement of the second attempt seizing signal.

To minimize the probability of double seizing, the circuit selection at the two ends should be such that, as far as possible, double seizing can occur only when a single circuit remains (e.g. by selection of circuits in opposite order at the two ends).

Recommendation Q.143

2.3 LINE SIGNAL SENDER¹⁾

2.3.1 Signalling frequencies

2400 ± 6 Hz (f_1) and $2600 \pm$ Hz (f_2).

These frequencies are applied separately or in combination.

2.3.2 Transmitted signal level

-9 ± 1 dBm0 per frequency.

For compound signals the difference in transmitted level between f_1 and f_2 shall not exceed 1 dB.

Note 1 – The noise as measured at the output of the line signal sender shall be as low as practicable but in any event, at least 40 dB below signal level. This noise includes all extraneous power in the frequency band between 300 Hz and 3400 Hz including power resulting from non-linear distortion of the signal.

Note 2 – The level of the leak current transmitted to line should be at least 50 dB below signal level per frequency.

¹⁾ See also Recommendation Q.112.

Recommendation Q.144^{*)}

2.4 LINE SIGNAL RECEIVER¹⁾

(Geneva, 1964; modified at Helsinki, 1993)

2.4.1 Operating limits

The line signal receiver shall operate in the conditions specified under 2.4.5 for the distortion of received signals that meet the following conditions:

- a) f_1 : 2400 ± 15 Hz; f_2 : 2600 ± 15 Hz.
- b) The absolute power level N of each unmodulated signal received shall be within the limits:

$$(-16 + n) \leq N \leq (-2 + n) \text{ dBm}$$

where n is the relative power level at the signal received input.

These limits give a margin of ± 7 dB on the nominal absolute level of each received signal at the input to the signal receiver.

- c) The absolute level of the two unmodulated signal frequencies in a compound signal may differ from each other by not more than 5 dB.

The tolerances given in a), b) and c) are to allow for variations at the sending end and for variations in line transmission.

2.4.2 Non-operate conditions of line signal receiver

- a) *Selectivity*

The signal receiver shall not operate on a signal having an absolute power level at the receiving end within the limits specified in 2.4.1 when the frequency is outside:

$$\begin{array}{ll} + 100 & \\ 2400 & \text{Hz for the } f_1 \text{ signal circuit or} \\ - 150 & \\ 2600 & \text{Hz for the } f_2 \text{ signal circuit} \\ - 100 & \end{array}$$

- b) *Maximum sensitivity of line signal receiver*

The signal receiver shall not operate on a signal of 2400 ± 15 Hz or 2600 ± 15 Hz whose absolute power level at the point of connection of the receiver is $(-17 - 9 + n)$ dBm, n being the relative power level at this point. This limit is 17 dB below the nominal absolute level of the signal current at the input to the signal receiver.

2.4.3 Efficiency of the guard circuit

The signal receiver must be protected by a guard circuit against false operation due to speech currents, circuit noise, or other currents of miscellaneous origin circulating in the line.

The purpose of the guard circuit is to prevent:

- a) signal imitation. (Signals are imitated if the duration of the resulting direct-current pulses at the output of the signal receiver is long enough to be recognized as signals by the switching equipment);
- b) operation of the splitting device from interfering with speech.

To minimize signal imitation by speech currents it is advisable that the guard circuit be tuned.

To minimize signal interference by low-frequency noise it is advisable that the response of the guard circuit falls off towards the lower frequencies and that the sensitivity of the guard circuit at 200 Hz be at least 10 dB less than that at 1000 Hz.

^{*)} The text of ITU-T Rec. Q.144 is as amended by WTSC in March 1993.

¹⁾ See also Recommendation Q.112.

An indication of the efficiency of the guard circuit is given by the following:

- a) during 10 hours of speech, normal speech currents should not, on the average, cause more than one false operation of the f_1 or the f_2 signal circuit lasting more than 90 ms (the minimum recognition time of a signal liable to imitation is 100 ms);
- b) the number of false splits of the speech path caused by speech currents should not cause an appreciable reduction in the transmission quality of the circuit.

Since Signalling System No. 5 and V.22 modem are using the same frequency, the following conditions should be verified when testing new receivers, so that the connection is not released during data transmission:

When the 2400 Hz or 2600 Hz frequencies are present at level from -2 dBm0 to -26 dBm0, the addition of one of the following should guard the receiver from recognizing them as line signalling frequencies:

- a) a tone of 1800 Hz at 10 dB below the line frequency signal level;
- b) any tone in the area of 1000 Hz to 1900 Hz at 7 dB below the line frequency signal level.

2.4.4 Guard circuit limits

A Steady noise

Considering:

- (a) that when there is noise on a telephone circuit an over-sensitive guard circuit might give rise to signalling difficulties and, in particular, inhibit the response of the signal receiver;
- (b) that unweighted noise of a level -40 dBm0 (100 000 pW) and uniform spectrum energy may arise on the longest international, i.e. intercontinental, circuit,

it is recommended that, for either one or two signalling currents (each being within the limits specified in 2.4.1), the signal receiver should satisfy the conditions indicated in 2.4.5 for the distortion of signals in the presence of noise of a level of -40 dBm0 and uniform spectrum energy over the frequency range 300 to 3400 Hz.

B Surges

A guard circuit with an excessive hand-over time may cause difficulties in receiving a signal, for example, when it has been immediately preceded by surges, and it is therefore recommended that the following condition should be fulfilled:

If a disturbing current of a frequency corresponding to the maximum sensitivity of the guard circuit and having an absolute power level of $(-10 + n)$ dBm at the relative level point n where the receiver is connected ceases 30 ms before the application of a signal satisfying the limits defined in 2.4.1, the lengths of the received signals must remain within the limits specified in 2.4.5.

2.4.5 Distortion of received signals

When the signal frequencies and levels are within the limits specified in 2.4.1, the change in signal length in the presence of noise as defined in 2.4.4, A should not exceed:

- a) 15 ms when the signal receiver receives a pulse of one frequency f_1 or f_2 with a minimum duration of 150 ms;
- b) 25 ms when the signal receiver receives a compound pulse of the two frequencies f_1 and f_2 with a minimum duration of 150 ms, the change being defined as the difference between the simultaneous reception of the two frequencies at the input to the receiver and the simultaneous production of the two components as a direct-current signal at the output of the signal receiver.

In general, the response time of the signal receiver should be as short as practicable to minimize the time required for signalling purposes.

Except for the forward transfer pulse signal the above pulse distortion requirements are of minor importance for the remaining line signals, which are all of the continuous compelled type²⁾. Nevertheless the limits are specified for receiver design and test purposes.

²⁾ See 2.1.6/Q.141 explaining the term "continuous compelled".

Recommendation Q.145

2.5 SPLITTING ARRANGEMENTS

Sending line split

- 2.5.1 According to Recommendation Q.25, § 2, sending split arrangements have to be provided.
- 2.5.2 The exchange side of the international circuit shall be disconnected 30 to 50 ms before a voice-frequency signal is sent over the circuit.
- 2.5.3 The exchange side of the international circuit will not be reconnected for 30 to 50 ms following the end of the sending of a voice-frequency signal over the circuit.
- 2.5.4 Exceptionally, the values quoted in §§ 2.5.2 and 2.5.3 above may be 0 to 50 ms as the values are of minor importance with respect to compelled-type signals.

Receiving line split

- 2.5.5 The international circuit should be split at the international exchange when either a single-frequency or a compound-frequency signal is received, to ensure that no fraction of the signal exceeding 35 ms duration may pass out of the international circuit.

The splitting time of 35 ms may be reduced by each Administration concerned in order to help to protect its national network against the effect of signals coming from the international circuit. It should be noted, however, that a shorter splitting time can lead to an increase in the number of false operations of the splitting device by speech currents and impair speech transmission.

- 2.5.6 The split must be maintained for the duration of the signal but must cease within 25 ms of the end of the direct-current signal which caused the splitting device to operate.
- 2.5.7 The splitting of the line must not give rise to surges which might cause interference with signalling over the international circuit or with other signalling systems associated with it for setting up an international call.
- 2.5.8 The splitting device may be any suitable arrangement – for example, physical line disconnection, high impedance electronic device, insertion of signalling frequency band stop filter, etc. The level of leak current transmitted to the subsequent circuit from the splitting device in the split condition should be at least 40 dB below the received signal level. Exceptionally, the level of the leak current may be 25 dB below the received signal level if this causes no interference with the relevant networks.