INTERNATIONAL TELECOMMUNICATION UNION

ITU-T Q.412

TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

SPECIFICATIONS OF SIGNALLING SYSTEM R2

LINE SIGNALLING, ANALOGUE VERSION

CLAUSES FOR EXCHANGE LINE SIGNALLING EQUIPMENT

ITU-T Recommendation Q.412

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation Q.412 was published in Fascicle VI.4 of the *Blue Book*. This file is an extract from the *Blue Book*. While the presentation and layout of the text might be slightly different from the *Blue Book* version, the contents of the file are identical to the *Blue Book* version and copyright conditions remain unchanged (see below).

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

2.2 CLAUSES FOR EXCHANGE LINE SIGNALLING EQUIPMENT [1)]

2.2.1 *Recognition time for transition of signalling condition*

The recognition time t_r for a changed condition (transition from tone-on to tone-off or vice versa) is 40 ± 10 ms [2)] . The recognition time is defined as the minimum duration that the presence or absence of a direct current signal must have at the output of the signal receiver in order to be recognized as a valid signalling condition by the exchange equipment. Thus the specified value does not include the response time t_{rs} of signalling receivers (see Recommendation Q.415). However, it is determined on the assumption that there is interruption control (see Recommendation Q.416).

2.2.2 *States and procedures under normal conditions*

2.2.2.1 *Seizure*

The outgoing end removes the tone in the forward direction. If seizure is immediately followed by release, removal of the tone must be maintained for at least 100 ms to make sure that it is recognized at the incoming end.

2.2.2.2 *Answering*

The incoming end removes the tone in the backward direction. When another link of the connection using tone-on-idle continuous signalling precedes the outgoing exchange, the tone-off condition must be established on this link immediately after it is recognized in this exchange. When another signalling system is used on the preceding link, the rules for interworking are applicable.

2.2.2.3 *Clear-back*

The incoming end restores the tone in the backward direction. When another link of the connection using tone-on-idle continuous signalling precedes the outgoing exchange the *tone-on* condition must be established on this link immediately after it is recognized in this exchange. When another signalling system is used on the preceding link, the rules for interworking are applicable. The provisions set forth in § 2.2.2.6 below must also be taken into consideration.

2.2.2.4 *Clear-forward procedure*

The outgoing end restores the tone in the forward direction (see § 2.2.2.1 above). The forward connection is released and the release-guard sequence begins as soon as the changed signalling condition is recognized at the incoming end. In the outgoing exchange the circuit remains blocked until the release-guard sequence is terminated (see § 2.2.2.6 below).

2.2.2.5 *Blocking and Unblocking procedure*

At the outgoing exchange the circuit stays blocked so long as the tone remains off in the backward direction.

Restoration of the tone in the backward direction - accompanied by the presence of the tone in the forward direction restores the circuit to the idle state. The circuit may then be seized for a new call.

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1) Although the signalling condition (tone-on or tone-off) physically only appears in transmission equipment, it is used in this section as a reference criterion to specify functions of exchange equipment.

2) Originally this value was (20 ± 7) ms. Since there will be no problem in the interworking between equipment having the original recognition time t_r = (20 ± 7) ms, and equipment having the new recognition time t_r = (40 ± 10) ms, existing equipment need not necessarily be changed to the value t_r = (40 ± 10) ms.

2.2.2.6 *Release and release-guard sequence*

Release-guard must be ensured whatever the state of the circuit at the moment the clear-forward signal is sent - seized prior to answer, answered or cleared by the called party. It may also happen that answering or clearing by the called party occurs when release has already begun at the outgoing exchange. The cases are described below and shown in the Figures 2/Q.412 to 4/Q.412. The exact timing is shown in Figure 5/Q.412.

a) *Release prior to answered state*

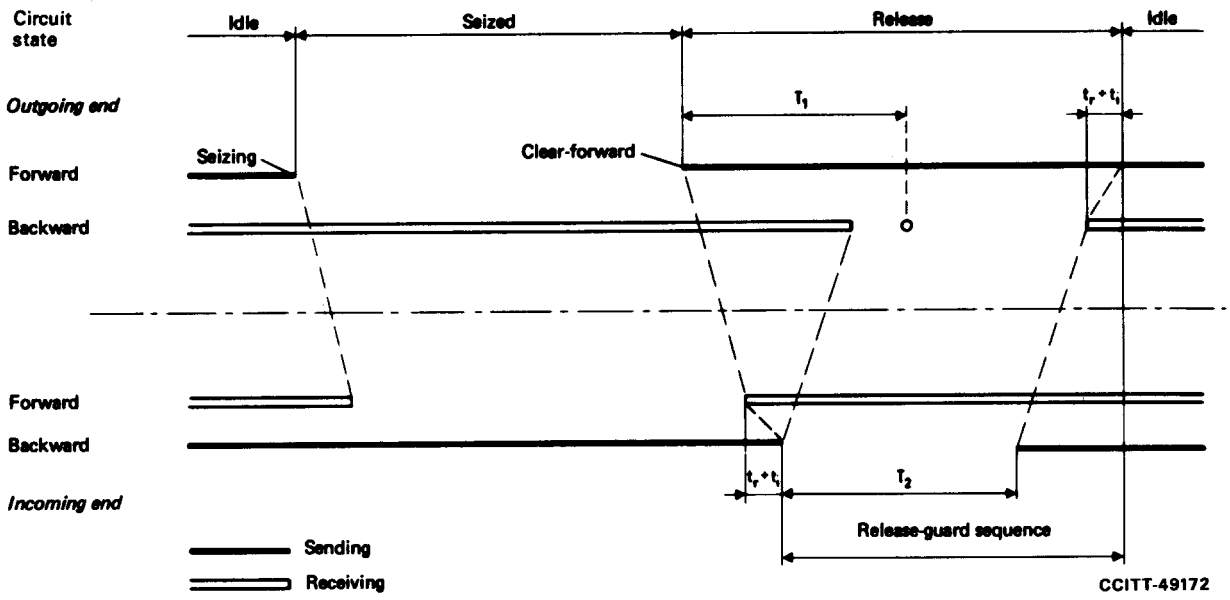
The clear-forward signal is sent from the outgoing end by restoring the tone in the forward direction (see Figure 2/Q.412). Recognition of this tone has the following consequences at the incoming end:

i) the tone in the backward direction is removed;

ii) the release of the switching units is initiated;

iii) the release-guard sequence starts.

When release operations at the incoming end are complete, but not before an interval T_2 has elapsed after the removal, the tone is again restored at the incoming end in the backward direction.



Legend: see Figure 5/Q.412.

FIGURE 2/Q.412

Release prior to answered state

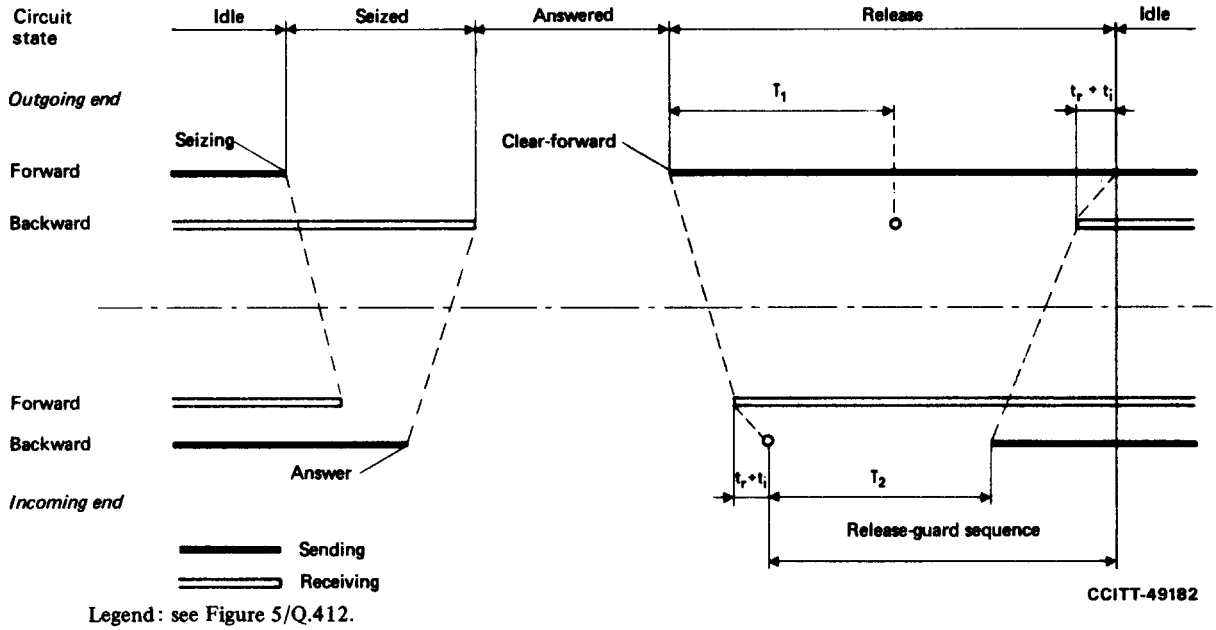
When T_1 has elapsed the outgoing end must recognize that the tone-off condition in the backward direction is established. After this recognition the restoring of the tone in the backward direction returns the circuit to the idle state and completes the release-guard sequence.

At the incoming end the sending of an answer signal can only be prevented after the clear-forward signal has been recognized. To avoid any false operation should answer coincide with release, transition from *tone-on* to *tone-off* in the backward direction must not be interpreted, at the outgoing end, as part of the release-guard sequence during an interval T_1. The interval T_1 starts with the sending of the tone in the forward direction. It is long enough to make quite sure that the clear-forward signal is recognized and the *tone-off* condition established at the incoming end.

For the calculation of the intervals T_1 and T_2 see § 2.2.2.7 below.

b) *Release in answered state*

In this case, the release operations differ only from a) above in so far as i) does not apply. At the incoming end, however, sending of a clear-back signal can only be prevented after the clear-forward signal has been recognized. Should there be a clear-back signal the specified interval T_1 enables any resultant difficulties to be obviated (see Figure 3/Q.412).



Legend: see Figure 5/Q.412.

FIGURE 3/Q.412

Release in answered state

c) *Release in clear-back state*

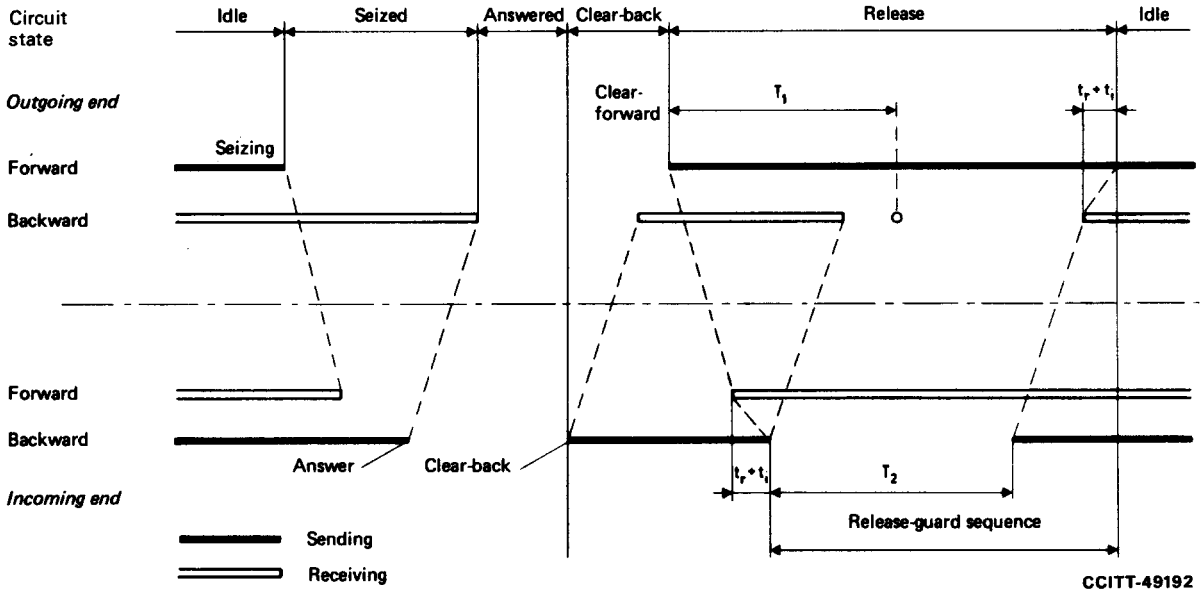
The release operations are identical to those described in a) above. Should there be a second answer signal, the specified interval T_1 enables any resultant difficulties to be obviated (see Figure 4/Q.412).

2.2.2.7 *Calculation of the intervals* T_1 *and* T_2 *Specified for release and release-guard operations*

Figure 5/Q.412 shows the factors involved in calculating the intervals T_1 and T_2.

At the outgoing end when the interval T_1 has elapsed (Figure 5/Q.412, point D) the tone-off condition in the backward direction can be expected and recognized with certainty in all cases mentioned in § 2.2.2.6 above.

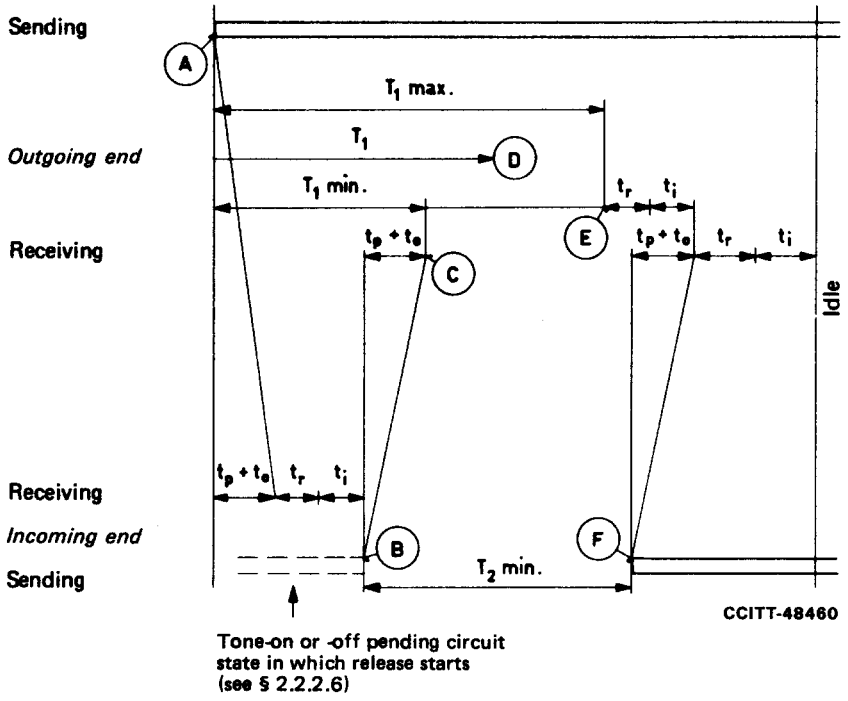
Similarly, the interval T_2 preceding the restoring of the tone in the backward direction may be applied in all cases. To avoid false operation in the event of coinciding forward and backward signals or an irregular sequence of signals, the time interval T_2 must also be observed with the release operation [see § 2.2.2.6 b) above].



Legend: see Figure 5/Q.412.

FIGURE 4/Q.412

Release in clear-back state



Legend

t_p: Propagation time

t_o: Overall response time of signalling sender and receiver

t_r: Recognition time

t_i: Internal operating time

FIGURE 5/Q.412

Release-guard sequence

The minimum value of T_1 is the sum of the maximum values of the times required for the various operations which take place between application of the tone in the forward direction and recognition of the absence of tone in the backward direction.

T_2 delays release of the circuit. It must therefore be as short as possible. However, it must be long enough to ensure recognition of the tone-off condition in the backward direction at the outgoing end when T_1 is at its maximum, even when this condition begins as early as possible.

a) Exclusive terrestrial circuits

The calculation is based on a maximum one-way transmission delay of 30 ms for a circuit. Thus, for circuits on high-velocity transmission systems via terrestrial lines (including submarine cables) the maximum operating range of the specified line signalling system is 4800 km[3)] .

Values used for the calculation of T_1 and T_2:

$0 < t_p < 30$ ms
$0 < t_o < 30$ ms (see § 2.3.2.4)
$30 \text{ ms} < t_r < 50$ ms
$0 < t_i < 20$ ms

Calculation of intervals T_1 and T_2:

$T_1 > \overline{AC}$

$$T_1 > 2(t_p + t_o)\,\text{max.} + t_r\,\text{max.} + t_i\,\text{max.}$$
$$T_1 > (2 \times 60 + 50 + 20)\ \text{ms}$$
$$T_1 > 190\ \text{ms}$$

Allowing a safety margin of 10 ms and a tolerance of ± 20%, the specified value of T_1 is (250 ± 50) ms.

$T_2 > \overline{BF}$

$$T_2 > T_1\,\text{max.} + t_r\,\text{max.} + t_i\,\text{max.} - 2(t_p + t_o)\,\text{min.} - t_r\,\text{min.} - t_i\,\text{min.}$$
$$T_2 > (300 + 50 + 20 - 0 - 30 - 0)\ \text{ms}$$
$$T_2 > 340\ \text{ms}$$

Allowing a safety margin of 20 ms and a tolerance of ± 20%, the specified value of T_2 is (450 ± 90) ms.

b) Circuits including a satellite link

The calculation is based on the assumption that the complete connection includes two terrestrial sections with a maximum one-way transmission delay of 15 ms each and a satellite section with a one-way transmission delay of (270 ± 20) ms.

Values used for the calculation of T_1 and T_2:

$250 < t_p < 320$ ms
$0 < t_o < 30$ ms (see § 2.3.2.4)
$30 < t_r < 50$ ms
$0 < t_i < 20$ ms

Calculation of intervals T_1 and T_2:

$T_1 > \overline{AC}$

$$T_1 > 2(t_p + t_o)\,\text{max.} + t_r\,\text{max.} + t_i\,\text{max.}$$
$$T_1 > (2 \times 350 + 50 + 20)\ \text{ms}$$
$$T_1 > 770\ \text{ms}$$

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3) See Recommendation G.114, Fascicle III.1.

Allowing a safety margin of 30 ms and a tolerance of ± 20%, the specified value of T_1 (1000 ± 200) ms.

$T_2 > \overline{BF}$ $\quad T_2 > T_1 \text{ max.} + t_r \text{ max.} + t_i \text{ max.} - 2(t_p + t_o) \text{ min.} - t_r \text{ min.} - t_i \text{ min.}$

$T_2 > (1200 + 50 + 20 - 2 \times 250 - 30 - 0)$ ms

$T_2 > 740$ ms

Allowing a safety margin of 60 ms and a tolerance of ± 20%, the specified value of T_2 is (1000 ± 200) ms.

c) Terrestrial circuits and circuits including a satellite link

The situation in which equipment can serve terrestrial circuits as well as circuits including a satellite link is not to be preferred because for the case of terrestrial circuits the release sequence is unduly prolonged. The calculation is based on the same assumption as in b) above, but with a minimum for $(t_p + t_o) = 0$. This does not affect the value of T_1 , so also in this situation T_1 = 1000 ± 200 ms.

Values used for the calculation of T_2:

$0 < t_p < 320$ ms
$0 < t_o < 30$ ms (see § 2.3.2.4)
$30 < t_r < 50$ ms
$0 < t_i < 20$ ms

Calculation of interval T_2:

$T_2 > \overline{BF}$ $\quad T_2 > T_1 \text{ max.} + t_r \text{ max.} + t_i \text{ max.} - 2(t_p + t_o) \text{ min.} - t_r \text{ min.} - t_i \text{ min.}$

$T_2 > (1200 + 50 + 20 - 0 - 30 - 0)$ ms

$T_2 > 1240$ ms

Allowing a safety margin of 40 ms and a tolerance of ± 20%, the specified value of T_2 is (1600 ± 320) ms.

2.2.3 *Abnormal conditions*

The situations described below are those in which interruption control of signalling channels (see Recommendation Q.416) does not function and which occur only during interruptions of individual channels or in the event of a fault in a line-signalling equipment. In addition, the situations described in §§ 2.2.3.3 and 2.2.3.4 below may also result from operation of interruption control at the incoming end of the circuit. In that case the circuit automatically returns to normal at the command of interruption control.

2.2.3.1 If an exchange recognizes tone-off condition in the backward direction (premature answer) before the outgoing R2 register has received a signal A-6 or a Group B-signal, the connection must be released. Congestion information is then sent backwards or a repeat attempt is made to set up the call.

2.2.3.2 In the case of non-reception of the answer signal, of delay in clearing by the calling subscriber in automatic working, or of non-reception of the clear-forward signal by the incoming exchange after the clear-back signal has been sent, the provisions of Recommendation Q.118 apply.

2.2.3.3 If, in the cases given in § 2.2.2.6 a) or c) above, the tone in the backward direction is not removed, the circuit will remain blocked, since it cannot return to the idle state of its own accord. The action to be taken in such cases is described in § 6.6.

2.2.3.4 If after sending of the clear-forward signal the signalling tone in the backward direction is not restored, the circuit stays blocked, as described in section § 2.2.2.5 above. The same occurs when, in the idle state, the signalling tone in the backward direction is interrupted by a fault.

2.2.3.5 When the signalling tone in the forward direction of an idle circuit is interrupted owing to a fault, the incoming end recognizes seizure and connects multifrequency signalling equipment, but no interregister signalling follows.

a) When the interruption is greater than the incoming R2 register time-out (see Recommendation Q.476) the register will release and the circuit must be brought into blocked state by removal of the signalling tone in the backward direction. As soon as the fault is cleared and the tone in the forward direction consequently restored, the circuit returns to the idle state in accordance with § 2.2.2.6 b) above.

b) When the interruption is shorter than the time-out, restoration of the signalling tone in the forward direction will return the circuit to the idle state in accordance with § 2.2.2.6 a) above.

2.2.4 *Alarms for technical staff*

According to Recommendation Q.117, an alarm should in general be given to technical staff as soon as an abnormal condition is recognized as probably due to a fault.

It is recommended that a delayed action alarm should be operated at the outgoing end for the conditions described in §§ 2.2.2.5, 2.2.3.3 and 2.2.3.4 above, i.e. when the circuit does not revert to the idle state after sending of the clear-forward signal or receipt of the blocking signal.

Arrangements for the operation of the alarm will be made by each Administration.

At both the outgoing and the incoming end, when interruption control (see Recommendation Q.416) functions, alarm condition must first be established for the transmission equipments. However, in this case a delayed-action alarm may also be given to the technical staff of the exchange.