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SPECIFICATIONS OF SIGNALLING SYSTEM No. 5

SIGNAL CODE FOR LINE SIGNALLING

CLAUSE 2 – LINE SIGNALLING

ITU-T Recommendation Q.141

(Previously "CCITT Recommendation")

FOREWORD

The ITU Telecommunication Standardization Sector (ITU-T) is a permanent organ of the International Telecommunication Union. The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, established the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

ITU-T Recommendation Q.141 was revised by the ITU-T Study Group XI (1988-1993) and was approved by the WTSC (Helsinki, March 1-12, 1993).

NOTES

1 As a consequence of a reform process within the International Telecommunication Union (ITU), the CCITT ceased to exist as of 28 February 1993. In its place, the ITU Telecommunication Standardization Sector (ITU-T) was created as of 1 March 1993. Similarly, in this reform process, the CCIR and the IFRB have been replaced by the Radiocommunication Sector.

In order not to delay publication of this Recommendation, no change has been made in the text to references containing the acronyms "CCITT, CCIR or IFRB" or their associated entities such as Plenary Assembly, Secretariat, etc. Future editions of this Recommendation will contain the proper terminology related to the new ITU structure.

2 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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CONTENTS

			Page
2.1	Signal code for line signalling		1
	2.1.1	General	1
	2.1.2	Transit working	1
	2.1.3	Sending duration of line signalling	1
	2.1.4	Recognition times of line signals	2
	2.1.5	Line signal code of System No. 5	3
	2.1.6	Further specification clauses relative to the signalling code	3
	2.1.7	Backward signals on multilink connections (consider as an example a connec-tion A-T-B)	5

Clause 2 – LINE SIGNALLING

(Geneva, 1964; modified at Helsinki, 1993)

2.1 Signal code for line signalling

2.1.1 General

The line-signal coding arrangement is based on the use of two frequencies $f1$ (2400 Hz) and $f2$ (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 $f2$ 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 ($f1$) permits discrimination between the busy-flash and the clear-back signals (both $f2$).

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.

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 cleardown 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 – *Prise*	⟶	*f*1	Continuous	40 ± 10 ms
Proceed-to-send – *Invitation à transmettre*	⟵	*f*2	Continuous	40 ± 10 ms
Busy-flash – *Occupation*	⟵	*f*2	Continuous	125 ± 25 ms
Acknowledgement – *Accusé de réception*	⟶	*f*1	Continuous	125 ± 25 ms
Answer – *Réponse*	⟵	*f*1	Continuous	125 ± 25 ms
Acknowledgement – *Accusé de réception*	⟶	*f*1	Continuous	125 ± 25 ms
Clear-back – *Raccrochage du demandé*	⟵	*f*2	Continuous	125 ± 25 ms
Acknowledgement – *Accusé de réception*	⟶	*f*1	Continuous	125 ± 25 ms
Forward-transfer – *Signal d'intervention*	⟶	*f*2	850 ± 200 ms	125 ± 25 ms
Clear-forward – *Signal de fin*	⟶	*f*1 + *f*2 (compound)	Continuous	125 ± 25 ms
Release-guard – *Libération de garde*	⟵	*f*1 + *f*2 (compound)	Continuous	125 ± 25 ms

a) ⟶ forward signals ⟵ backward signals

b) *f*1 = 2400 Hz *f*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 signal[1)].

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 later[1)].

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 recognized[1)].

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.

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

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 elapsed[2)] (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.

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

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.

b) *Overlap compelled signalling for the answer signal*

With *overlap compelled signalling* at a transit point T, the process of transmitting the primary signal from T to A is initiated as soon as the signal receiver response has caused at T the receiving end line split of BT. The normal signal recognition of the primary signal is still required at each transit point. The acknowledgement signal on a particular link should not be transmitted until signal recognition time of the primary signal has elapsed. To speed up the transmission of the answer signal, the overlap compelled technique is applied for this signal at a transit exchange when two No. 5 circuits are switched in tandem.

More details of the overlap compelled technique are given below:

If the primary signal from B to T lasts less than the signal recognition time, transmission of a primary signal already initiated at a transit point T from T to A will be stopped.

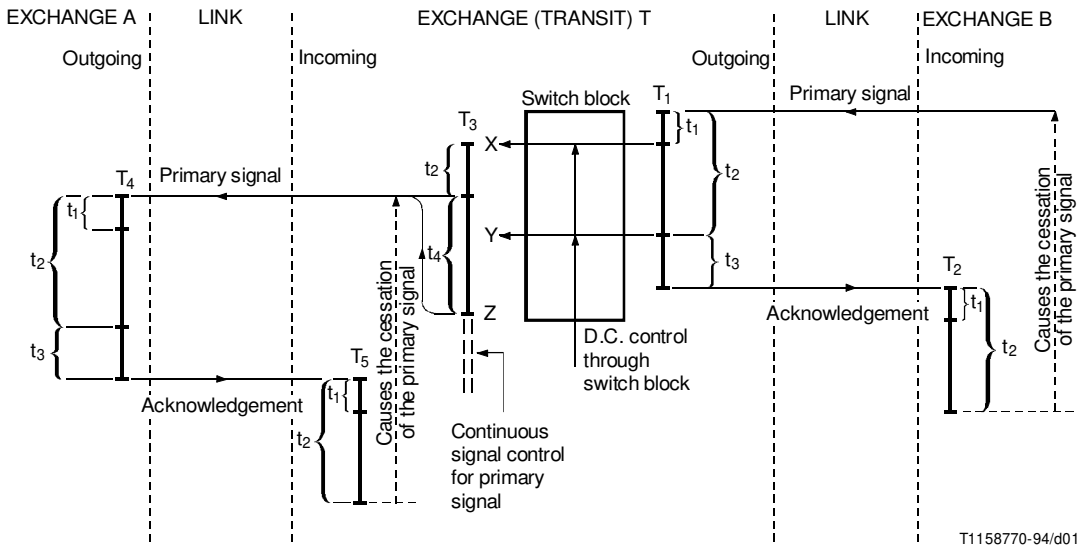
After the recognition time at T of a primary signal from B to T has elapsed, there shall be no control at T of the primary signal sent from T to A by the primary signal sent from B to T. In this case the primary signal on each link is ceased by its acknowledgement signal on that link [as in 2.1.6 c) above].

Figure 1 illustrates a typical arrangement and is included to illustrate the principle of overlap compelled signalling at transit points. Other design arrangements may be adopted as preferred by Administrations.

Transmission of the primary signal from T to A is initiated (by a "start to send" control condition *X* through the switch block at the transit point) as soon as the signal receiver response on the primary signal from B to T has caused the receiving-end line split (t_1 of T_1). The primary signal is transmitted from T to A after the sending-end line split (t_3 of T_3). Signal recognition of the primary signal is required at the transit point and the acknowledgement signal on a particular link should not be transmitted until the signal recognition time (t_2 of T_1, t_2 of T_4) has elapsed. The primary signal is ceased after the signal recognition time (t_2 of T_2, t_2 of T_5) of the relevant acknowledgement signal.

To prevent imitations of the primary signal on link BT lasting less than the signal recognition time from giving rise to an effective compelled signalling sequence on link TA, transmission of the primary signal on link TA is first under the "start to send" control *X* of a time base T_3 followed, without break at the termination of the time base (at time *Z*), by the continuous signal control required for compelled signalling. Should the duration of the primary signal on link BT be less than the signal recognition time (t_2 of T_1), the "start to send" control (*X* control) is interrupted. This stops transmission of a primary signal on link TA (should this have commenced) within the period *X-Z* of T_3 and hence before the continuous signal control can be applied.

After the signal recognition time of the primary signal on link BT has elapsed, there shall be no control of the transmission of the primary signal on link TA by the primary signal on link BT at the transit point. To achieve this, a condition is applied to the *Y* control to inhibit the *X* control, which should ensure that transmission of the primary signal on link TA cannot be stopped during the period *X-Y* of T_3 and that the continuous signal control of the primary signal is applied without break at time *Y* (or at time *Z* depending upon the particular design). In these circumstances the primary signal on each link is ceased by its relevant acknowledgement signal.



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