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SERIES Q: SWITCHING AND SIGNALLING

Specifications of Signalling System No. 4

ITU-T Recommendations Q.120-Q.139

(Formerly CCITT Recommendations)

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ITU-T Recommendations Q.120-Q.139

Specifications of Signalling System No. 4

Source

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FOREWORD

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SPECIFICATIONS OF SIGNALLING SYSTEM No. 4

CHAPTER I

DEFINITION AND FUNCTION OF SIGNALS

Recommendation Q.120

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.

The seizing signal can also perform switching functions and two different types of seizing signal are provided for this purpose, viz:

- a) the *terminal seizing* signal, which can be used at the incoming international exchange, to seize equipment used exclusively for switching the call to the national network of the incoming country;
- b) the *transit seizing* signal, which can be used in the exchange at the incoming end of the international circuit to seize equipment used exclusively for switching the call 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.

In System No. 4 two different proceed-to-send signals are provided:

- a) the *terminal* proceed-to-send signal, used to invite the sending of the language digit¹⁾ (or the discriminating digit¹⁾ plus the national (significant) number¹⁾;
- b) the *transit* proceed-to-send signal, used to invite the sending of only those numerical signals (beginning with the first digit of the country code)¹⁾ necessary for routing the call through the international transit exchange towards the incoming international exchange or to another international transit exchange.

1.3 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⁾ For definitions, see Recommendations Q.10/E.160 and Q.104.

1.4 end-of-pulsing signal, also called for System No. 4 code 15 (sent in the forward direction)

This numerical type signal is sent from the international outgoing exchange to show that there are no more numerical signals to follow. In semi-automatic working, this signal is always sent. In automatic working, this signal *may* be sent, viz., when, in the outgoing international exchange, it is known that there are no more digits to follow.

1.5 number-received signal (sent in the backward direction)

1.5.1 This signal is sent from the incoming international exchange to the outgoing international exchange when the incoming register has recognized that all the digits required for routing the call to the called subscriber have been received.

Purpose of the signal

1.5.2 In the semi-automatic working, the number-received signal may be used to inform the outgoing operator that the international switching operations have been completed.

1.5.3 In automatic working, this signal is essential to show the outgoing register at the outgoing international exchange that it can release, and to set up speech conditions at this exchange. Hence, it is desirable that the signal be sent as soon as possible.

Generation of the signal

1.5.4 In semi-automatic working, the incoming register (or associated equipment) after reception of the end-of-pulsing signal acknowledges this numerical signal with an x and then sends back the number-received signals.

1.5.5 In automatic working, the incoming register (or associated equipment) recognizes that all the digits of a national (significant) number²⁾ have been received³⁾ :

1.5.5.1 by the receipt of the end-of-pulsing signal; or

1.5.5.2 a) by checking the number of digits received, in countries where the national (significant) number²⁾ is always made up of the same number of digits; or

b) in countries where this is not so:

i) by the receipt of the maximum number of digits, used in the numbering plan of the country; or

ii) by analyzing the first digits in the national (significant) number to decide how many digits there are in the subscribers' numbers in the particular national numbering zone; or

iii) by using a national end-of-selection or national "electrical" ringing-tone signal; or

iv) exceptionally, by observing that 4 to 10 (for new equipment 4 to 6) seconds have elapsed since the last digit was received, and that no fresh information has been received; in such circumstances, retransmission to the national network of the last digit received must be prevented until the end of the waiting period which causes the number-received signal to be sent over the international circuit. In this way, it is ensured that no national answer signal can arrive before the number-received signal has been sent.

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

This 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 to indicate that there is congestion at that exchange or on the appropriate outgoing routes.

b) An incoming international exchange *must* send this signal 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.

²⁾ See definition in Recommendation Q.10/E.160.

³⁾ See Recommendation Q.180 for interworking between Systems No. 4 and No.5, Q.232 for interworking between Systems No. 4 and No. 5 *bis*, Q.261 for interworking between Systems No. 4 and No. 6, Q.381 for interworking between Systems No. 4 and R2, Q.382 for interworking between Systems No. 5 and R2, Q.383 for interworking between Systems No. 5 *bis* and R2 and Q.388 for interworking between Systems No. 6 and R2.

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
- in automatic working, the sending of the clear-forward by the outgoing exchange to release the international connection (except when otherwise arranged, for example, in the 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 call⁴⁾.

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 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 measurements of call duration if, between one and two 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

1.8.1 *Note 1* – In general, the sequence of answer and clear-back signals that will be sent when the called subscriber depresses and releases the switch-hook of his telephone will not always be able to follow the frequency of this operation of the switch-hook, but correct indication of the *final* position of the switch-hook must *always* be given:

- to the outgoing international operator in semi-automatic operation;
- to the outgoing international equipment in automatic operation.

1.8.2 *Note 2* – The "call party" referred to in the definitions of the answer and clear-back signals may be:

- the called subscriber;
- in semi-automatic working, the operator who puts the call through in her own country and who sends an answer signal when she answers the call.

1.8.3 *Note 3* – The following is a detailed description of the various possible circumstances in which the answer and clear-back signals are sent.

A. *Called subscriber obtained automatically by the international outgoing operator*

The answer and clear-back signals are sent every time the called subscriber answer or clears.

B. *Called subscriber not obtained automatically by the international outgoing operator*

- a) *Only one operator involved in the incoming country, without through-supervision via her position* – (This operator can be an incoming or a delay operator or a manual exchange operator obtained automatically from the outgoing international exchange.)

The answer signal is sent when the operator enters the circuit.

The clear-back signal is sent when the operator clears the connection.

⁴⁾ 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.

- b) *Only one operator involved in the incoming country, with through-supervision via her position* – (The operator can be the same as for a) above.)

Through-supervision can be effected:

- via the cord circuits, the incoming operator intervening to clear down the connection at the end of the call;
- via cordless positions, in which case the connection is released automatically without the intervention of an operator when the called subscriber clears and when the outgoing operator causes the clear-forward signal to be sent.

The answer signal is sent when the operator enters the circuit.

A clear-back signal is sent when the operator goes out of circuit. This can happen, for example, when the operator hears the ringing tone but does not wait for the called subscriber to reply.

A second answer signal is sent when the called subscriber answers or when the incoming operator again enters the circuit.

The clear-back signal is also sent when the called subscriber clears or when the incoming operator, by mistake, clears the connection before the called subscriber has cleared.

The same signal (answer signal or clear-back signal) must not be sent twice in succession.

- c) *Two operators involved in the incoming country.*

These can be:

- an incoming or a delay operator at the international exchange; and
- an operator at a national manual exchange.

- c.1) There is no through-supervision via the operators' positions at the international exchange. The answer and clear-back signals are sent as described in a) above.

- c.2) The international operator's position is normally able to provide through-supervision. There are still two cases to consider:

- c.2.1) If the whole of the national chain, including the operator's positions, gives through-supervision from the called subscriber, the operating conditions can be as described in b) above. An operator intervenes to send an answer signal: her withdrawal causes the sending of a clear-back signal, an answer signal is sent when the called subscriber answers, and a clear-back signal is sent when the called subscriber clears. If an operator clears down the connection in error, before the called party clears, a clear-back signal is sent.

- c.2.2) If the whole of the national chain does not give through-supervision from the called subscriber, supervision is extended from the point at which through-supervision cases.

In a), b) and c) above, it is recommended that the incoming or the delay operator should have facilities to recall the outgoing operator by sending a succession of clear-back and answer signals, by means of a special key, for example.

If *automatic service requirements* necessitate the action described under C below, it will inevitably follow that in *semi-automatic working* correct supervision cannot be given, so that the sequence of answer and clear-back signals described above cannot be guaranteed.

C. *Automatic calls*

When direct access by a subscriber to an operator's position in the incoming country cannot be barred, it is essential, to avoid mistakes in charging, not to give the answer signal at the moment this operator replies. Arrangements must be made to ensure that the answer signal is sent when the called subscriber, or paid special service, answers. The answer signal is sent:

- either by an operator (using a key);
- or automatically, by through-supervision.

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

1.9.1 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).

In automatic working, 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 §§ 4.3.1 and 4.3.2 in Recommendation Q.118 and Recommendation Q.131.

In semi-automatic working there may be forced release in the case of § 4.3.1 of Recommendation Q.118.

1.9.2 At the end of the clear-forward signal, all switching units held on the call must release at the outgoing, incoming and transit international exchanges. (The clear-forward signal must therefore be recognized at an international transit exchange.) Each international circuit, however, is guarded against subsequent seizure until the release-guard signal has been received from the incoming end of the international circuit concerned.

1.9.3 In a transit exchange, the following arrangements must be made on disconnection:

- a) the GO channel must not be split until the clear-forward signal has completely ceased;
- b) the RETURN channel must be split as soon as possible after recognition of the clear-forward signal;
- c) a clear-forward signal received at the moment a call is established, but before speech conditions have been set up, must be repeated over the outgoing circuit that has been seized.

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, to indicate that the latter has been fully effective in bringing about the release of the switching equipment at the incoming end of an international circuit. 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.

1.11 blocking signal (sent in the backward direction)

This signal is sent, when required, to the outgoing end of the circuit to cause engaged conditions to be applied to the outgoing end of the international circuit.

The design of the signalling equipment at the outgoing end of international circuits should be such that the receipt of a blocking signal over a free circuit will cause that circuit to be engaged to operators or automatic equipment which would otherwise have access to it.

1.12 forward-transfer signal (sent in 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 operator⁵⁾ into the circuit if the call is automatically set up at that exchange. When a call is completed via an operator (incoming operator or, delay operator) at the incoming international exchange, the signal will cause this operator to be recalled.

1.13 *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 Part I.

Tables of Annex 2 to Part II give a description of the operations corresponding to the various normal and abnormal conditions which may arise in setting up a call.

⁵⁾ See the definition of assistance operator in § 1.1.6 of Recommendation Q.101.

CHAPTER II

SIGNAL CODE

Recommendation Q.121

2. SIGNAL CODE

2.1 General

The signals of System No. 4 are:

- signal called "line signals" for the so-called supervisory functions;
- signals (binary code signals and their acknowledgement signals) used for the transmission of numerical information.

2.2 Transit working

In transit operation, the line equipment at the transit exchange shall record that the condition is transit; this will facilitate, in particular, the parallel reception of the clear-forward signal at the transit and incoming international exchanges. (See Recommendation Q.120, item 1.9).

2.3 Line signals

2.3.1 Line signal code

The line signal code is given in Table 1.

The use of two frequencies in this code makes it possible to form a characteristic *compound signal*, in which both frequencies are transmitted simultaneously and which can be used as a preparatory signal element (called a *prefix*) to the control signal element (called a *suffix*) having a single frequency.

The compound signal prefix element is much less likely to be imitated by speech currents than a single-frequency element of the same duration and serves to prepare a switching circuit for the reception of the suffix element which follows. The prefix signal element also serves to bring about the splitting of the line at the receiving end to prevent the remaining part of the signal from passing out of the section in which it is intended to be operative.

2.3.2 Sending duration of line signal elements

The elements of each of the voice-frequency line signals shown in Table 1 have a duration of:

P	150 ± 30 ms
X and Y	100 ± 20 ms
XX and YY	350 ± 70 ms.

TABLE 1

Code for Signalling System No. 4

The symbols used in Table 1 have the following significance:

Prefix signal element	P	prefix signal constituted by two frequencies <i>x</i> and <i>y</i> compounded
Control signal elements or "suffixes"	X	short signal element of the single frequency <i>x</i>
	Y	short signal element of the single frequency <i>y</i>
	XX	long signal element of the single frequency <i>x</i>
	YY	long signal element of the single frequency <i>y</i>

List No.	Name of signal	Code
(See Rec. Q.120)	FORWARD SIGNALS	
1	a) Terminal seizing – <i>Prise terminale</i>	PX
3	b) Transit seizing – <i>Prise pour transit international</i>	PY
4	Numerical signals – <i>Signaux de numérotation</i>	} Binary code (see Table 2)
9	End-of-pulsing signal – <i>Signal de fin de numérotation</i>	
12	Clear-forward – <i>Signal de fin</i>	
	Forward transfer – <i>Signal d'intervention</i>	
	BACKWARD SIGNALS	
2	Proceed-to-send <i>Invitation à transmettre</i> } a) Terminal – <i>Terminale</i>	X
	b) International transit – <i>de transit international</i>	Y
5	Number-received – <i>Numéro reçu</i>	P
6	Busy-flash – <i>Occupation</i>	PX
7	Answer – <i>Réponse</i>	PY
8	Clear-back – <i>Raccrochage du demandé</i>	PX
10	Release-guard – <i>Libération de garde</i>	PYY
11	Blocking ^{a)} – <i>Blocage</i>	PX
–	(Unblocking) (<i>Déblocage</i>) = use of signal 10 of the list	PYY

- a) In addition to the blocking which results from the reception of a blocking signal at the outgoing end of a circuit, the outgoing equipment should be such that a *temporary* condition of "circuit busied" should result at the outgoing end on receiving, on a free circuit, one or other of the frequencies *x* or *y* or both these frequencies. This condition should be maintained for as long as the frequency or frequencies are received. The maintenance instructions given to the maintenance staff stipulate that such an occupation of a circuit should be as short as possible and in any case less than 5 minutes.

(The durations of the signal elements P, X and Y, XX and YY are multiples of 50 ms with a tolerance of ± 10 ms.)

Once the sending of a signal has begun it must be sent completely. If two signals have to be sent one immediately after the other in the same direction, a silent interval must separate the two successive signals. The duration of this interval must not be less than 100 milliseconds but it must not be so long as to cause an unreasonable delay in signalling.

This 100 ms interval must also occur between the sending of a numerical signal including the acknowledgement signal and a subsequent line signal.

Sending of the proceed-to-send or busy-flash signal by an incoming or transit exchange should not take place until 50 ms after the end of the receipt of the corresponding seizing signal. Such a delay will normally result from the operation of equipment (operating times of relays, time of hunting for register).

On sending, there will be no intentional interval of silence between the prefix element and the suffix element of a signal but where such an interval exists its duration at the sending end must not exceed 5 ms.

It can happen, when sending the P prefix element, that the two frequencies will not be sent simultaneously. The interval of time between the instants when each of the two frequencies is sent must not, in this case, exceed 1 ms. In the same way, if the suffix element does not immediately follow the prefix but is separated from it by an interval of silence as explained in the paragraph above, the interval of time between the two instants when the sending of each of the two frequencies ceases shall not exceed 1 ms.

2.3.3 Recognition time¹⁾ of line-signal elements at the receiving end

At the output of the signal receiver, the duration of the direct current signal elements produced by the line signals is determined in terms of the sending duration of the voice-frequency signal elements and the distortion due to the line and to the signal receiver.

This overall distortion due to the line and the signal receiver is taken to be 10 ms maximum for a prefix-element and 15 ms for a suffix-signal element. (The distortion of the suffix-signal element may be greater than that of the prefix-signal element, because it depends not only on the distortion of the pulse consisting of a single frequency which is sent as a suffix element, but also on the moment when the other frequency used for the prefix element ceases.)

The incoming switching equipment must recognize a signal only after a certain time, called the recognition time, from the beginning of the receipt of the direct current signal, so that risk of recognizing false signals is reduced and so that signals of different length can be distinguished.

The recognition times of the line signal elements are:

P: 80 + 20 ms
X e Y: 40 + 10 ms
XX e YY: 200 + 40 ms.

The incoming switching equipment shall be able to recognize a signal correctly when the prefix and the suffix of this signal are separated by an interval of silence of 15 ms or less.

2.4 Numerical signals

2.4.1 Binary numerical signal code

The numerical signal code is given in Table 2. This code is a binary code of four elements each separated from the next by a short interval of silence *s*; each element consists of the sending of one or other of the signalling frequencies.

The symbols used in Table 2 and in Figure 2/Q.121 have the following significance:

x short element of the single frequency *x*
y short element of the single frequency *y*.

TABLE 2
Binary Code of System No. 4

Signal	Combination				
	Number	Elements			
		1	2	3	4
Digit 1	1	y	y	y	x
" 2	2	y	y	x	y
" 3	3	y	y	x	x
" 4	4	y	x	y	y
" 5	5	y	x	y	x
" 6	6	y	x	x	y
" 7	7	y	x	x	x
" 8	8	x	y	y	y
" 9	9	x	y	y	x
" 0	10	x	y	x	y
Call operator code 11	11	x	y	x	x
Call operator code 12	12	x	x	y	y
Space code (except case envisaged under 1.4.2.3 of Q.104)	13	x	x	y	x
Incoming half-echo suppressor required ^{a)}	14	x	x	x	y
End-of-pulsing	15	x	x	x	x
Space code	16	y	y	y	y

The relation between the transmitted digits and the different combinations of the binary code is arrived at by giving the value 8, 4, 2 or 1 to the presence of an element *x* depending on whether this element *x* constitutes the 1st, 2nd, 3rd or 4th element of the numerical code.

a) Signal code 14 is available for use upon multi-lateral or bilateral agreement for echo suppressor control (see Recommendations Q.107 and Q.115).

¹⁾ See definition of recognition time in § 2.5 hereafter.

2.4.2 *Sending duration of the signal elements x and y*

The sending duration of the signal elements x and y to line, as voice-frequency signals, shall be:

$$35 \pm 7 \text{ ms.}$$

The sending duration of the interval of silence s between signal elements of the same digit shall have the same value of $35 \pm 7 \text{ ms.}$

(The maximum duration of the signal elements and intervals of silence is not a critical factor in the design of the system but is specified in order that the speed of signalling is not unduly slow.)

2.4.3 *Recognition time²⁾ of the x , y and s elements at the receiving end*

The recognition time by the incoming switching equipment:

- a) of the direct current signal elements x and y ;
- b) of intervals of silence s ;

received from the output of the signal receiver is: $10 \pm 5 \text{ ms.}$

2.4.4 *Acknowledgement signals*

Incoming international and international transit exchanges shall return an acknowledgement signal to the outgoing international exchange *at the end of the reception* of the 4th element of a numerical signal.

At the outgoing international exchange a numerical signal will be sent only if a signal is received from the incoming and acknowledging the receipt of the preceding numerical signal. However, to avoid this procedure delaying the transmission of numerical signals the sending of numerical signals may begin *as soon as the acknowledgement signal is recognized*.

Two types of acknowledgement signals are provided, one constituted by the signal element x defined above and the other constituted by the signal element y defined above.

The acknowledgement signal x has two meanings:

- after a terminal proceed-to-send signal has been received by the outgoing register: "digit received; send next digit";
- after a transit proceed-to-send signal, but before a terminal proceed-to-send signal has been received: "digit received; stop the sending of digits".

The acknowledgement signal y has one meaning only, i.e. after a transit proceed-to-send signal has been received: "digit received; send next digit".

2.5 *Signalling timing diagrams*

Figures 1/Q.121 and 2/Q.121 give diagrams showing for line signal elements (Figure 1) and for numerical signal elements x and y (Figure 2):

- a) the sending duration (transmission at voice-frequency over the line);
- b) the received duration (direct current signals at the signal receiver output);
- c) the safety margins that allow for equipment not being in adjustment, etc.;
- d) the recognition time of the receiving switching equipment; this time assumes an operating margin is defined between a lower limit t and an upper limit T . The switching equipment must *not* recognize a signal element *before* t but must *certainly* have recognized it *at the end of time* T .

2.6 *General note on the operation of signalling and switching equipment*

The tolerances defined in §§ 2.3 and 2.4 concerning the sending duration of signal and their recognition times at the receiving end must be strictly observed in all circumstances and especially under all conditions of battery voltage variation likely to arise in working conditions.

²⁾ See definition of recognition time in § 2.5 d) above.