INTERNATIONAL TELECOMMUNICATION UNION

ITU-T

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TELECOMMUNICATION
STANDARDIZATION SECTOR
OF ITU

SPECIFICATIONS OF SIGNALLING SYSTEM R2

LINE SIGNALLING, ANALOGUE VERSION

INTERRUPTION CONTROL

ITU-T Recommendation Q.416

(Extract from the *Blue Book*)

NOTES

1 ITU-T Recommendation Q.416 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.

2.4 INTERRUPTION CONTROL

2.4.1 *General*

In System R2, removal of the tone corresponds to the sending of the seizing and answer signals. Steps must be taken, therefore, to guard against unwanted interruption of the signalling channels resulting in false signalling. Special devices monitor a number of circuits and transmit an indication to each individual equipment as soon as an interruption occurs. The whole protection system against the effect of interruptions is designated by the term *interruption control*

In each case, the response time of the interruption control must be based on the time required to recognize the signalling condition.

The interruption control systems in the two directions of transmission operate independently of each other.

The interruption control specified uses the group pilot to detect interruptions.

2.4.2 *Mode of operation of interruption control*

For each direction of transmission of a carrier circuit connection the equipment for interruption control comprises:

- a group pilot generator at the outgoing end;
- a pilot receiver and a wiring system for signalling the interruption at the incoming end.

In principle, the existing pilots of the carrier system will be used.

The receiver at one end supervises the pilot transmitted by the other end. When a considerable fall in the level of the pilot is detected it is assumed that an interruption has occurred on the signalling channels associated with the carrier circuits. The interruption control equipment then reacts to prevent the unwanted transmission of certain signals on those circuits which have already been seized or to ensure that idle circuits are blocked.

Figure 10/Q.416 shows functionally an arrangement where the pilot receiver controls the relay sets of interrupted circuits.

To ensure proper interruption control, it is essential that the individual transmission or switching equipments should not react to any change of signalling state due to a fault. The action initiated by the interruption control must therefore be completed in less time than the sum of the response time of the signalling receiver and the recognition time for the *tone-off* condition caused by interruption of the signalling channel. Again, to prevent the unwanted transfer of certain signals, interruption control, during re-establishment of the pilot, must return to *alarm off* after an interval long enough for the signalling equipment to revert to normal.

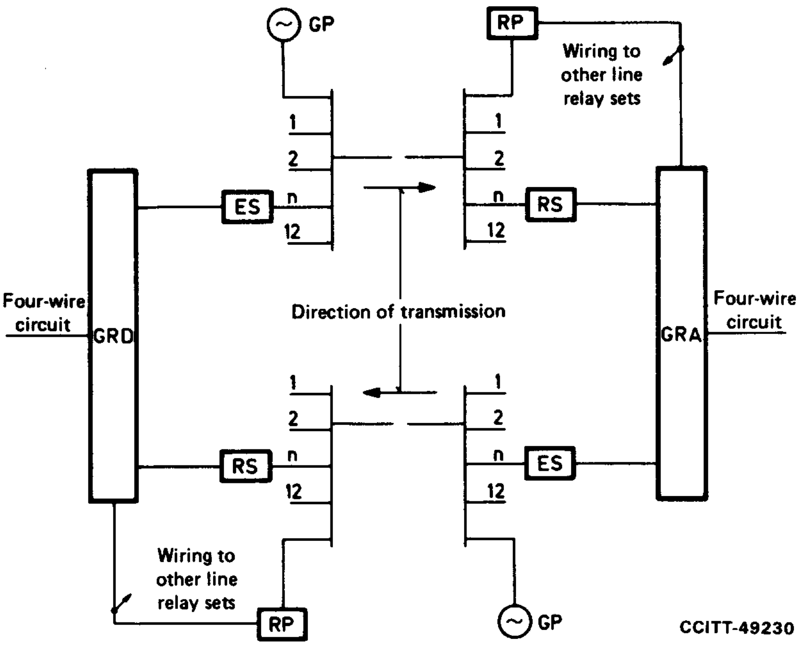
To operate independently for each direction of transmission the incoming end interruption control supervises only the forward direction and, if necessary, initiates an operation at the outgoing end via the line signalling system. Conversely, interruption control at the outgoing end supervises the backward direction of transmission only.

Blocking of a circuit at the outgoing end therefore takes place in two different ways:

- immediate blocking by intervention of interruption control at the outgoing end;
- blocking on recognition in the backward direction of the *tone-off* condition caused by interruption control intervention at the incoming end.

When the transmission system is re-established, interruption control reverts to normal and the signalling equipment must automatically revert to normal operating.

Since the action to be taken on the individual circuits differs according to their state at the time the fault occurs, the different possibilities are dealt with in detail below.



GP = pilot generator
RP = pilot receiver
RS = signalling receiver
ES = signalling sender
GRD = outgoing relay set
GRA = incoming relay set

FIGURE 10/Q.416

Protection from the effect of interruptions (interruption control)

2.4.2.1 *Mode of operation of interruption control at the incoming end (transmission interrupted in the forward direction)*

a) *Circuit in idle state*

Transition of interruption control to alarm brings about:

i) removal of the tone in the backward direction by locking of the sending unit in the *tone-off* condition;

ii) locking of the receiving unit in its position, i.e. in the *tone-on* condition.

The effect of operation i) is to block the circuit at the outgoing end against possible seizing; operation ii) prevents incorrect recognition of seizing of the incoming circuit.

Return of interruption control to normal ensures return to the idle state of the circuits affected by the fault, by switching sending units at the incoming end to the *tone-on* condition.

b) *Circuit seized prior to answered state*

Transition of interruption control to alarm brings about:

i) locking of the sending unit in its position, i.e. in the *tone-on* condition;

ii) locking of the receiving unit in its position, i.e. in the *tone-off* condition;

iii) start of a time-out device which after a certain interval clears the chain beyond the faulty circuit; this timing arrangement may be the one specified in Recommendation Q.118, § 4.3.3.

Operation i) prevents the transfer of an answer signal while interruption control is in action. If the called subscriber answers before the time out delay mentioned in iii) above has elapsed, then the timer is stopped. For existing equipment this requirement may not apply. If the called subscriber clears while interruption control is active, the part of the connection beyond the faulty circuit must be released immediately.

Operation iii) prevents blocking of the called subscriber's line if the fault persists; short breaks, on the other hand, have no effect.

When the caller clears, operations i) and ii) block the faulty circuit against any new seizure even when the backward signalling channel is still intact; since the release-guard signal has not been sent the outgoing circuit cannot return to the idle state.

When interruption control reverts to normal before the called subscriber has answered, the call may still mature normally, provided the caller is holding.

If the called subscriber has answered during the time-out delay and the interruption control reverts to normal with both the calling and called subscribers holding, the answer signal is sent immediately.

If at the moment when interruption control reverts to normal the called subscriber has already cleared, operation ii) ensures that in all cases the release-guard sequence takes place as in § 2.2.2.6 a) above (either immediately if the outgoing exchange has already sent the clear-forward signal or when the caller clears). If, on the other hand, the called subscriber is still holding and the outgoing exchange is already sending the clear-forward signal when interruption control reverts to normal the circuit returns to the idle state at the outgoing end as described in § 2.2.2.6 b) above.

c) *Circuit in answered state*

Transition of interruption control to alarm brings about:

i) locking of the sending unit in its position, i.e. in the *tone-off* condition;

ii) locking of the receiving unit in its position, i.e. in the *tone-off* condition.

When the caller clears, operation i) blocks the faulty circuit against any new seizure, even when the backward signalling channel is still intact; since the release-guard signal has not been sent, the outgoing circuit cannot return to the idle state.

When the called subscriber clears, the part of the connection beyond the faulty circuit (including the called subscriber's line) must be released immediately.

When interruption control reverts to normal with both subscribers still on the line, the connection is maintained.

When the caller has already cleared by the time the interruption control reverts to normal, the release-guard sequence is carried out as in Recommendation Q.412, § 2.2.2.6 b) or c).

d) *Circuit in clear-back state*

Transition of interruption control to alarm causes:

i) locking of the sending unit in its position, i.e. in the *tone-on* condition;

ii) locking of the receiving unit in its position, i.e. in the *tone-off* condition;

iii) immediate release of the part of the connection beyond the faulty circuit (including the called subscriber's line).

When interruption control reverts to normal, the release-guard signal is sent as in Recommendation Q.412, § 2.2.2.6 c) as soon as the clear-forward signal is recognized.

e) *Circuit in release*

When interruption control functions after a clear-forward signal has been recognized at the incoming end, it causes:

i) locking of the sending unit in the *tone-off* condition; if at the instant interruption control operates, *the tone-on* condition exists in the backward direction, it will be switched to the *tone-off* condition following recognition of the clear-forward signal and locking in the *tone-off* condition can take place as prescribed;

ii) locking of the receiving unit in its position, i.e. in the *tone-on* condition.

The effect of operation i) is to guard the faulty circuit from a new seizure at the outgoing exchange.

Operation ii) ensures the release of the part of the connection beyond the faulty circuit (including the called subscriber's line).

When interruption control reverts to normal the *tone-on* condition is established in the backward direction and causes the circuit at the outgoing exchange to return to the idle state.

2.4.2.2 *Mode of operation of interruption control at the outgoing end* (transmission in the backward direction interrupted)

a) *Circuit in idle state*

Transition of interruption control to alarm is immediately followed by blocking of the outgoing circuit.

b) *Circuit seized but not in answered state (including clear-back)*

i) Transition of interruption control to alarm causes locking of the receiving unit in its position, i.e. the *tone-on* condition. This operation prevents recognition of an answer signal or return to the *answered* state should the called subscriber have cleared.

ii) As soon as a clear-forward signal is sent on the part of the connection preceding the faulty circuit, it must be retransmitted; the tone must therefore be established in the forward direction to ensure, assuming that the forward signalling channel is left intact, that the part of the connection beyond the faulty circuit is released.

iii) When interruption control reverts to normal, the tone may already have been sent in the forward direction as a clear-forward signal. If the forward signalling channel has remained intact, recognition at the incoming end of the *tone-on* condition will have caused generation of the release-guard sequence which, because of the fault, will not have been received at the outgoing end. Exceptionally, therefore, return of the outgoing circuit to the idle state must take place simply on recognition of *tone-on* in the backward direction without necessarily taking into account time-out T1.

c) *Circuit in answered state*

In this case transition of interruption control to alarm does not cause immediate action. A clear-forward signal sent on the part of the connection preceding the faulty circuit must be repeated forward to ensure that, if the forward signalling channel is left intact, the part beyond the faulty circuit is cleared.

Once the interruption control reverts to normal the connection is maintained provided the caller and the called subscriber are still holding. On the other hand, by the time the interruption control reverts to normal the clear-forward signal may already have been sent and the situation will be the one described in § 2.4.2.2 b), iii).

d) *Circuit in release*

[See § 2.4.2.2 b), iii).]

2.4.3 *Clauses on interruption control equipment*

Adoption of thresholds with widely differing levels makes for economy in the design of interruption control equipment. Against this must be set the fact that the device cannot cope with the effects of certain slow drops in level. However, the probability of these occurring in practice is very small.

2.4.3.1 *Pilots*

Interruption control uses the 84.08 kHz group pilot or by bilateral agreement and, at the request of the receiving end country, the 104.08 kHz group pilot.

However, if the ends of the supergroup link coincide with the end of the five group links it is carrying, the supergroup pilot may also be used.

2.4.3.2 *Alarm-on threshold*

Interruption control must pass to *alarm-on* when the pilot level, measured at the group distribution frame or at an equivalent point, drops to -29 dBm0.

2.4.3.3 *Alarm-off threshold*

Interruption control must revert to *alarm-off,* i.e. normal when the pilot level, measured at the group distribution frame or at an equivalent point, rises to -24 dBm0.

2.4.3.4 *Response time for a drop in level*

Interruption control must pass from normal to alarm-on within an interval $t\downarrow$ such that:

$$5 \text{ ms} \leq t\downarrow \leq t_{rs \min} + 13 \text{ ms}$$

when the pilot level, measured at the group distribution frame or at an equivalent point, suddenly drops from its nominal level to -33 dBm0.

In the above formula, $t_{rs \min}$ is the minimum response time of the signalling receiver for a drop in level, taking into account a possible variation of ± 3 dB in the signalling tone level from its nominal value, the level being measured on the receiving side of the group distribution frame or at an equivalent point.

The figure of 13 ms in the above formula is derived on the assumption that the output of the interruption control equipment acts upon the input of the device which regulates the recognition time for the *tone-on* and *tone-off* conditions (20 ± 7 ms)[1], i.e. absence of a direct current signal at this input for a period of up to 13 ms has no relevance.

2.4.3.5 *Response time for rise in level*

Interruption control must revert from the alarm-on to normal in an interval $t\uparrow$ such that:

$$t_{rs \max} - 13 \text{ ms} \leq t\uparrow \leq 500 \text{ ms}$$

when the pilot level, measured at the group distribution frame or at an equivalent point, suddenly rises from its nominal level to -33 dBm0.

In the above formula, $t_{rs \max}$ is the maximum response time of the signalling receiver for a rise in level, taking into account a possible variation of ± 3 dB in the signalling tone level from its nominal value, the level being measured on the receiving side of the group distribution frame or at an equivalent point.

The figure of 13 ms in the above formula is derived on the assumption that the output of the interruption control equipment acts upon the input of the device which regulates the recognition time for *tone-on* and *tone-off* condition
(20 ± 7 ms) [1] i.e. absence of a direct current signal at this input for a period of up to 13 ms has no relevance.

2.4.3.6 *Precautions against noise*

An interruption may produce increased noise on the group link. Interruption control must be capable of distinguishing between the pilot itself and a high level noise simulating the pilot.

Interruption control must not revert to normal in the presence of white noise having a spectral power density of not more than -47 dBm0 per Hz.

To facilitate the design of interruption control equipment operating satisfactorily at high noise levels, the upper limit of 500 ms for $t\uparrow$ has been specified.

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[1] If the value (40 ± 10) ms is exclusively applied, it is possible to use the minimum value of 30 ms instead of 13 ms for the interruption control device.