INTERNATIONAL TELECOMMUNICATION UNION

CCITT

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

YELLOW BOOK

VOLUME VI - FASCICLE VI.2

SPECIFICATIONS OF SIGNALLING SYSTEMS Nos. 4 AND 5

RECOMMENDATIONS Q.120-Q.180

VIITH PLENARY ASSEMBLY
GENEVA, 10-21 NOVEMBER 1980

Geneva 1981

INTERNATIONAL TELECOMMUNICATION UNION

CCITT

THE INTERNATIONAL
TELEGRAPH AND TELEPHONE
CONSULTATIVE COMMITTEE

YELLOW BOOK

VOLUME VI - FASCICLE VI.2

SPECIFICATIONS OF SIGNALLING SYSTEMS Nos. 4 AND 5

RECOMMENDATIONS Q.120-Q.180

VIIᵀᴴ PLENARY ASSEMBLY
GENEVA, 10-21 NOVEMBER 1980

Geneva 1981

ISBN 92-61-01061-X

CONTENTS OF THE CCITT BOOK
APPLICABLE AFTER THE SEVENTH PLENARY ASSEMBLY (1980)

YELLOW BOOK

---

[1] "Telematic services" is used provisionally.

Volume V – Telephone transmission quality. Series P Recommendations (Study Group XII).

Volume VI

FASCICLE VI.1 – General Recommendations on telephone switching and signalling. Interface with the maritime service. Recommendations Q.1 - Q.118 *bis* (Study Group XI).

FASCICLE VI.2 – Specifications of signalling systems Nos. 4 and 5. Recommendations Q.120 - Q.180 (Study Group XI).

FASCICLE VI.3 – Specifications of signalling system No. 6. Recommendations Q.251 - Q.300 (Study Group XI).

FASCICLE VI.4 – Specifications of signalling systems R1 and R2. Recommendations Q.310 - Q.480 (Study Group XI).

FASCICLE VI.5 – Digital transit exchanges for national and international applications. Interworking of signalling systems. Recommendations Q.501 - Q.685 (Study Group XI).

FASCICLE VI.6 – Specifications of signalling system No. 7. Recommendations Q.701 - Q.741 (Study Group XI).

FASCICLE VI.7 – Functional Specification and Description Language (SDL). Man-machine language (MML). Recommendations Z.101 - Z.104 and Z.311 - Z.341 (Study Group XI).

FASCICLE VI.8 – CCITT high level language (CHILL). Recommendation Z.200 (Study Group XI).

Volume VII

FASCICLE VII.1 – Telegraph transmission and switching. Series R, U Recommendations (Study Group IX).

FASCICLE VII.2 – Telegraph and "telematic services"[1] terminal equipment. Series S, T Recommendations (Study Group VIII).

Volume VIII

FASCICLE VIII.1 – Data communication over the telephone network. Series V Recommendations (Study Group XVII).

FASCICLE VIII.2 – Data communication networks; services and facilities, terminal equipment and interfaces. Recommendations X.1 - X.29 (Study Group VII).

FASCICLE VIII.3 – Data communication networks; transmission, signalling and switching, network aspects, maintenance, administrative arrangements. Recommendations X.40 - X.180 (Study Group VII).

Volume IX – Protection against interference. Series K Recommendations (Study Group V). Protection of cable sheaths and poles. Series L Recommendations (Study Group VI).

Volume X

FASCICLE X.1 – Terms and definitions.

FASCICLE X.2 – Index of the Yellow Book.

---

1) "Telematic services" is used provisionally.

CONTENTS OF FASCICLE VI.2 OF THE YELLOW BOOK

Part I – Series Q Recommendations

Specifications of Signalling System No. 4

Part II – Series Q Recommendations

Specifications of Signalling System No. 5

Part III – Series Q Recommendations

Interworking of Signalling Systems No. 4 and No. 5

REMARKS

1 The Questions entrusted to each Study Group for the Study Period 1981-1984 can be found in Contribution No. 1 to the Study Group.

2 The strict observance of the specifications for standardized international signalling and switching equipment is of the utmost importance in the manufacture and operation of the equipment. Hence these specifications are obligatory except where it is explicitly stipulated to the contrary.

The values given in Fascicles VI.1 to VI.6 are imperative and must be met under normal service conditions.

3 For reasons of economy the Recommendations in this Fascicle have been reproduced without modification from the text of the *Green Book*, with the exception of Recommendations Q.126, Q.155 and Q.161 which have been deleted and Recommendations Q.141 and Q.180 which have been slightly modified. Therefore, when reference is made to Recommendations not contained in this Fascicle, the *Green Book* or later CCITT Books should be consulted.

CCITT NOTE

In this Fascicle, the expression "Administration" is used for shortness to indicate both a telecommunication Administration and a recognized private operating agency.

PART I

Recommendations Q.120 to Q.139

SPECIFICATIONS OF SIGNALLING SYSTEM No. 4

PAGE INTENTIONALLY LEFT BLANK

PAGE LAISSEE EN BLANC INTENTIONNELLEMENT

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 digit [1] (or the descriminating digit) [1] plus the national (significant) number [1] ;

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 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) number [1] have been received [2]:

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) number [1] 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.

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

2) 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.

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 call [1].

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 "called 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 answers 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.

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.

---

[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.

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 operators' 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 ceases.

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 paragraph 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 paragraph 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 operator[1)] 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 IX. Tables of Annex 2 to Part IX give a description of the operations corresponding to the various normal and abnormal conditions which may arise in setting up a call.

---

1) See the definition of assistance operator in paragraph 1.1.6 of Recommendation Q.101.

PAGE INTENTIONALLY LEFT BLANK

PAGE LAISSEE EN BLANC INTENTIONNELLEMENT

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 *x* and *y* compounded
Control signal elements or "suffixes"	X	short signal element of the single frequency *x*
	Y	short signal element of the single frequency *y*
	XX	long signal element of the single frequency *x*
	YY	long signal element of the single frequency *y*

List No.	Name of signal	Code
(See Rec. Q.120)	FORWARD SIGNALS	
1	a) Terminal seizing – *Prise terminale*	**PX**
	b) Transit seizing – *Prise pour transit international*	**PY**
3	Numerical signals – *Signaux de numérotation*	Binary code (see Table 2)
4	End-of-pulsing signal – *Signal de fin de numérotation*	Binary code (see Table 2)
9	Clear-forward – *Signal de fin*	**PXX**
12	Forward transfer – *Signal d'intervention*	**PYY**
	BACKWARD SIGNALS	
2	Proceed-to-send *Invitation à transmettre*: a) Terminal – *Terminale*	**X**
	Proceed-to-send *Invitation à transmettre*: b) International transit – *de transit international*	**Y**
5	Number-received – *Numéro reçu*	**P**
6	Busy-flash – *Occupation*	**PX**
7	Answer – *Réponse*	**PY**
8	Clear-back – *Raccrochage du demandé*	**PX**
10	Release-guard – *Libération de garde*	**PYY**
11	Blocking[a] – *Blocage*	**PX**
–	(Unblocking) *(Déblocage)* = 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 time [1] 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 signallinf 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 paragraph 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 ± 7 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 time*[1] *of the* x, y *and* s *elements at the receiving end*

The recognition time by the incoming switching equipment:

a) of the directcurrent signal elements x and y;

b) of intervals of silence s;

received from the output of the signal receiver is: 10 ± 5 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 end acknowledging the receipt of the preceding numerical signal However, to avoid this procedure delaying the transmission of numerical signals the sending of mumerical 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 digity".

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 Sections 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.

[1] See definition of recognition time in paragraph 2.5 d) above.

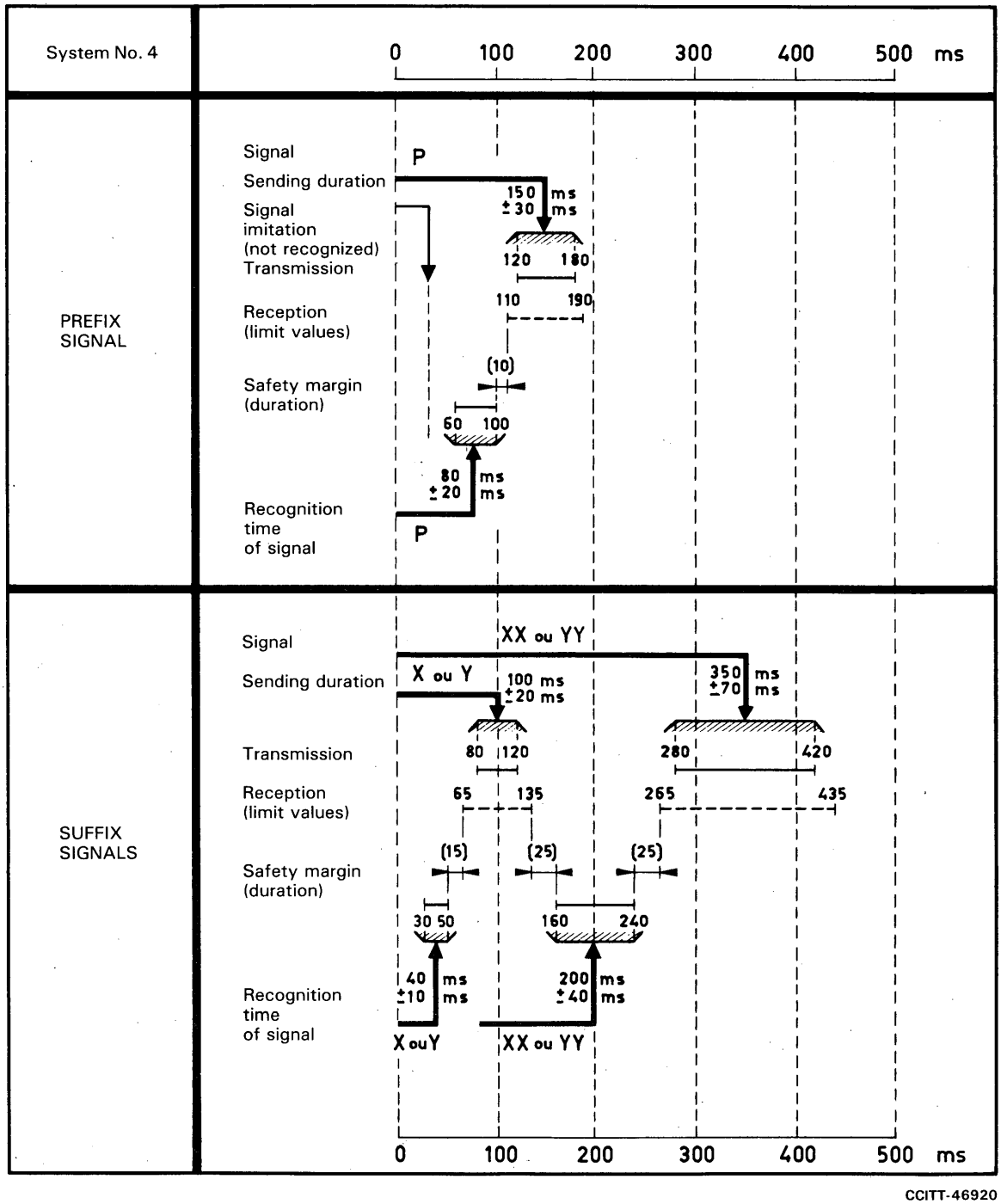


FIGURE 1/Q.121

Duration of Line Signal Elements

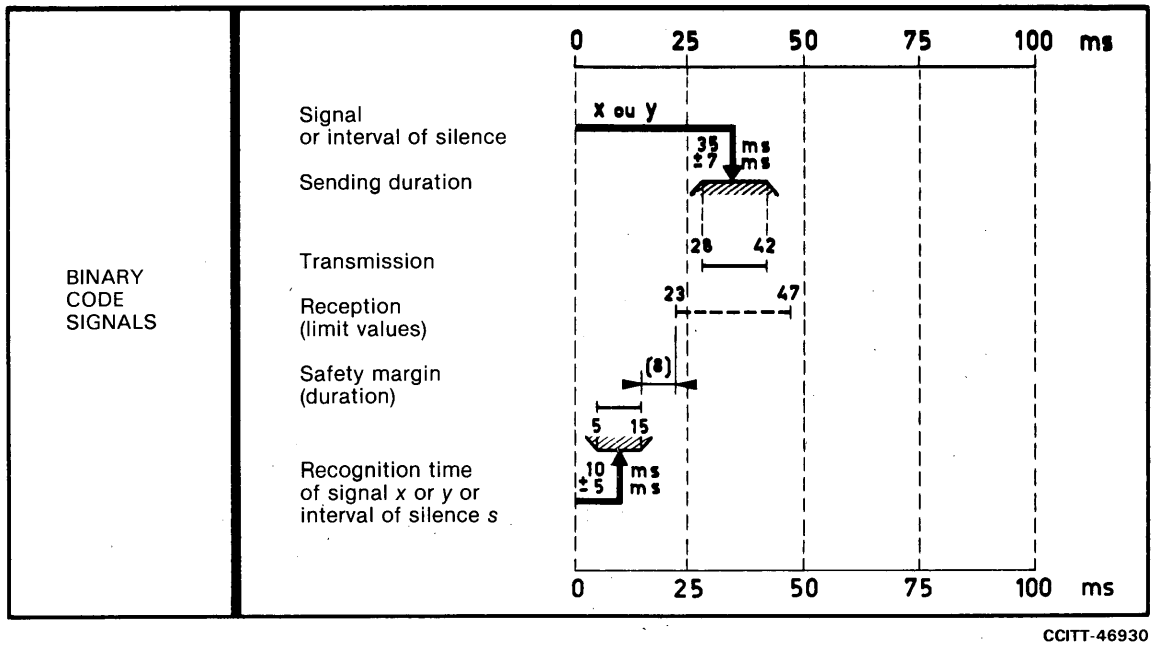


FIGURE 2/Q.121

Numerical Signal Elements

Legend to Figures 1 and 2/Q.121

Signalling timing diagrams

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

- the sending duration (transmission at voice-frequency over the line);
- the received duration (direct current signals at the signal receiver output);
- the safety margins that allow for equipment not being in adjustment, etc.;
- the recognition time (which assumes an operating margin) of the receiving switching equipment; this 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.

CHAPTER III

SIGNAL SENDER AND SIGNAL RECEIVER

Recommendation Q.122

3.1 SIGNAL SENDER [1]

3.1.1 *Signalling frequencies*

The signalling frequencies shall be:

2040 ± 6 Hz ("*x*" frequency); and
2400 ± 6 Hz ("*y*" frequency),

these frequencies being applied separately or in combination.

3.1.2 *Absolute power level transmitted*

The absolute power level of the unmodulated signal frequencies at a zero relative level point shall be −9 dBm with a tolerance of ± 1 dB.

These levels also apply to each signal frequency in a signal element made up of a combination of the two frequencies (compound signal element) but the two signalling frequencies making up such a signal must not differ in level by more than 0.5 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 which might be transmitted to line, for example when static modulators are used for signal transmission, should be at least 50 dB below signal level per frequency.

Recommendation Q.123

3.2 SIGNAL RECEIVER [1]

3.2.1 *Operating limits of the signal receiver*

The signal receiver shall operate in the conditions specified under 3.2.5 to received signals that meet the following three conditions.

a) The signal frequencies shall be within the following limits:

"*x*" frequency: 2040 ± 15 Hz
"*y*" frequency: 2400 ± 15 Hz.

b) The absolute power level N of each unmodulated received signal frequency shall be within the limits:

$$-18 + n \leqslant N \leqslant n \text{ dBm};$$

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

---

[1] See also Recommendation Q.112.

These limits give a margin[1] of ± 9 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 may differ from each other, but the received level of the 2400 Hz signal shall not be more than 3 dB above, nor more than 6 dB below the received level of the 2040 Hz signal.

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

3.2.2 *Non-operate conditions for the signal receiver*

a) *Selectivity*

The signal receiver shall not operate to a signal having an absolute power level at the receiving end within the limits specified in paragraph 3.2.1 when the frequency differs by more than 150 Hz from the nominal value of 2040 Hz or of 2400 Hz.

b) *Maximum sensitivity of the receiver*

The signal receiver shall not operate to a signal of 2040 ± 15 Hz or 2400 ± 15 Hz whose absolute power level at the point of connection of the receiver is $(-26 - 9 + n)$ dBm, n being the relative power level at this point.

This limit is 26 decibels below the nominal absolute level of the signal current at the input to the signal receiver.

3.2.3 *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.

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 simultaneous operation of the receiver relays for each of the two signalling frequencies lasting more than 55 ms (the minimum recognition time of a compound signal element is 60 ms);

b) the number of false splits of the speech path caused by speech currents should not cause an appreciable reduction in transmission quality of the circuit.

3.2.4 *Guard circuit limits*

A. – *Steady noise*

Considering:

a) that when there is noise on a 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 during end-to-end signalling over a multilink chain of System No. 4 circuits;

it is recommended that, for either one or two signalling currents (each being within the limits of the level specified in paragraph 3.2.1) the signal receiver should satisfy the conditions indicated in paragraph 3.2.5 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.

[1] See 2.1.2 of Recommendation Q.112.

B. – *Surges*

A guard circuit with an excessive hangover 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 paragraph 3.2.1, the lengths of the received signals must remain within the limits specified in paragraph 3.2.5.

3.2.5 *Distortion of received signals*

When the signal frequencies and levels are within the limits specified in paragraph 2.3.1, the following conditions should be met:

1. a) the delay in the start of a received pulse consisting of one of the two signalling frequencies should be less than 20 ms;

   b) the delay in reproducing the beginning of a signal consisting of a combination of the two frequencies x and y (compound signal) should be less than 20 ms; this delay is defined as the interval between the moment when the beginning of the compound signal arrives at the signal receiver input and the moment of beginning the reproduction of the two frequencies x and y as a direct current signal output of the signal receiver;

2. the change of signal length in the presence of the noise defined in paragraph 2.3.4 should be less than:

   a) 5 ms when the signal receiver receives an *isolated pulse at one frequency only*, with a minimum duration of 25 ms;

   b) 8 ms when the signal receiver receives a *compound pulse* of the two frequencies with a minimum duration of 50 ms; this change is defined as the difference between the simultaneous reception of the two received frequencies at the input to the receiver and the simultaneous reproduction of the two components as a direct current signal at the output of the signal receiver;

   c) 6 ms when the signal receiver receives a pulse of current of a *single frequency* with a minimum duration of 80 ms, *preceded by a compound signal element* (separated or not by an interval of silence of 5 ms maximum). Consequently the change in the duration of a signal suffix[1], measured from the moment when the prefix ends to the moment when the suffix ends, and taking account of the change in the duration of the prefix signal mentioned under b, will be less than $6 + 8 = 14$ ms.

[1] See the definition of prefix and suffix signals under paragraph 2.3.1 of Recommendation Q.121.

PAGE INTENTIONALLY LEFT BLANK

PAGE LAISSEE EN BLANC INTENTIONNELLEMENT

CHAPTER IV

SWITCHING CONDITIONS

Recommendation Q.124

4.1 SPLITTING ARRANGEMENTS [1)]

Sending line split

4.1.1 According to Recommendation Q.25, Section 2, sending split arrangements have to be provided.

4.1.2 The exchange side of the international circuit shall be disconnected 30 to 50 ms before a voice-frequency signal is sent over the circuit.

4.1.3 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.

Receiving line split

4.1.4 The international circuit should be split (completely cut) at outgoing and incoming international exchanges when a compound signal is received, to ensure that no fraction of the combination of the two frequencies exceeding 55 ms duration may pass out of the international circuit.

The splitting time of 55 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.

4.1.5 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.

For the correct operation of the splitting device, it is necessary to take into account the delay in the reproduction of the compound signal caused by the signal receiver for which the conditions are as described in Recommendation Q.123, 3.2.5.1 b).

4.1.6 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.

---

1) See Recommendation Q.25

Recommendation Q.125

4.2 SPEED OF SWITCHING IN INTERNATIONAL EXCHANGES

4.2.1 It is recommended that the equipment in international exchanges (terminal or transit) shall have a high switching speed so that the switching time may be as short as possible.

4.2.2 It is also recommended that the incoming register at the incoming international exchange should begin to set up the national part of the connection as soon as the register has received a sufficient number of digits and without waiting to receive the complete number of the called subscriber.

4.2.3 At the outgoing international exchange:

- with semi-automatic operation it may be desirable for the outgoing register to start sending numerical signals to line without waiting to receive all the digits of the called subscriber's number. However, this may depend on national conditions.
- with automatic operation, it is evident that the sending of numerical signals must begin without waiting for the receipt of all the digits of the called subscriber's number because the outgoing register will not generally know how many digits there are going to be.

4.2.4 At international exchanges, use may be made of the advantages of continuous hunting (of circuits or common equipment), i.e. economy in the number of outgoing circuits to be provided or improvement in the quality of service for a given number of circuits. However, at incoming and transit exchanges, the return of a busy-flash signal must take place within the following delay times, specified in particular so that the release conditions of registers can be laid down.:

- a maximum delay of 5 seconds following recognition of a seizing signal at an incoming or transit exchange if a free register and/or link circuit is not found;
- a maximum delay of 10 seconds following receipt, at an incoming exchange, of the information necessary for determining the required route, if congestion is encountered;
- a maximum delay of 10 seconds following receipt of the digits necessary to determine the routing at a transit exchange, if congestion is encountered.

Recommendation Q.126

4.3 ANALYSIS AND TRANSFER OF DIGITAL INFORMATION

(see Recommendation Q.107 *bis* in Fascicle VI.1)

Recommendation Q.127

4.4 RELEASE OF REGISTERS

4.4.1 *Outgoing register*

4.4.1 (1) *Normal release conditions*

The outgoing register shall release in either of the following two cases:

Case 1 – The register has sent forward all the numerical signals *and* has received a local sending-finished signal from the outgoing operator indicating that there are no more digits to follow.

Case 2 – The register has received:

- either a number-received signal from the incoming international exchange indicating that all the digits comprising the complete national number have been received;
- or a busy-flash signal (this assumes that a busy-flash signal does not initiate re-routing).[1)]

4.4.1 (2) *Abnormal release conditions*

Arrangements should be made at the outgoing exchange for the possibility of releasing the outgoing register when any one of the following conditions arises:

1. With semi-automatic operation if, after a delay of 10 to 20 seconds from the seizure of the register or the receipt of the last digit, no further digit or local sending-finished signal is received.

---

1) See definition of "re-routing" in Recommendation E.170 (Q.12).

2. With automatic operation if, after a delay of 15 to 30 seconds from the seizure of the register or the receipt of the last digit, the register is in one of the following conditions:

   - seized, but no further digit received from the calling subscriber;
   - not all the digits necessary to determine the routing received;
   - correct number of digits to determine the routing received, but no further digit from the calling subscriber;
   - no busy-flash or a number received signal has been received although the complete national (significant) number or part of it has been sent.

In the first two cases, a shorter delay may nevertheless be adopted by certain Administrations.

In the last two cases, release of the outgoing register is made to accompany release of the international circuit by sending the clear-forward signal.

The method of indicating the above abnormal conditions to the calling subscriber will depend on the practice followed in the various countries: a tone may be sent or, better, a recorded announcement will ask the caller to recommence his call after having checked the number to be dialled. (See also Recommendations Q.116 and Q.118).

The delay of 15 to 30 seconds provided for in the above conditions is considered sufficient to cover the maximum period for receiving a number-received signal under the most unfavourable conditions.

b) Numerical information received for which no routing has been provided.

c) Proceed-to-send signal or busy-flash signal not received within:

   - 10 to 30 seconds following the sending of a seizing signal;
   - 15 to 30 seconds following the sending to a transit centre of the digits necessary to determine the routing.

d) An acknowledgement signal not received within 5 to 10 seconds following the sending of a digit.

e) More than the appropriate number of transit proceed-to-send signals is received (see, Recommendation Q.112, 2.1.2., for the maximum number of circuits switched in tandem).

In the various cases mentioned above, an appropriate indication should be given to the operator or calling subscriber.

4.4.2 *Transit register*

4.4.2 (1) *Normal release conditions*

The transit register shall release as soon as it has selected an outgoing circuit and sent forward a seizing signal on the circuit.

However, a different procedure may be used, in which release of the register is delayed until either a proceed-to-send signal or a busy-flash signal is received from the next exchange. It may be judged more convenient to make use of the transit register when it is desired to give an alarm to show that a proceed-to-send signal has not been received. In this case, the circuit should be switched to the speech condition in both directions of transmission immediately following the operations mentioned above so as to allow the proceed-to-send signal and the following numerical signals to pass through the transit exchange.

If there is outgoing congestion from the transit exchange, the register will release after it has returned a busy-flash signal, and made connection to a recorded announcement.

4.4.2 (2) *Abnormal release conditions*

The transit register will release *without returning any signal* under either of the following conditions:

a) the digits necessary for determining the routing not received within 5 to 10 seconds following the sending of a proceed-to-send signal to the outgoing exchange:

b) numerical information received for which no routing has been provided.

On the other hand, if release of the transit register is deferred until a proceed-to-send signal is received, in accordance with the alternative method mentioned in paragraph 4.4.2 (1), it will release if a proceed-to-send signal or busy-flash signal is not received within 10 to 30 seconds following the sending of a seizing signal to the next exchange.

4.4.3 *Incoming register*

4.4.3 (1) *Normal release conditions*

The incoming register will release when all the numerical information necessary to set up the connection in the incoming country has been sent and after a number-received signal bas been returned over the international circuit. The register will determine when the complete national (significant) number has been received under the conditions defined in Recommendation Q.120, paragraph 1.5.5.

If the incoming register finds that there is congestion within or outgoing from the incoming international exchange, it will release after returning a busy-flash signal.

4.4.3 (2) *Abnormal release conditions*

The incoming register will release if any one of the following three conditions occurs:

a) No further digit is received after a delay of 30 to 60 seconds from receipt of the last digit and it is not possible to determine by one of the methods described in paragraph 1.5 of Recommendation Q.120 that the number which is received is a complete number.

b) No digit is received within 5 to 10 seconds following the return of a proceed-to-send signal.

c) A number is received for which no routing exists, or an incomplete number is received followed by an end-of-pulsing signal (code 15).

In cases a) and b) no signal is returned because the outgoing register remains in circuit and can itself detect any abnormal condition in the establishment of the call.

In case c), before the incoming register releases, a number-received signal will be returned, followed, if possible, by a recorded announcement, a number-unobtainable tone or by the intervention of an interception operator.

Recommendation Q.128

4.5 SWITCHING TO THE SPEECH POSITION

4.5.1 *Outgoing international exchange*

The circuit shall be switched to the speech position when the outgoing register releases (see 4.4.1).

4.5.2 *International transit exchange*

The circuit shall be switched to the speech position immediately the transit register has sent the seizing signal (see 4.4.2).

4.5.3 *Incoming international exchange*

The circuit shall be switched to the speech condition immediately the incoming register:

- has sent back the number-received signal and sent forward the numerical information to the national network equipment;
- or has sent back the busy-flash signal;

or, if these signals are not sent, when the register releases under abnormal conditions (see 4.4.3 (2)).

Recommendation Q.129

4.6 MAXIMUM DURATION OF A BLOCKING SIGNAL

When a blocking signal is sent on a circuit, an alarm should be given at the outgoing end of the circuit if the blocking condition persists for more than about 5 minutes.

4.7 SPECIAL ARRANGEMENTS IN CASE OF FAILURES IN THE SEQUENCE OF SIGNALS

4.7.1 *Blocking an outgoing circuit*

Installations should provide the following facilities for blocking outgoing circuits. These facilities will be used or not according to the maintenance instructions which will be promulgated.

1. If, after sending a seizing signal, a proceed-to-send signal or a busy-flash signal is not received within 10 to 30 seconds, the outgoing circuit should be blocked and an alarm given.[1)]
2. The outgoing circuit should be blocked and an alarm given[1)] if a proceed-to-send signal or a busy-flash signal is not received within 15 to 30 seconds of the sending to a transit exchange of the digits necessary to determine the routing.
3. If, after sending a clear-forward signal, a release-guard signal is not received within 5 to 10 seconds, the outgoing end of the circuit should be blocked and an alarm given.[1)]

At the incoming end of the circuit the clear-forward signal should be recognized at any time even if the circuit is in the idle state; the incoming line circuit must therefore be able to recognize a clear-forward signal and to return a release-guard signal even if the clear-forward signal has not been preceded by a seizing signal.

4.7.2 *Abnormal recognition of a release-guard signal at an international transit exchange*

In the case where a release-guard signal is recognized at an international transit exchange without a clear-forward signal having been recognized, arrangements should be made at the transit exchange to:

- send a blocking signal in the backward direction, to busy the outgoing end of the incoming circuit at the transit exchange;
- immediately release the circuit outgoing from the transit exchange.

This prevents the receipt of the release-guard signal from giving a wrong indication that the circuit to the transit exchange is cleared.

4.8 ABNORMAL RELEASE CONDITIONS OF THE OUTGOING REGISTER CAUSING RELEASE OF THE INTERNATIONAL CIRCUIT

In automatic operation the international circuit should be released when the following abnormal conditions arise:

a) if, after receiving the digits necessary to determine the routing, the outgoing register receives no further digit within a period of 15 to 30 seconds;

b) if no busy-flash or number-received signal is received by the outgoing register within a period of 15 to 30 seconds although the national (significant) number (or part of it) has been sent.

The release of the outgoing register under these abnormal conditions is dealt with in paragraph 4.4.1 (2) of Recommendation Q.127.

[1)] The alarm may be immediate or delayed depending upon the desire of the Administration concerned.

PAGE INTENTIONALLY LEFT BLANK

PAGE LAISSEE EN BLANC INTENTIONNELLEMENT

CHAPTER V

TESTING ARRANGEMENTS[1)]

Recommendation Q.133

5.1 NUMBERING FOR ACCESS TO AUTOMATIC MEASURING AND TESTING DEVICES

5.1.1 Automatic measuring and testing devices situated in the I.T.M.C.s and the I.S.M.C.s of other countries will be obtainable from the access point defined in Recommendation Q.75 by means of the following digit sequences:

a) terminal seizing signal;
b) code 13 replacing the language digit;
c) code 12;
d) digit 0;
e) two digits which will be associated with the type of testing or measuring device required;
f) end-of-pulsing signal (code 15).

Note – The allocation of the digits in e) above will enable access to be given to a number of different types of measuring or testing equipment. Combination 51 to combination 59 are allocated to automatic transmission measuring devices standardized by the C.C.I.T.T. for A.T.M.E. No. 1. Combination 00 is used for access to the automatic testing device specified in Recommendation Q.137. Combination 61 to 63 are allocated to the automatic transmission measuring and signalling testing equipment No. 2.[1)]

Recommendation Q.134

5.2 ROUTINE TESTING OF EQUIPMENT (LOCAL MAINTENANCE)

5.2.1 Routine testers for testing individual items of equipment such as circuit equipment, connecting circuits, operator's line calling equipment, selectors, registers, etc., must be provided in every international exchange equipped for automatic switching. These routine testers will be provided in accordance with the practice followed in each country for the local maintenance of the switching equipment.

5.2.2 The testing equipment must conform to the following principles:

a) An item of equipment must not be taken for test until it is free; a signal will show the exchange staff that a piece of apparatus has not been taken for test because it was engaged on a call; it will then be possible to test this piece of apparatus later;

b) An item of equipment taken for test will be marked engaged for the duration of the test. When an incoming circuit equipment is taken for test, a blocking signal will be sent to the outgoing exchange (see Recommendation Q.129).

---

1) See A.T.M.E. No. 2 specification in Recommendation Q.49 (O.22).

5.2.3 Testing of the circuit and signalling equipment should include a check that the specifications of System No. 4 are met in regard to the following:

Signalling frequencies;
Transmitted signal levels;
Signal frequency leak;
Receiver operate and non-operate limits;
Receiving-end line split;
Sending-end line split;
Line signal codes;
Sending duration of line signal elements;
Recognition time of line signal elements;
Sending duration of numerical signal elements;
Recognition time of numerical signal elements;
Time-out and alarm features.

Recommendation Q.135

5.3 PRINCIPLES OF RAPID TRANSMISSION TESTING EQUIPMENT

Rapid transmission tests can be made by two methods:

a) The first method consists of a loop measurement of the GO and RETURN paths of an international circuit, these paths being looped at the incoming end of a circuit when it is free.

b) The second method consists of sending a special code on the international circuit to be tested so as to obtain access to an automatic testing equipment in the incoming exchange.

The first method requires that the incoming end of all circuits should be equipped as described later in Recommendation Q.136.

The second method assumes the existence of rapid transmission testing equipment in all exchanges between which this method is used. This testing equipment must be designed in accordance with Recommendation Q.137.

Note – The first method provides overall testing on the GO and RETURN paths without being able to differentiate between the conditions of each of the two directions of transmission. The second method enables separate transmission tests in the two directions. (A situation can occur, however, when it is not possible to determine whether a transmission fault is on the GO path or on the RETURN path of the circuit.) Since the second method requires that for access to the incoming testing apparatus signals must be passed over the circuit, there is some check of good signalling conditions.

Recommendation Q.136

5.4 LOOP TRANSMISSION MEASUREMENTS

A permanent loop will be connected between the GO and RETURN paths of an international circuit at is incoming end when the circuit is free, so that transmission tests can be made independently of the signalling conditions.

The loop between the GO and RETURN paths shall be connected in such a manner that the level diagrams of each of the two paths will be respected when the circuit is free (loop established); the loop may therefore include an attenuation pad of the required value.

The loop at the incoming end of the international circuit should be disconnected when a seizing signal is received. The loop must be disconnected within 35 ms so as to ensure that the part of a seizing signal which passes round the loop and which is returned to the outgoing end cannot be recognized as a signal.

5.5 AUTOMATIC TESTING EQUIPMENT

The second method for rapid transmission tests consists of extending international circuit, by means of a special code, to an automatic testing equipment at the incoming exchange. For this method, there must be incoming testing equipment at the incoming international exchange and outgoing testing equipment at the outgoing international exchange. This equipment should be designed in accordance with the following conditions.:

5.5.1 *Incoming testing equipment*

(1) Connection to incoming testing equipment:

The incoming testing equipment will normally be connected in the four-wire part of the circuit.

Access to this equipment from an outgoing international exchange will be obtained by sending successively on the international circuit, according to Recommendation Q.133:

a) terminal seizing signal;
b) code 13 replacing the language digit;
c) code 12;
d) three digits 000, the last two being the combination for access to the automatic testing equipment;
e) end-of-pulsing signal (code 15).

If the incoming testing equipment is free, the answer signal will be sent 800 to 1200 ms after it is connected.

If the incoming testing apparatus is occupied, a busy-flash signal will be returned.

(2) Measuring condition:

When the answer signal has been sent, the incoming testing equipment will pass to the measuring condition, in which the level of the test signal by the outgoing testing apparatus will be measured. The passage to the measuring condition will be effected after a period of 600 to 900 ms calculated from the moment when the testing equipment prompts the sending of the answer signal. This delay is necessary to ensure that the noise which may be produced at the moment of the passage of the circuit to the speech conditions will not influence the measuring arrangement.

The measurement of the received signal will be made with an accuracy of ± 1 dB.

To provide time for the test signal to become stabilized, there should be a delay of 100 to 150 ms after the operation of the detector circuit, before indications on the level of the test signal are given.

The incoming testing equipment will determine whether the level of the test signal is within the prescribed limits; these limits will be predetermined by an adjustement of the equipment to specified values. These limits will provisionally be ± 4 dB with respect to the nominal level at which the test tone should be received.

(3) Passage to the sending condition:

If the received test signal is within the prescribed limits (deviation of ± 4 dB from the nominal value) the incoming testing equipment will send a test signal on the RETURN path of the circuit.

This test signal will have a frequency of 800 Hz which is the same as the test frequency sent on the GO path of the circuit by the outgoing testing equipment. The frequency sent should be controlled within ± 3 %. The test signal sent by the incoming testing equipment will give a power of 1 milliwatt at a zero relative level point of the circuit. The sending level must be maintained to ± 0.5 dB.

If, due to the non-reception of a clear-forward signal, the test signal is transmitted for a period of 1 to 2 minutes, the incoming testing equipment will stop transmitting this test signal and a clear-back signal will be sent. The release of the incoming testing equipment will then be carried out in accordance with the provisions of Recommendation Q.118, paragraph 4.3.3.

(4) Indication of unsatisfactory transmission on the GO path of the circuit:

If the level of the received test signal is outside the prescribed limits or if the incoming testing equipment does not receive the test signal, a clear-back signal will be returned to the outgoing end. This clear-back signal will be sent 5 seconds after passing to the measuring position and will indicate to the testing officer at the outgoing exchange that the transmission quality of the GO path of the circuit is not up to standard.

5.5.2 *Outgoing testing equipment*

(1) Connection to the outgoing testing equipment:

The outgoing testing equipment will be designed to automatically send the numerical information mentioned under (1) in paragraph 5.5.1 above.

(2) Sending condition:

The receipt of an answer signal sent by the incoming testing equipment will cause the sending of the test signal by the outgoing testing equipment. This test signal will be sent for a period of 500 to 800 ms. To allow the incoming testing equipment to pass into the measuring condition, this test signal should not be sent immediately after the answer signal but should be delayed for a period of at least 700 ms.

The test signal will be sent automatically or under the control of the officer making the tests. If the test signal is sent automatically, the delay in sending the test signal following the end of the receipt of the answer signal should be between 700 and 900 ms. If the test signal is sent under the control of the operator, the latter should operate quickly, because the clear-back signal can be returned by the incoming testing apparatus after a delay of 5 seconds.

The frequency of the test signal will be 800 Hz ± 3%.

The level of the sent test signal will be adjusted to give a power of 1 milliwatt at a zero relative level point of the circuit. The sent level will be accurate to ± 0.5 dB.

(3) Passage to the measuring condition:

As soon as the outgoing testing equipment has sent the test signal, it will pass automatically from the sending condition to the measuring condition. In this condition, the level measuring equipment will measure the level of the test signal received from the incoming end. The operator or the automatic device at the outgoing end will check that the level of the received signal is within the prescribed limits.

Recommendation Q.138

5.6 INSTRUMENTS FOR CHECKING EQUIPMENT AND MEASURING SIGNALS

5.6.1 *General*

For local checks of correct equipment operation and for readjusting the equipment, international exchanges should have available instruments of the following two types:

a) calibrated signal generator;
b) signal measuring apparatus.

These instruments should have the following characteristics:

5.6.2 *Calibrated signal generator*

Duration of sent signals to be adjustable between the extreme limits given in the equipment specifications, i.e. 3 to 500 ms.

The accuracy required in the duration of sent signals should be the higher of the following two values:

± 1 ms or ± 1% of the nominal value of the sent signal.

Frequency:

The sent frequency shall not differ by more than ± 5 Hz from the nominal value and shall not vary during the time required for testing.

Level of the sent signals to be variable between the extreme limits given in the equipment specifications and able to be set to a particular fixed value equal to the nominal value as defined in these specifications.

Tolerances on the reading of the level of the sent signalling frequencies to be ± 0.2 dB.

5.6.3 *Signal-measuring equipment*

Duration of signals to be measured to be between the extreme limits given in the equipment specifications, i.e. 3 to 500 ms.

The accuracy required in the duration of the measured signals should be the higher of the following two values:

± 1 ms or ± 1% of the nominal value of the received signal.

Signal frequency to be measured to be between the extreme limits set by the specifications, the reading being made with an accuracy of ± 1 Hz.

Level of the signalling frequencies to be measured to be adjustable between the extreme limits set by the specifications, the reading being made with an accuracy of ± 0.2 dB.

5.7 MANUAL TESTING

5.7.1 *Functional testing of signalling arrangements*

Functional tests from one end of the circuit to the other can be made in the following three ways:

a) The first method consists of a rapid verification of satisfactory signal transmission by ensuring that a seizing signal is followed by the return of a proceed-to-send signal, that a clear-forward signal is followed by the return of a release-guard signal and that the circuit is clear.

b) The second method consists of verification of satisfactory signal transmission by initiating a test call:

   1) to technical personnel at the distant-end international exchange; or
   2) to a test call signal testing and answering device, if such equipment is available at the distant-end international exchange.

c) The third method will consist of complete verification of satisfactory line and register signal transmission. The verification consists of a check of ability to:

   1) generate and receive line and register signals;
   2) transmit the appropriate acknowledgement signals;
   3) complete terminal and transit calls.[1)]

5.7.2 *First method: rapid test*

1. Verification of satisfactory signal transmission:

   a) Initiate a seizing signal and verify the receipt and recognition of the proceed-to-send signal from the distant end;
   b) Initiate a clear-forward signal and verify the receipt and recognition of the release-guard signal from the distant end.

2. In the event of a failure appropriate steps should be taken to locate and correct the trouble.

3. The above tests are short, simple, and should be performed at least monthly from each end of the circuit as appropriate. This minimum periodicity should be increased to as often as daily if the incidence of trouble encountered is unsatisfactory.

5.7.3 *Second method: test calls*

1. Verification of satisfactory transmission of signals involved in completion of test calls (manual method):

   a) Place a call to the technical personnel at the distant international exchange.
   b) On completion of connection:
      1. the audible ringing tone should be heard;
      2. the answer signal should be received when the call is answered at the distant end.
   c) Request distant end to initiate a clear-back signal, followed by an answer signal.
   d) A clear-back signal should be received and recognized when the distant end hangs up and a second answer signal should be received and recognized when the distant end re-answers the call.
   e) Initiate a forward-transfer signal which should result in bringing in the assistance operator at the distant end.
   f) Terminate the call and observe that the circuit restores to the idle condition.

2. Verification of satisfactory transmission of signals involved in completion of test calls (semi-automatic method).

If test call signal testing and answering devices are available at the distant international exchange, the signal verification test should be made using this equipment to the extent that the applicable features indicated in 1. above are available.

3. The tests should be made monthly when the manual testing methods prescribed in paragraph 5.7.3.1 are used.

They may be made daily when semi-automatic test arrangements are available.

---

1) Transit test calls are not intended to check the performance or the quality of the circuit beyond the transit exchange, this being entirely the responsibility of the Administration concerned. However, it is important that in principle the transit operations can be checked.

5.7.4 *Third method: comprehensive tests; terminal and transit calls*

1. Verification of satisfactory signal transmission (frequency, level, duration, etc.) involved in terminal and transit calls.

   a) These tests are made in conjunction with:
      - verification and location of faults;
      - ensuring that new circuits are satisfactory in operation before being brought into service.

   b) When establishing new circuits all of the tests outlined in Section 5.2.3 should have been completed at both terminals.

2. *Terminal calls*

Initiate a call to the distant end test centre. Coordinate this test with the distant end so that appropriate test equipment is connected prior to establishing the call. The tests shall proceed as follows:

a) at the originating end, check that a terminal seizing signal is followed by the receipt of a terminal proceed-to-send signal from the distant end;

b) at the distant end check that the individual signal elements are correctly received and that each digit is acknowledged correctly;

c) at the originating end check that the number received signal is received;

d) check that the audible ringing tone is heard at the originating end;

e) at the distant end initiate an answer signal;

f) at the originating end check that the answer signal is received and recognized;

g) at the distant end initiate a clear-back signal;

h) at the originating end check that the clear-back signal is received and recognized;

i) at the originating end initiate a forward-transfer signal;

j) at the distant end check the receipt of the forward-transfer signal;

k) at the distant end arrange to transmit a succession of clear-back and answer signals; first at a slow rate, then at a rate which is faster than the system is capable of following;

l) at the originating end check during the slow transmission of the switch-hook flashes that each clear-back and answer signal is received and properly recognized. Verify that after the transmission of the fast switch-hook flashes the equipment indicates the final position of the switch-hook;

m) at the originating end initiate the release of the circuit;

n) at the distant end check that the clear-forward signal is received and recognized and that the circuit releases;

o) at the originating end check that the release-guard signal is received and recognized and that the circuit releases;

p) at the originating end set up a call to a busy line or to a test call device which provokes the return of a busy-flash signal and check that the busy-flash signal is received and recognized;

q) at the originating end, after receipt of the busy-flash signal, initiate a release of the connection and check that the equipment releases correctly;

r) at the distant end, after sending the busy-flash signal, check that the clear-forward signal releases the equipment;

s) at the distant end initiate the transmission of a blocking signal;

t) at the originating end check that the blocking signal busies the circuit;

u) at the distant end initiate the transmission of an unblocking signal;

v) at the originating end check that the unblocking signal restores the circuit to normal;

w) at the distant end connect in turn a continuous x tone, a continuous y tone, a continuous $x + y$ tone, with the circuit in the idle state in each case;

x) at the originating end, check that the receipt of a continuous x tone, or a continuous y tone, or a continuous $x + y$ tone busies the circuit;

y) at the originating end, check that the clear-forward signal sent to the incoming equipment in the idle condition results in the return of the release-guard signal and that the equipment restores to the idle condition;

z) at the originating end, check the presence of a transmission test loop with the circuit in an idle condition and then check that within 35 ms of receipt of a seizure signal, the loop is removed.

3. *Transit calls* (System No. 4 to System No. 4)

After securing the cooperation of a third international centre to act as a terminal centre, initiate a transit call to this centre through the international centre, covered in 2. above, which thus becomes the transit centre. Check the following sequence:

a) at the originating end check that a transit seizure signal is followed by the receipt of a transit proceed-to-send signal from the transit centre;

b) at the transit centre check that the necessary routing digits are received and acknowledged correctly and that a circuit to the terminal centre is selected;

c) at the originating centre check that a terminal proceed-to-send signal is received and that the correct digital information is sent to the terminal centre;

d) with the assistance of technical personnel at the terminal centre, check that the number received, answer, clear-back, forward-transfer, busy-flash, clear-forward and release-guard are correctly interpreted.

PAGE INTENTIONALLY LEFT BLANK

PAGE LAISSEE EN BLANC INTENTIONNELLEMENT

ANNEXES TO SIGNALLING SYSTEM No. 4
SPECIFICATIONS

ANNEX 1

Signalling sequences

Table 1 – Signalling sequences in terminal traffic

Table 2 – Signalling sequences in transit traffic

In these tables the arrows have the following meanings:

——▶ transmission of a signalling frequency (permanent or pulse emission).

- - - - -▶ end of transmission of the signalling frequency in the case of its permanent transmission.

·····▶ transmission of an audible tone.

ANNEX 2

Descriptions of the operations corresponding to the various normal and abnormal conditions which may arise in setting up a call

Table 1 – Outgoing exchange – Normal conditions

Table 2 – Outgoing exchange – Abnormal conditions

Table 3 – Incoming exchange – Normal conditions

Table 4 – Incoming exchange – Abnormal conditions

Table 5 – Transit exchange – Normal conditions

Table 6 – Transit exchange – Abnormal conditions

ANNEX 1

(to the specifications of System No. 4)

TABLE 1

Semi-automatic (SA) and automatic (A) terminal traffic

Outgoing international exchange		Incoming international exchange
CALL TO A FREE SUBSCRIBER		
Terminal seizing signal is sent forward.	PX →	The receipt of this signal causes an incoming terminal register to be connected and when this is ready to receive the digital information a proceed-to-send (terminal) signal is returned.
The receipt of a proceed-to-send signal causes the whole of the digital information to be sent forward SA: Language digit, national (significant) number of the called party followed by the end-of-pulsing signal. A: Discriminating digit, national (significant) number of the called party.	← X	
	Binary code →	The digital information is received in the incoming register. This register then controls the setting up of the connection within the incoming country to the called party or, on code 11 or code 12 calls in semi-automatic operations, routes the call to an operator.
	x = acknowledgement of the reception of a digit	A number-received signal is returned as soon as the incoming register has determined that it has received a complete number.
The register will then release and establish the speech path at the outgoing end of the circuit: SA: after an end-of-pulsing signal is sent	←	As soon as the register has sent forward all the information received, it releases and establishes speech conditions at the incoming end of the circuit.
A: after the receipt of the number-received signal	← P	
SA: an indication is given to the operator that the international selection operations have been accomplished.		
The operator (SA) or the calling subscriber (A) } hears the ringing tone	←	The called subscriber, found free, is rung. The ringing tone of the incoming country is sent back.
SA: An answer supervisory signal is given to the controlling operator. A: The charging of the subscriber and the measurement of call duration start.	← PY	*Called party answers;* answer signal is returned.
SA: A clearing supervisory signal is given to the controlling operator. A: After 1-2 min. in the absence of a clear-forward signal, the international connection will be released, the charging of the subscriber and the measurement of call duration will be ceased.	← PX	*Called party clears;* clear-back signal is returned.

ANNEX 1

TABLE 1 *(continued)*

Outgoing international exchange		Incoming international exchange
SA: An answer supervisory signal is given to the controlling operator. A: The measuring of the delay of 1-2 min. will be ceased.	← PY	*Called party re-answers;* answer signal is returned.
SA: Controlling operator clears down the connection. A: The calling subscriber clears: Clear-forward signal is sent.	PXX →	
This signal removes the guard from the outgoing end and frees the circuit for further traffic.	← PYY	Releases the connection at the incoming exchange and when release is fully effective a release-guard signal is returned.

CALL TO A BUSY SUBSCRIBER (OR CONGESTION)

The succession of signals is the same as for a call to a free subscriber up to the point of sending the number-received signal.

SA: An indication can be given to the outgoing operator that the international selection operations have been completed.	← P	Transmission of the number-received signal and establishment of speech conditions at the incoming end.
		1st case
		The national network of the incoming country can give the busy-flash signal.
SA: A "busy" indication is given to the outgoing operator.	← PX	The national busy-flash signal is detected by the international incoming equipment. The busy-flash signal is sent back.
The operator hears the busy tone. The outgoing operator releases the connection (see above).	◄	The busy tone of the incoming country if present is sent back.
A: The international connection will be released automatically. The calling subscriber hears the busy tone from the (national or international) outgoing exchange.		*2nd case*
		The national network of the incoming country cannot give the busy-flash signal.
The operator and/or the calling subscriber hears the busy tone, and releases the connection (see above).	◄	The busy tone of the incoming country is sent back.

ANNEX 1

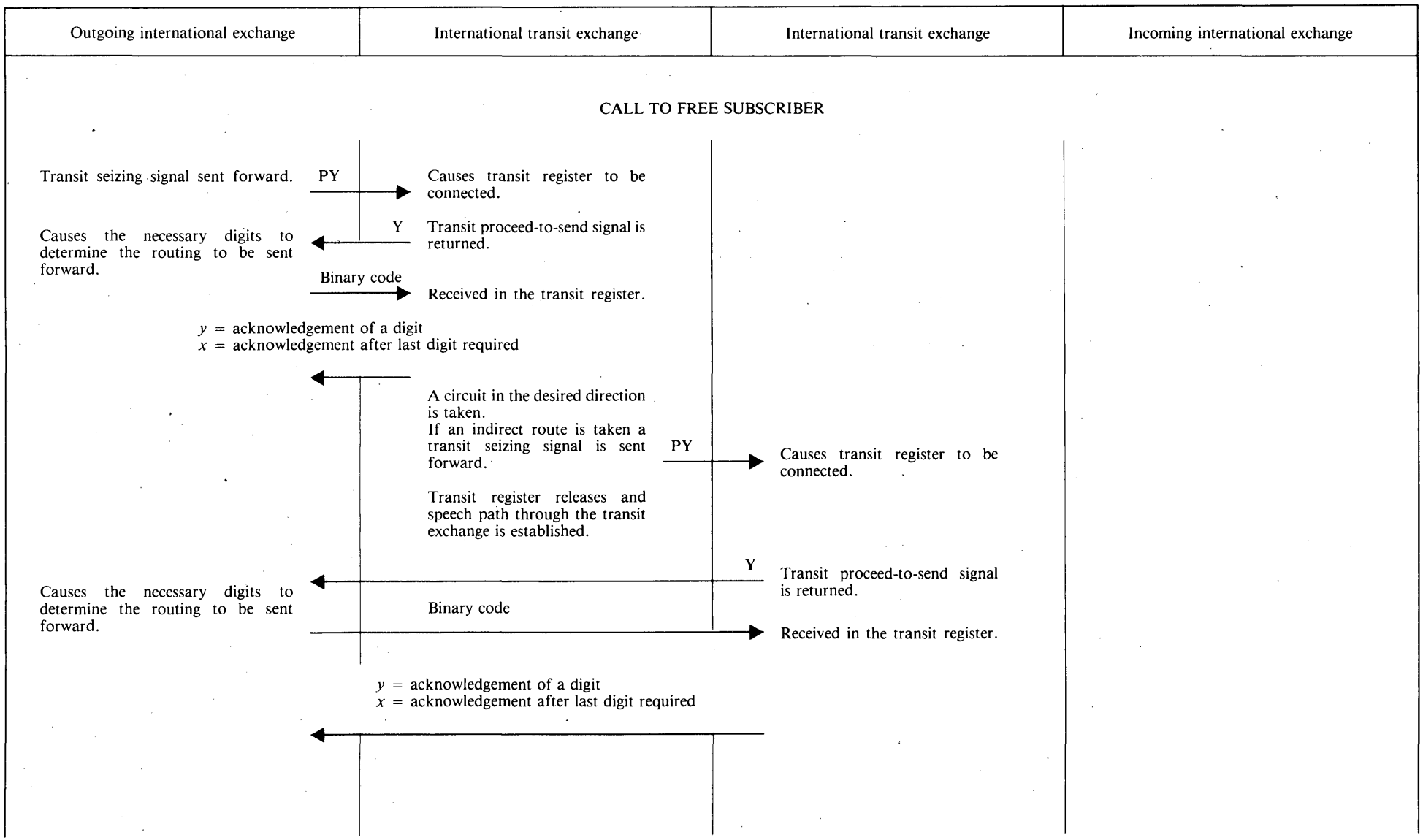
TABLE 1 *(concluded)*

Outgoing international exchange		Incoming international exchange
SPECIAL CONDITIONS		
SA: Following a call switched automatically to a subscriber, the controlling operator wishes to bring about the intervention of an assistance operator at the incoming international terminal exchange; a forward-transfer signal is sent.	PYY →	Causes an assistance operator to intervene at the incoming terminal exchange on an established connection completed automatically.
SA: Following a call via code 11 or code 12, the controlling operator wishes to recall the incoming operator at the incoming international terminal exchange; a forward-transfer signal is sent.	PYY →	Recalls the incoming operator on calls completed via an operator at this exchange.
This signal causes a guarding condition to be applied to block further traffic.	← PX (or continuous frequency)	Engineering personnel wish to busy the international circuit at the outgoing end; a blocking signal is sent.
Guarding condition removed on cessation of continuous frequency.	← – – – – – – – – – – – – – –	Following the continuous frequency, the guarding condition is removed when this signal is disconnected.
This signal removes the guarding condition at the outgoing end.	← PYY	Following the PX-signal, a release guard signal is sent when the blocking condition is disconnected at the incoming end.

ANNEX 1

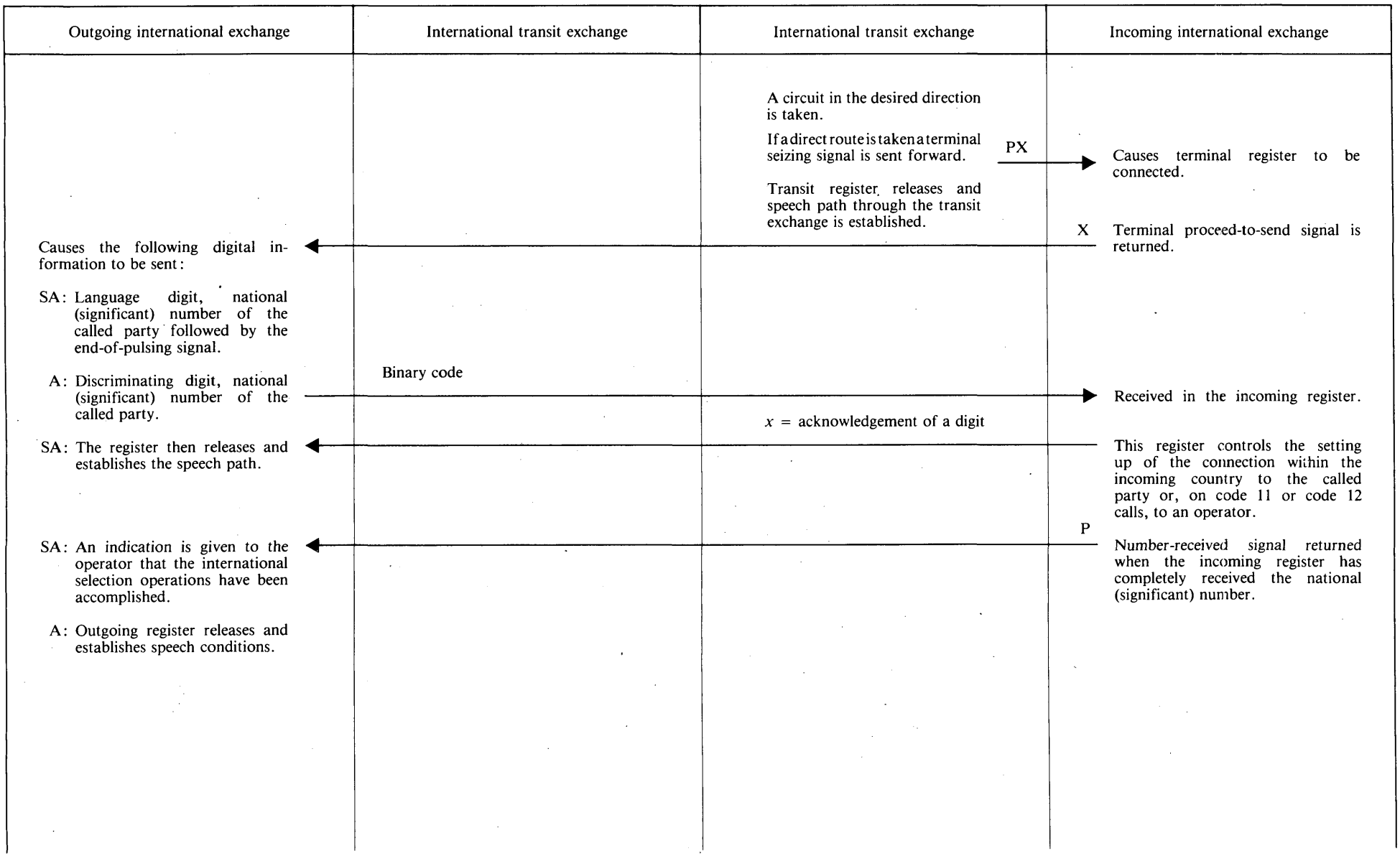
TABLE 2

Semi-automatic (SA) and automatic (A) transit traffic



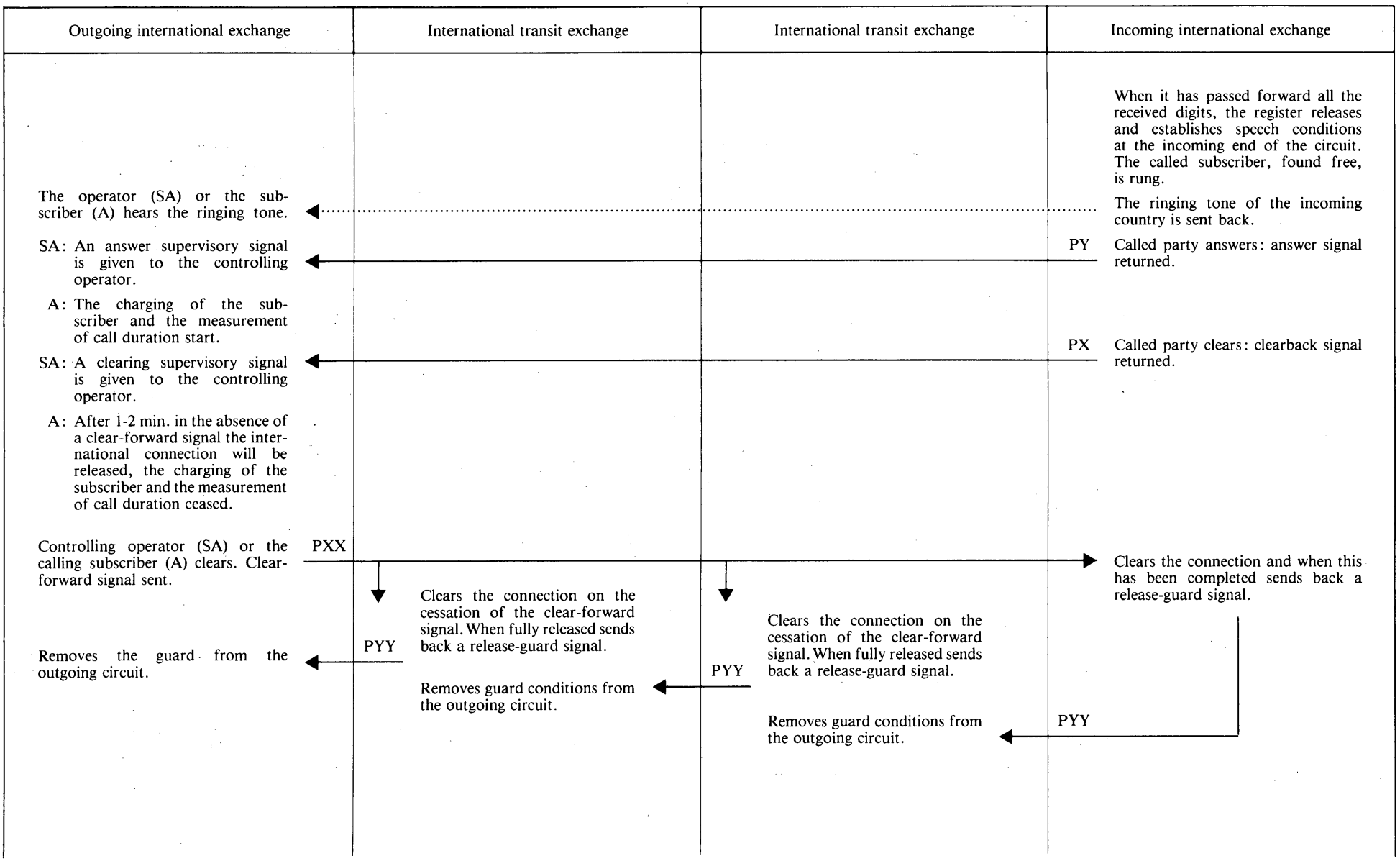
ANNEX 1

TABLE 2 *(continued)*



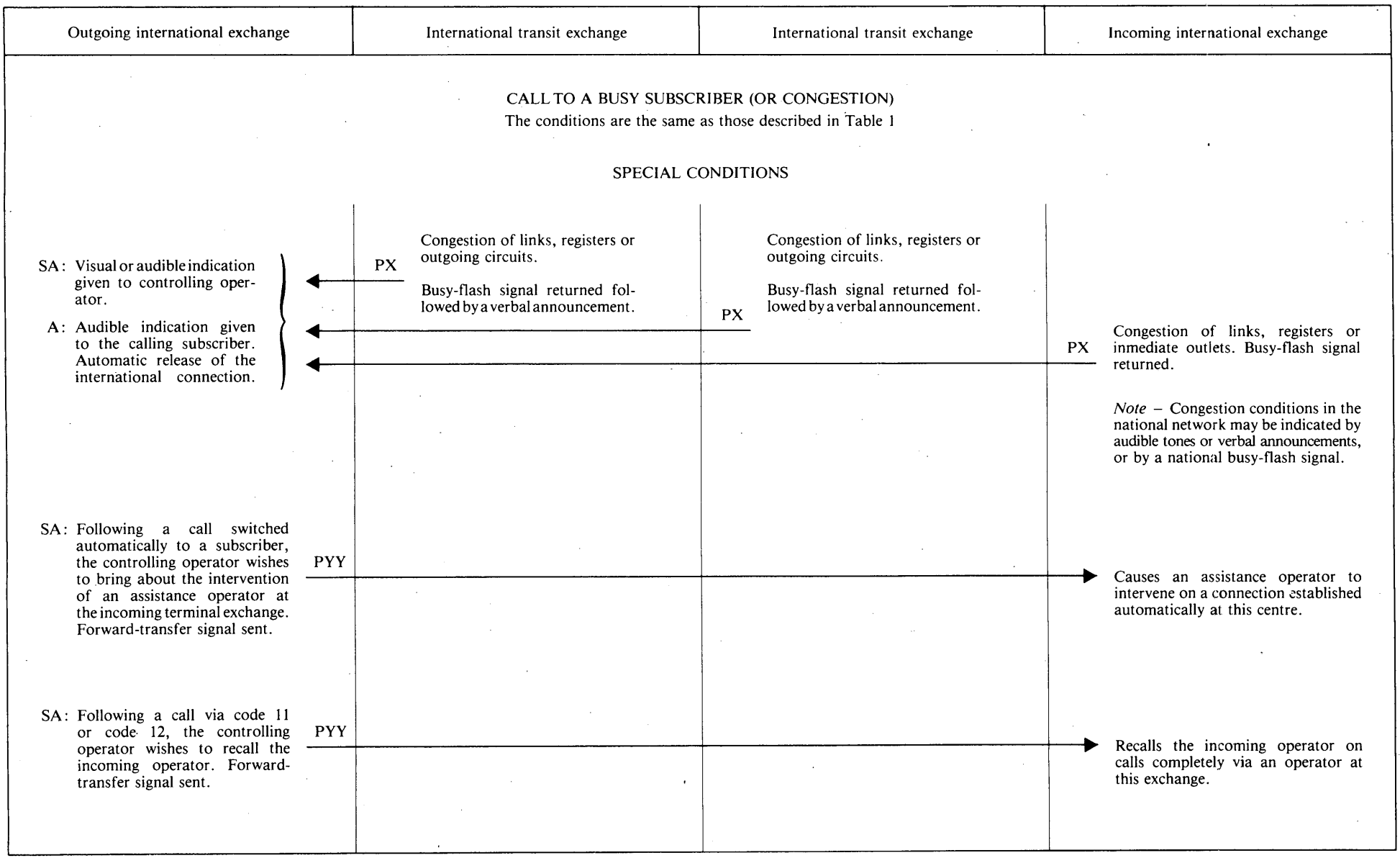
ANNEX 1

TABLE 2 *(continued)*



ANNEX 1

TABLE 2 *(concluded)*



ANNEX 2

TABLE 1

Outgoing exchange – Abnormal conditions

<table>
<tr><td colspan="2" rowspan="3">Conditions</td><td rowspan="3">Subscriber free</td><td colspan="2">Subscriber busy or national congestion</td><td rowspan="3">Congestion outgoing from the incoming exchange</td><td colspan="3">Congestion of common equipment at the exchange</td><td rowspan="3">Congestion outgoing from the transit exchange[a]</td></tr>
<tr><td colspan="2">The busy-flash signal</td><td colspan="2">Incoming exchange</td><td rowspan="2">1st transit exchange</td></tr>
<tr><td>is not provided</td><td>is provided</td><td>Terminal traffic</td><td>Transit traffic</td></tr>
<tr><td rowspan="5">Operations effected</td><td rowspan="2">Release of register</td><td colspan="3">SA – after sending code 15</td><td>SA – after sending code 15 or after reception of busy-flash signal</td><td colspan="2" rowspan="2">After reception of busy-flash signal</td><td rowspan="2">After reception of busy-flash signal[b]</td></tr>
<tr><td colspan="2">A – after reception of number-received signal</td><td colspan="2">A – after reception of number-received or busy-flash signal</td></tr>
<tr><td>Speech position</td><td colspan="3">After release of register</td><td colspan="4">SA – after release of register</td></tr>
<tr><td>Action on the international circuit</td><td colspan="3"></td><td colspan="3">A – Release of the circuit after reception of busy-flash signal</td><td>Possibly automatic re-routing</td></tr>
<tr><td>SA – Local signals given to the operator[c]</td><td colspan="2">End of international selection operations</td><td>End of selections, then busy</td><td colspan="3">Busy</td><td>Busy or re-routing</td></tr>
<tr><td></td><td>A – Transmission of an appropriate indication to the calling subscriber</td><td colspan="3"></td><td colspan="4">Busy tone</td><td>Busy tone (possibly[b])</td></tr>
<tr><td rowspan="2">Information received from the international circuit</td><td>Signals received</td><td colspan="2">Number received</td><td>Busy-flash preceded or not by number-received</td><td>Terminal proceed-to-send, then:</td><td></td><td>Transit proceed-to-send, then:</td><td></td><td>Terminal proceed-to-send, then:</td></tr>
<tr><td>Audible indication received</td><td>Ringing tone</td><td colspan="2">Busy tone</td><td colspan="4">Busy-flash signal</td><td>Name of transit exchange</td></tr>
<tr><td colspan="2">References</td><td colspan="2">1.5
4.4.1 (1)</td><td colspan="5">1.6
4.4.1 (1)</td><td>Q.12, Q.119;
1.6
4.4.1 (1)</td></tr>
</table>

SA – Semi-automatic service
A – Automatic service. } When there is no specific indication, the clause is applicable to both services.

a) Similarly for congestion of the common equipment of a 2nd or subsequent transit exchange.

b) Not applicable if automatic re-routing is provided.

c) The indications to be given to operators in situations quoted on this line will be determined by each Administration, as this question is purely national matter.

ANNEX 2

TABLE 2

Outgoing exchange – Abnormal conditions

Conditions		The outgoing register receives no more digits	Registration of unused numerical information	Non-receipt of a backward signal after sending the seizing signal	Non-receipt of an acknowledgement signal after sending a digit	The outgoing register not having dectected an abnormality, the incoming register receives:		Non-receipt of a backward signal after sending the routing-digits to a transit exchange	Receipt of too many transit proceed-to-send signals
						an incomplete number followed by code 15 (SA)	a non-existing national number (SA and A)		
Operations effected	Release of register	SA 10-20 seconds, A 15-30 seconds after seizure or the receipt of the last digit	Immediately the anomaly is recognized	10-30 seconds after sending the seizing signal	5-10 seconds after sending the digit	After sending code 15 (SA) of after receipt of the number-received signal (A)		15-30 seconds after sending the required digits	After receipt of the third signal
	Speech position					After release of the register			
	Action on the international circuit	A – Release (if a circuit has been seized)		Possible blocking of the circuit				Possible blocking of the circuit	
	SA – Local signals given to the operator[a]	Faulty call	Wrong number	Fault	Fault	End of international selection operations		Fault	Busy
	A – Indication given to the subscriber	Appropriate audible indication							
Information received from the international circuit	Signals received					Number received			
	Tone received					If possible, national number-unobtainable tone, or verbal announcement			
References		4.4.1 (2) a	4.4.1 (2) b	4.7.1 4.4.1 (2) c	4.4.1 (2) d	4.4.3 (2) c		4.7.1 4.4.1 (2) c	4.4.1 (2) e

a) The indications to be given to operators in situations quoted on this line will be determined by each Administration as this question is a purely national matter.

ANNEX 2

TABLE 3

Incoming exchange – Normal conditions

Conditions / Operations effected	Called subscriber free	Subscriber busy or national congestion		Congestion immediately outgoing from the incoming exchange	Congestion of common equipment at the incoming exchange
		The incoming exchange cannot recognize the busy condition	The incoming exchange can recognize the busy condition		
Release of register	After sending the number-received back and sending the numerical information to the national network equipment			After sending the busy-flash signal	
Speech position				After sending the busy-flash signal	
Sending of number-received signal	After recognition of the complete national number			After recognition of the complete national number as the case may be	
Sending of busy-flash signal			After sending number-received signal	0-10 seconds after receipt of the information necessary for determining the route	0-5 seconds after receipt of the seizing signal
Sending of an audible indication	National ringing tone	National busy tone	National busy tone		
References	1.5 4.4.3 (1)	1.5 1.6b	1.5 1.6b	1.6b 4.2.4, 4.4.3 (1)	4.2.4

ANNNEX 2

TABLE 4

Incoming exchange – Abnormal conditions

Conditions / Operations effected	Non-receipt of first digit	Break in the receipt of digits	Receipt of an unused number	Receipt of an incomplete number followed by code 15
Release of register	5-10 seconds after sending the proceed-to-send signal	30-60 seconds after receipt of the last digit	After sending the number-received signal	
Speech position	After release of the register			
Sending of number-received signal			After recognition of the anomaly	
Sending of national number-unobtainable tone or a verbal announcement			If possible (after sending number-received signal)	
References	4.4.3 (2) b	4.4.3 (2) a	4.4.3 (2) c	

ANNEX 2

TABLE 5

Transit exchange – Normal conditions

Conditions / Operations effected	Successful attempt (so far as transit exchange is concerned)	Congestion on switches or on international circuits outgoing from the transit exchange	Congestion on common equipment at the transit exchange
Release of register	After sending seizing signal or after receipt of proceed-to-send signal or busy-flash signal	After sending busy-flash signal	
Speech position	After sending the seizing signal	After sending busy-flash signal	
Sending of busy-flash signal		0-10 seconds after receipt of the digits necessary to determine the routing	0-5 seconds after receipt of the seizing signal
Sending of a recorded announcement (name of transit exchange)		After sending the busy-flash signal	
References	4.4.2 (1)	1.6.a 4.2.4, 4.4.2 (1), Q.118	1.6.a 4.2.4, Q.118

ANNEX 2

TABLE 6

Transit exchange – Abnormal conditions

Conditions / Operations effected	Non-receipt of the digits necessary to determine the routing	Receipt of an unused numerical information	Non-receipt of a proceed-to-send or a busy-flash signal
Release of register	5-10 seconds after sending the proceed-to-send signal	After recognition of the anomaly	10-30 seconds after sending the seizing signal, if the register is still connected
Speech position			After sending the seizing signal
Action on the outgoing international circuit			Possible blocking of the outgoing circuit
References	4.4.2 (2) a	4.4.2 (2) b	4.4.2 (2) 4.7.1 (1)

PART II

Recommendations Q.140 to Q.164

SPECIFICATIONS OF SIGNALLING SYSTEM No. 5

PAGE INTENTIONALLY LEFT BLANK

PAGE LAISSEE EN BLANC INTENTIONNELLEMENT

SIGNALLING SYSTEM No. 5

INTRODUCTION

PRINCIPLES OF No. 5 SIGNALLING SYSTEM

General

System No. 5 is compatible with both TASI[1] 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 compelled[2] 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 this Volume.

[2] See for this term Recommendation Q.141, section 2.1.6

Except for the answer signal, all the compelled signals are normal compelled[1] type. For reasons of fast speed, the answer signal is overlap-compelled[1] 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 bloc[2] 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 sending[2] 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 signalling[2] 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.

---

[1] See for these terms Recommendation Q.141, section 2.1.7.

[2] See for these terms footnote to Recommendation Q.151, section 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 signals 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 exemple, 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 call.[1)]

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, paragraphs 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 operator[1] 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 Part II.

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 Part II.

---

[1] See the definition of assistance operator in paragraph 1.1.6 of Recommendation Q.101.

PAGE INTENTIONALLY LEFT BLANK

PAGE LAISSEE EN BLANC INTENTIONNELLEMENT

CHAPTER II

LINE SIGNALLING

Recommendation Q.141

2.1 SIGNAL CODE FOR LINE SIGNALLING

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.

c) Once the sending of a signal (pulse or compelled) has begun it should be completed (but see paragraph 2.1.1 in regard to the clear-forward signal releasing the circuit at any stage and paragraph 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 seize, busy-flash, answer, clear-back or clear-forward signal persist beyond a maximum of 10 to 20 seconds, the signal shall be terminated.

Note – 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 nay proceed-to-send, release-guard or other acknowledgement signal persist beyond a maximum of 4 to 9 seconds, the signal shall be terminated.

Note – 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.

iii) Upon the occurrence of a time-out under the above two conditions, the attention of the maintenance personnel should be drawn to the fact that time-out has occurred.[1)]

iv) Upon the occurrence of a time-out, the circuit should automatically be removed from service. 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.[1)]

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 agains 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.

[1)] An Administration may decide that on the time-out of an acknowledgement signal at the incoming end of the connection, when an automatic repeat attempt is provided, no indication is given to the maintenance personnel, neither is the circuit take out of service.

2.1.5 *Line signal code of system No. 5*

The line signal code is given in Table 1.

TABLE 1

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.

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[1)] (see section 2.1.7 with respect to the transmission of the answer signal at a transit point).

1) This type of signalling is called "*continuous compelled*".

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 paragraph 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.

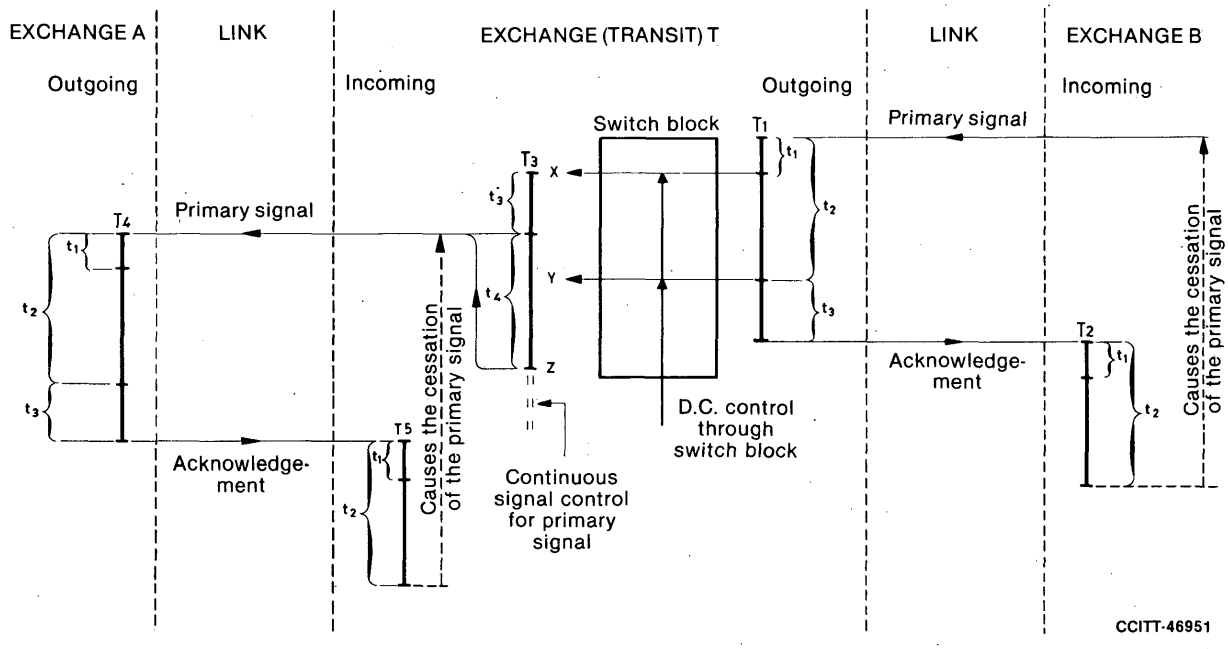
f) Receipt of busy-flash at a transit exchange will cause after signal recognition time:

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 – 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 – 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.



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

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/Q.141 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.

Recommendation Q.142

2.2 DOUBLE SEIZING WITH BOTH-WAY OPERATION

2.2.1 *Unguarded interval*

Considering that on long international (intercontinental) circuits:

a) the sending end splitting time may be 50 ms prior to signal transmission;
b) TASI may occasionally clip the initial 500 ms of seizing signals;
c) circuit propagation time may be relatively long;
d) the signal receiver response time must be taken into account;
e) 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 section 2.2.2.

2.2.2 *Detection of double seizing*

In the event of double seizing, the same frequency ($f1$) 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 SENDER[1)]

2.3.1 *Signalling frequencies*

2400 ± 6 Hz ($f1$) and 2600 ± 6 Hz ($f2$).

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 $f1$ and $f2$ 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.

Recommendation Q.144

2.4 LINE SIGNAL RECEIVER[1)]

2.4.1 *Operating limits*

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

a) $f1$: 2400 ± 15 Hz; $f2$: 2600 ± 15 Hz.

b) The absolute power level N of each unmodulated signal received shall be within the limits:

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

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.

[1)] See also Recommendation Q.112.

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 section 2.4.1 when the frequency is outside:

$2400 \begin{matrix} + 100 \\ - 150 \end{matrix}$ Hz for the $f1$ signal circuit or

$2600 \begin{matrix} + 150 \\ - 100 \end{matrix}$ Hz for the $f2$ signal circuit.

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.

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 $f1$ or the $f2$ 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.

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 section 2.4.1), the signal receiver should satisfy the conditions indicated in section 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 hang-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 section 2.4.1, the lengths of the received signals must remain within the limits specified in section 2.4.5.

2.4.5 *Distortion of received signals*

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

a) 15 ms when the signal receiver receives a pulse of one frequency $f1$ or $f2$ with a minimum duration of 150 ms;

b) 25 ms when the signal receiver receives a compound pulse of the two frequencies $f1$ and $f2$ 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 type[1]. Nevertheless the limits are specified for receiver design and test purposes.

Recommendation Q.145

2.5 SPLITTING ARRANGEMENTS

Sending line split

2.5.1 According to Recommendation Q.25, section 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.

---

[1] See Recommendation Q.141, section 2.1.6, explaining the term "continuous compelled".

2.6 SPEED OF SWITCHING IN INTERNATIONAL EXCHANGES

2.6.1 It is recommended that the equipment in the international exchanges shall have a high switching speed so that the switching time may be as short as possible.

2.6.2 At the outgoing international exchange the seizing of the circuit and the setting up of the connection should take place as soon as the ST end-of-pulsing condition is available (see Recommendation Q.152). In automatic operation advantage should be taken of all cases in which the ST condition can be reasonably determined at once, i.e. with avoidance of the 4-6 seconds time-out.

At an international transit exchange the setting up of the connection on the outgoing circuit should take place as soon as the digits necessary to determine the routing are received and analyzed.

At the incoming international exchange the setting up of the national part of the connection should start as soon as the register has received a sufficient number of digits.

2.6.3 At international exchanges the return of a proceed-to-send signal should be as fast as possible but in any case the return should normally be guaranteed before the time-out (minimum 10 seconds) of the seizing signal.

Furthermore, in the case of congestion on the circuits outgoing from a transit or an incoming exchange, a busy-flash signal should be returned as soon as practicable, but in any case within a maximum delay of 10 seconds following the receipt of the information necessary to determine the routing.

PAGE INTENTIONALLY LEFT BLANK

PAGE LAISSEE EN BLANC INTENTIONNELLEMENT

CHAPTER III

REGISTER SIGNALLING

Recommendation Q.151

3.1 SIGNAL CODE FOR REGISTER SIGNALLING

3.1.1 *General*

1) Automatic access to the international circuits must be used for outgoing traffic and the numerical signals from the operator or subscriber are stored in an outgoing international register before an international circuit is seized. As soon as the ST (end-of-pulsing) condition is available to the outgoing register, a free international circuit is selected and a seizing line signal transmitted. On receipt of a proceed-to-send line signal the seizing signal is terminated and a KP ("start of pulsing") pulse, followed by the numerical signals, is transmitted by the register. The final register signal transmitted is an end-of-pulsing (ST) pulse. The register signalling is not required to be TASI-prefixed.

2) Link-by-link register signalling applies. The register signals are always sent en bloc[1]. En bloc non-overlap[1] applies at the outgoing international register. En bloc overlap[1] applies at the transit and incoming international registers.

3) On a particular link, the KP signal sent by the international register (outgoing or transit register) on receipt of a proceed-to-send signal may be used to prepare the distant international register on this link for the receipt of the subsequent numerical signals. This signal may also serve to discriminate between terminal and transit traffic:

   a) Terminal KP (KP1). Used to create conditions at the next exchange so that equipment (or techniques) used exclusively for switching the call to the national network of the incoming country is brought into circuit.

   b) Transit KP (KP2). Used to bring into circuit, at the next exchange, equipment (or techniques) required to switch to call to another international exchange.

4) The register signalling is a 2-out-of-6 multifrequency code, forward signalling only, as shown in Table 2.

---

[1] *En bloc register signalling* is the transmission, by a register, of all the call information as a whole in a regular timed sequence of signals.

The technique requires that, in one register on the connection, all the relevant call information from a subscriber or operator shall be completely stored before output en bloc signal transmission takes place from that register.

At registers subsequent to the one where all the call information from a subscriber or operator is completely stored, the output signal transmission may commence before the complete reception of the input information; thus overlap to any desired degree of the output signal transmission with the input signal reception may occur and this may be understood as being *en bloc overlap*. Alternatively, the output signal transmission may be delayed until all the call information is received and stored. This may be understood as being *en bloc non-overlap*.

TABLE 2

Register signal code of system No. 5

Signal	Frequencies *(compound)* Hz	Remarks
KP1	1100 + 1700	Terminal traffic
KP2	1300 + 1700	Transit traffic
Digit 1	700 + 900	
" 2	700 + 1100	
" 3	900 + 1100	
" 4	700 + 1300	
" 5	900 + 1300	
" 6	1100 + 1300	
" 7	700 + 1500	
" 8	900 + 1500	
" 9	1100 + 1500	
" 0	1300 + 1500	
Code 11	700 + 1700	Code 11 operator
Code 12	900 + 1700	Code 12 operator
ST	1500 + 1700	End-of-pulsing

3.1.2 *Sending sequence of register signals*

The sequence of the register signals shall conform to the sequence indicated in Recommendation Q.107, noting the following:

a) a KP start-of-pulsing signal shall precede the sequence of numerical signals in all the cases indicated;

b) the ST end-of-pulsing signal will be transmitted from the register in automatic as well as in semi-automatic operation;

c) exceptionally, special numbers for giving access to incoming operators or delay operators may be dialled by outgoing operators and transmitted by outgoing international registers instead of code 11 and code 12 signals.

Recommendation Q.152

3.2 END-OF-PULSING CONDITIONS – REGISTER ARRANGEMENTS CONCERNING ST (END-OF-PULSING) SIGNAL

3.2.1 The register signalling arrangements provide for the sending of a ST signal for both semi-automatic and automatic operation; the arrangements in the outgoing international register for recognizing the ST end-of-pulsing condition will vary as follows:

a) *Semi-automatic operation*

The ST condition is determined by the receipt of the "sending-finished" signal from the operator (see Recommendation Q.106).

b) *Automatic operation*

1) Where the ST condition is determined by the originating national network and an ST signal is produced and transmitted to the outgoing international register, no further arrangements are necessary in that register for this purpose.

2) Where the ST condition is not received from the originating national network, the outgoing international register will be required to determine the ST condition. This ST condition is determined when the cessation of numerical information input to the register exceeds a period of 4 seconds (5 ± 1 seconds) in either of the following two circumstances, as preferred by the Administration:

i) after the minimum number of digits in the world numbering plan; or

ii) after the minimum number of digits of the destination country numbering plan.

In i) and ii), prolonged cessation of the numerical information input before the minimum number of digits should result in time-out release of the register without the production of the ST condition.

An immediate ST condition may be produced by a digit count to avoid the 4-second delay ST condition in the following circumstances:

i) when the destination country numbering plan has a fixed number of digits;

ii) when the maximum number of digits in the numbering plan of the destination country has been received.

3.2.2 Under all conditions, the outgoing international circuit should not be seized until the ST end-of-pulsing condition is available in the outgoing international register.

Recommendation Q.153

3.3 MULTIFREQUENCY SIGNAL SENDER

3.3.1 *Signalling frequencies*

700, 900, 1100, 1300, 1500 and 1700 Hz.

A signal shall consist of a combination of any two of these six frequencies. The frequency variation shall not exceed ± 6 Hz of each nominal frequency.

3.3.2 *Transmitted signal level*

-7 ± 1 dBm0 per frequency.

The difference in transmitted level between the two frequencies comprising a signal shall not exceed 1 dB.

Note – The level of the leak current transmitted to line should be at least:

a) 50 dB below the single-frequency level when a multifrequency signal is not being transmitted;

b) 30 dB below the transmitted signal level of either of the two frequencies when a multifrequency signal is being transmitted.

3.3.3 *Signal duration*

KP1 and KP2 signals: 100 ± 10 ms
All other signals: 55 ± 5 ms
Interval between all signals: 55 ± 5 ms
Interval between cessation of the seizing line signal and transmission of the register KP signal: 80 ± 20 ms.

3.3.4 *Compound signal tolerance*

The interval of time between the moments when each of the two frequencies comprising a signal is sent must not exceed 1 ms. The interval of time between the moments when each of the two frequencies ceases must not exceed 1 ms.

Recommendation Q.154

3.4 MULTIFREQUENCY SIGNAL RECEIVER

3.4.1 *Operating limits*

The signal receiver must ensure a separate output signal for each of the six voice-frequency signals received, and must operate satisfactorily for any combination of two of the frequencies, received as a single pulse or in a train of pulses, satisfying the following conditions:

a) the frequency of the received signal is within ± 15 Hz of the nominal signalling frequency;

b) the absolute power level N of each unmodulated signal shall be within the limits $(-14 + n \leqslant N \leqslant n)$ dBm where n is the relative power level at the signal receiver 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 levels of the two unmodulated frequencies comprising a signal must not differ from each other by more than 4 dB;

d) when the signal frequencies and levels are within the limits specified in a), b) and c) above, and in the presence of noise as defined in section 3.4.3:

1) at the input of a signal receiver, the minimum duration of an MF signal necessary to ensure correct registration of the digit shall not exceed 30 ms; this includes the operate time of the signal receiver and the two and two only check feature;

2) furthermore, at the input of the signal receiver, the minimum duration of an interval necessary to ensure the correct functioning of the registration device shall not exceed 30 ms; this includes the release time of the signal receiver and the restoration time of the two-and-two only check feature.

Note 1 – The tolerances given in a), b) and c) are to allow for variations at the sending end and in line transmission.

Note 2 – The test values indicated in d) are less than the working values. The difference between the test and working values will allow for pulse distortion, difference in time of the receipt of the two frequencies comprising a signal, etc.

3.4.2 *Non-operating conditions*

a) *Maximum sensitivity*

The signal receiver shall not operate under the effect of a signal as indicated in paragraph 3.4.1 a) whose absolute power level at the point of connection of the receiver is $(-17 - 7 + n)$ dBm, n being the relative power level at this point.

This limit is 17 dB below the nominal absolute power level of the signal current at the input to the signal receiver.

b) *Transient response*

Operation of the signal receiver shall be delayed for a minimum period necessary to guard against false operation due to spurious signals generated within the receiver on reception of any signal.

c) *Short signal response*

The signal receiver should not operate to a pulse signal of 10 ms or less. This signal may be of single frequency or two frequencies received simultaneously.

Likewise the signal receiver should ignore short intervals.

3.4.3 *Steady noise*

Considering that unweighted noise of a level -40 dBm0 (100 000 pW) and uniform spectrum energy may arise on the longest international circuit, the multifrequency receiver should satisfy the condition indicated in paragraph 3.4.1 d) for minimum signal and interval durations in the presence of noise of level -40 dBm0 and uniform spectrum energy over the frequency range 300 to 3400 Hz.

3.4.4 *Input impedance*

The input impedance should be such that the return loss over a frequency range 300 to 3400 Hz against a 600 ohm non-inductive resistor is greater than 20 dB.

Recommendation Q.155

3.5 ANALYSIS OF DIGITAL INFORMATION FOR ROUTING

(see Recommendation Q.107*bis* in Fascicle VI.1)

Recommendation Q.156

3.6 RELEASE OF INTERNATIONAL REGISTERS

3.6.1 *Normal release conditions*

a) An outgoing international register shall be released when it has transmitted the ST signal.

b) An incoming international register shall be released in either one of the following two cases:

1. Depending on the arrangements adopted by the Administration concerned at the incoming international exchange. For example, release on transmission of the ST signal, release on receipt of a number-received condition from the national network, etc.

2. When the busy-flash signal is returned. The return of the busy-flash signal in the case of congestion at the incoming exchange should take place as soon as practicable, but in any case within a maximum delay of 10 seconds following the receipt, at the incoming exchange, of the digits necessary to determine the routing.

c) A transit international register shall be released in either one of the following two cases:

1. When it has transmitted the ST signal.

2. When the busy-flash signal is returned, The return of the busy-flash signal in the case of congestion at the transit exchange should take place as soon as practicable, but in any case within a maximum delay of 10 seconds following the receipt, at the transit exchange, of the digits necessary to determine the routing.

3.6.2 *Abnormal release conditions*

a) An outgoing international register shall be released in either one of the following two cases:

1. Proceed-to-send signal not received.

   To release after the maximum delay of 10 to 20 seconds indicated by the time-out of the seizing signal. Register release after this delay will depend upon the arrangements preferred by the Administrations concerned, but release should preferably take place as quickly as possible after the time-out of the seizing line signal.

2. Proceed-to-send signal received.

   This case assumes that the proceed-to-send signal has ceased at the incoming end in the normal way but owing to a fault condition the outgoing register has not pulsed out. The outgoing register will be released by the clear-forward/release-guard sequence prompted by the busy-flash signal sent from the incoming end on non-receipt of register signals within a certain time. This assumes that the busy-flash signal is received at the outgoing end before the termination of any forced release delay that Administrations may wish to incorporate in the outgoing register.

b) An incoming international register shall be released in either one of the following two cases:

1. The ST signal not received within a certain time after commencement of the transmission of the proceed-to-send signal from the incoming end.

2. On return of the busy-flash signal, transmitted from the incoming end when an error is detected in the receipt of the register multifrequency signals.

c) A transit international register shall be released in any one of the cases stated for the release of the outgoing and incoming registers in paragraphs a) and b) above.

Recommendation Q.157

3.7 SWITCHING TO THE SPEECH POSITION

At the outgoing and transit international exchanges, the circuit shall be switched to the speech position when the register (outgoing or transit) is released after sending the ST signal.

At the incoming international exchange, the circuit will be switched to the speech position when the register is released (see section 3.6.1 of Recommendation Q.156).

PAGE INTENTIONALLY LEFT BLANK

PAGE LAISSEE EN BLANC INTENTIONNELLEMENT

CHAPTER IV

MANUAL TESTING ARRANGEMENTS FOR SIGNALLING SYSTEM No. 5

Recommendation Q.161

4.1 GENERAL ARRANGEMENTS FOR MANUAL TESTING[1)]

(see Recommendation Q.107*bis* in Fascicle VI.1)

Recommendation Q.162

4.2 ROUTINE TESTING OF EQUIPMENT (LOCAL MAINTENANCE)

4.2.1 Routine tests for testing individual items of equipment such as circuit equipment, connecting circuits, operator's line calling equipment, selectors, registers, etc., must be provided for in every international exchange equipped for automatic switching. These routine tests will be made in accordance with the practice followed in each country for the local maintenance of the switching equipment.

4.2.2 The testing equipment must conform to the following principles:

a) an item of equipment must not be taken for test until it is free;

b) an item of equipment taken for test will be marked "engaged" for the duration of the test. Before a circuit equipment is taken for test, the circuit will be withdrawn from service at both international exchanges;

c) as an alternative to b), a like item of equipment, known to be properly adjusted, may be switched in, and the item of equipment to be tested is switched out during the test.

4.2.3 Testing of the circuit and signalling equipment should include a check that the specifications of system No. 5 are met in regard to the following:

a) *Line signalling system*

Signalling frequencies
Transmitted signal levels
Signal frequency leak
Receiver operate and non-operate limits
Receiving-end line split
Sending-end line split
Line signal codes
Sending duration of signals
Recognition time of signals
Overlap transmission of answer signal on transit calls
Double seizing
Time-out and alarm features

---

1) See Recommendation Q.49/O.22: "Specifications for the CCITT automatic transmission measuring and signalling testing equipment ATME No. 2."

b) *Register signalling system*

Signalling frequencies
Transmitted signal levels
Signal frequency leak
Sending duration of signals
Receiver operate and non-operate limits
Operation of the receiver to a series of pulses
Error-checking features

4.2.4 *Simulated end-to-end tests*

It is desirable that a means be provided whereby end-to-end testing can be simulated on a local basis. A local loop-around arrangement permitting an outgoing test call to be routed directly on a four-wire basis into incoming equipment should be provided. The loop-around arrangement replaces the international line and is connected to the circuit equipment under test on the one side and on the other side to similar working spare both-way circuit equipment and signalling equipment having access to the switching system.

Recommendation Q.163

4.3 MANUAL TESTING

4.3.1 *Functional testing of signalling arrangements*

Functional tests from one end of the circuit to the other can be made in the following three ways:

a) The first method consists of a rapid verification of satisfactory signal transmission by ensuring that a seizing signal is followed by the return of a proceed-to-send signal, that a clear-forward signal is followed by the return of a release-guard signal.

b) The second method consists of verification of satisfactory signal transmission by initiating a test call:

1. to technical personnel at the distant-end international exchange; or
2. to a test call signal testing and answering device, if such equipment is available at the distant-end international exchange.

c) The third method consists of complete verification of satisfactory line and register signal transmission. The verification consists of a check of ability to:

1. generate and receive line and register signals;
2. transmit the appropriate acknowledgement signals;
3. provide required duration and spacing of MF signals;
4. complete terminal and transit [1] calls.

4.3.2 *First method: rapid test*

1. Verification of satisfactory signal transmission:

a) Initiate a seizing signal and verify the receipt and recognition of the proceed-to-send signal from the distant end.

Note – Absence of numerical information following termination of the seizing signal may result in receipt of a busy-flash signal provided by some Administrations from the distant-end equipment.

b) Initiate a clear-forward signal and verify the receipt and recognition of the release-guard signal from the distant end.

2. Failure to complete the seizing/proceed-to-send signalling sequence or the clear-forward/release-guard signalling sequence should result in the automatic termination of the frequencies being transmitted within 10-20 seconds/4-9 seconds (see Recommendation Q.141, paragraph 2.1.3.1 e).

3. In the event of a failure, appropriate steps should be taken to locate and correct the trouble.

4. The above tests are short, simple, and should be performed at least monthly from each end of the circuit as appropriate. This minimum periodicity should be increased to as often as daily if the incidence of trouble encountered is unsatisfactory.

---

1) See the note to paragraph 4.3.4.3.

4.3.3 *Second method: test calls*

1. Verification of satisfactory transmission of signals involved in completion of test calls (manual method):

   a) Place a call to the technical personnel at the distant international exchange.

   b) On completion of connection:

      i) the audible ringing tone should be heard;

      ii) the answer signal should be received when the call is answered at the distant end.

   c) Request distant end to initiate a clear-back signal, followed by an answer signal.

   d) A clear-back signal should be received and recognized when the distant end hangs up and a second answer signal should be received and recognized when the distant end re-answers the call.

   e) Initiate a forward-transfer signal which should result in bringing in the assistance operator at the distant end.

   f) Terminate the call and observe that the circuit restores to the idle condition.

2. Verification of satisfactory transmission of signals involved in completion of test calls (semi-automatic method).

   If test call signal testing and answering devices are available at the distant international exchange, the signal verification tests should be made using this equipment to the extent that the applicable features indicated in 1 above are available.

3. The above tests should be made from each end of the circuit. They should be made monthly when the manual testing methods prescribed in 1 are used.

   They may be made daily when semi-automatic test arrangements are available.

4.3.4 *Third method: comprehensive tests; terminal and transit test calls*

1. Verification of satisfactory signal transmission (frequency, level, duration, etc.) involved in terminal and transit calls.

   a) These tests are made in conjunction with:
   - verification and location of faults;
   - ensuring that new circuits are satisfactory in operation before being brought into service.

   b) When establishing new circuits all of the tests outlined in 4.2.3 should have been completed at both terminals. New circuits assigned to Time Assignment Speech Interpolation (TASI) equipment should be patched as non-TASI for the duration of these tests.

2. Terminal calls

   Initiate a call to the distant end test centre. Coordinate this test with the distant end so that appropriate test equipment is connected prior to establishing the call. Check the following:

   a) At the originating end check that a seizing signal is followed by the receipt and recognition of the proceed-to-send signal from the distant end. Check that the proceed-to-send signal persists until the seizing signal ceases.

   b) At the distant end check the following:

	Duration of transmitted signal
1. Interval between termination of seizing signal and start of KP signal	80 ± 20 ms
2. KP signal duration	100 ± 10 ms
3. Digital and ST signal duration	55 ± 5 ms
4. Interval between all signals	55 ± 5 ms

   c) Check that the audible ringing tone is heard at the originating end.

   d) At the originating end check that the answer signal is received, recognized and acknowledged. Check that the acknowledgement signal persists until the answer signal ceases.

   e) At the distant end initiate a clear-back signal.

   f) At the originating end check that a clear-back signal is received, recognized and acknowledged. Check that the acknowledgement signal persists until the clear-back signal ceases.

   g) At the originating end initiate a forward-transfer signal.

   h) At the distant end check the receipt of the forward-transfer signal. The transmitted duration of this signal should be 850 ± 200 ms. This signal may be subject to TASI clipping.

   i) At the distant end arrange to transmit a succession of clear-back and answer signals; first at a slow rate, then at a rate which is faster than the system is capable of following.

j) At the originating end check during the slow transmission of the switch-hook flashes that each clear-back and answer signal is received and properly recognized. Verify that after the fast transmission of switch-hook flashes the equipment indicates the final position of the switch-hook.

k) At the originating end release the circuit and check that the clear-forward signal is followed by the receipt and recognition of the release-guard signal from the distant end. Check that the release-guard signal ceases after the clear-forward signal ceases. Check that the circuit restores to the idle condition.

l) At the originating end check that the clear-forward signal sent to the incoming equipment in the idle condition results in the return of the release-guard signal and that the equipment restores to the idle condition.

m) At the originating end check that the busy-flash signal is received, recognized and acknowledged. Check that the acknowledgement ceases after the busy-flash signal ceases. (Some Administrations at the incoming end may find it convenient to provide a test call device which prompts the return of a busy-flash signal.)

In normal service the receipt of a busy-flash signal causes (after the acknowledgement) a clear-forward signal to be sent automatically from the international exchange originating the call. On a test call procedure some Administrations may prefer to avoid this process. In this case, the release of the connection is controlled by the personnel at the terminal originating the test call.

Note on items a) *to* m) – As part of the comprehensive tests it may, in certain circumstances such as fault localization, be desirable to test the frequency, level, and duration of received signals. Normally, however, it may be assumed that each Administration has verified the accuracy of its signal transmission locally as covered in paragraph 4.2.3.

3. Transit calls[1)]

a) After securing the cooperation of a third international exchange initiate a transit call to this exchange through the international exchange covered in 2 above.

b) With the assistance of technical personnel at the third international exchange repeat steps 2 c) to 2 k) except that in step 2 h) measurement of the duration of the forward-transfer signal need not be made.

Note – Detailed tests of certain transit features such as that of the transmission of the answer signal on an overlap basis at the transit point should be performed locally.

Recommendation Q.164

4.4 TEST EQUIPMENT FOR CHECKING EQUIPMENT AND SIGNALS

4.4.1 *General*

For local checks of correct equipment operation and for readjusting the equipment, international exchanges should have test equipment available which includes:

a) Line and register signal generators.

b) Signal-measuring apparatus.

c) Loop-around equipment (see 4.4.4).

4.4.2 *Signal generators*

The signal generators should be able to simulate all line and register signals. The generators may be part of test equipment which cycles the equipment to be tested through actual signalling sequences, in a manner which enables rapid complete testing to determine whether the equipment meets the system specifications. The generators should have the following characteristics:

a) *Line signal generator*

1. Signal frequencies should be within ± 5 Hz of the nominal signalling frequency or frequencies and shall not vary during the time required for testing.

---

1) When making transit test calls it is not the intention to check the performance or the quality of the circuit beyond the transit exchange, this being completely the responsibility of the Administration concerned. However, it is important that in principle the transit operations can be checked.

2. Signal levels should be variable between the limits given in the specification and be able to be set within ± 0.2 dB.

3. Signal duration should be long enough so that the signals can be recognized and long enough in the case of compelled signals to complete the acknowledgement process.

b) *Register signal generator*

1. Signal frequencies should be within ± 5 Hz of the nominal signalling frequency or frequencies and shall not vary during the time required for testing.

2. Signal levels should be variable between the limits given in the specification and be able to be set within ± 0.2 dB.

3. Signal durations and intervals between signals shall be within the limits given in the specification in Recommendation Q.153, paragraph 3.3.3, for normal operate values and in Recommendation Q.154, paragraph 3.4.1 d), for test operate values.

4.4.3 *Signal-measuring equipment*

Equipment capable of measuring signal frequencies, signal levels, signal durations and other significant signal time intervals may be part of the test equipment referred to in section 4.4.2, or separate instruments. In either case the characteristics of the measuring equipment should be as follows:

a) *Line signal-measuring equipment*

1. Signal frequency or frequencies to be measured to be between the extreme limits given in the specification, the reading being made with an accuracy of ± 1 Hz.

2. Level of the signal frequency or frequencies measured over the range given in the specification to be measured with an accuracy of ± 0.2 dB.

3. Signal durations, signal recognition times and other significant time intervals as given in the specification should be measured within an accuracy of 1 ms or ± 1% of the nominal duration, whichever yields the higher value. The range of time intervals to be measured is approximately 5 to 1050 ms. Time-out intervals of 10 to 20 seconds and of 4 to 9 seconds should be determinable within an accuracy of ± 1 second.

b) *Register signal-measuring equipment*

1. Signal frequency or frequencies to be measured to be between the extreme limits given in the specification, the reading being made with an accuracy of ± 1 Hz.

2. Level of the signal frequency or frequencies measured over the range given in the specification to be measured with an accuracy of ± 0.2 dB.

3. Signal duration and intervals between signals as given in the specification should be measured with an accuracy within 1 ms.

c) In regard to measuring time intervals a recorder having a minimum of two input channels may be useful. The recorded characteristic should conform with the accuracy quoted in a) and b) above and be easily connected to the circuit under test. The recorder input characteristic should be such as to have a negligible effect on circuit performance.

4.4.4 *Loop-around equipment*

Local four-wire loop-around equipment should simulate line facilities without introducing signalling degradation. The gain of the loop-around equipment should be set to provide proper transmission levels. Alternatively, if the testing of the individual items of equipment is on a limit test basis it would not be essential to set the gain of the loop to provide the exact transmission levels. In this event a straight patch would be adequate.

PAGE INTENTIONALLY LEFT BLANK

PAGE LAISSEE EN BLANC INTENTIONNELLEMENT

ANNEXES TO SIGNALLING SYSTEM No. 5
SPECIFICATIONS

ANNEX 1

Signalling sequences

Table 1 – Semi-automatic (SA) and automatic (A) terminal traffic.

Table 2 – Semi-automatic (SA) and automatic (A) transit traffic.

In these tables the arrows have the following meanings:

——▶ transmission of a signalling frequency (permanent or pulse emission).

- - - - -▶ end of transmission of the signalling frequency in the case of its permanent transmission.

·····▶ transmission of an audible tone.

ANNEX 2

Description of the operations corresponding to the various normal and abnormal conditions which may arise in setting up a call

Table 1 – Outgoing exchange – Normal conditions

Table 2 – Outgoing exchange – Abnormal conditions

Table 3 – Incoming exchange – Normal conditions

Table 4 – Incoming exchange – Abnormal conditions

Table 5 – Transit exchange – Normal conditions

Table 6 – Transit exchange – Abnormal conditions

ANNEX 1

TABLE 1

Semi-automatic (SA) and automatic (A) terminal traffic

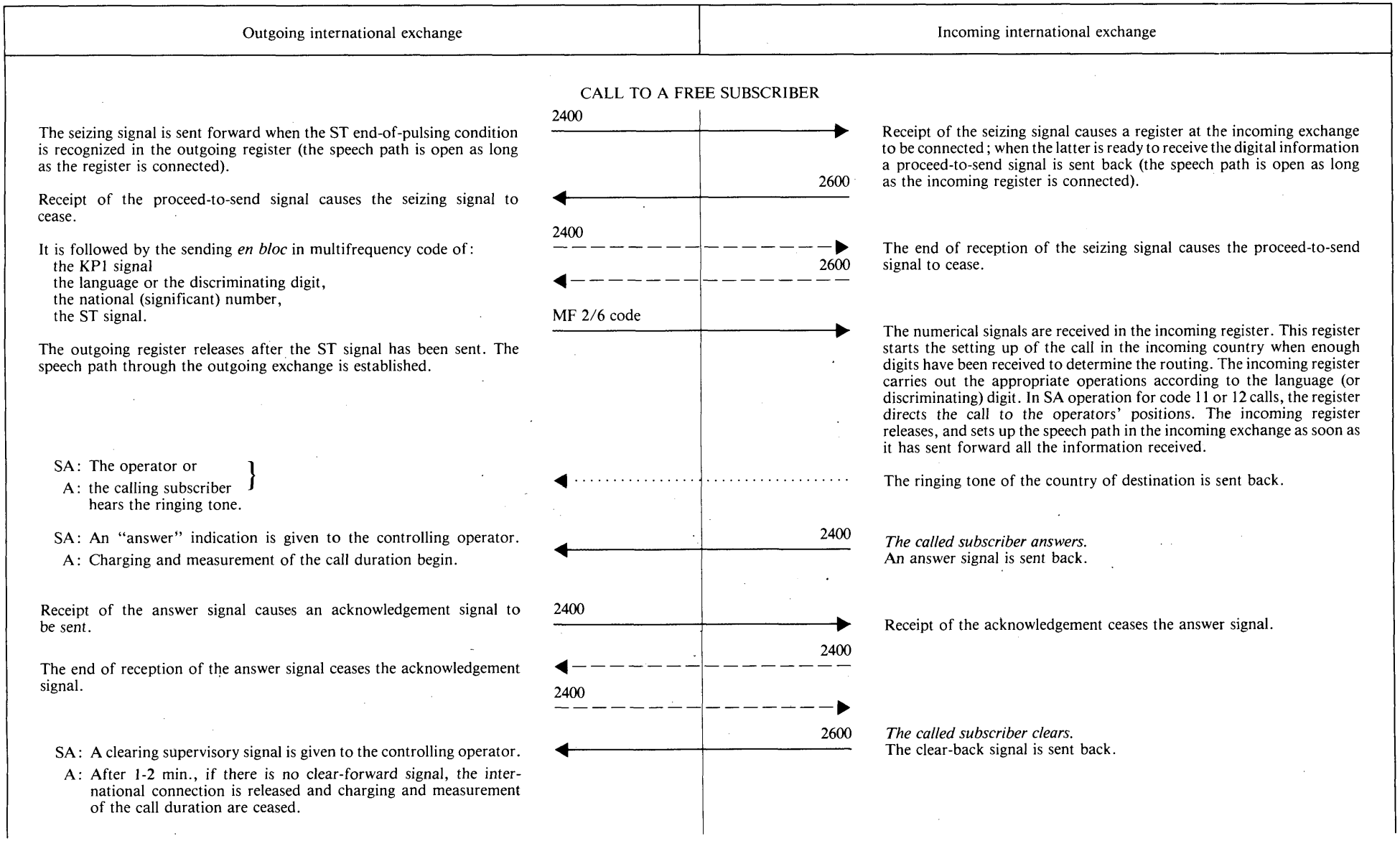
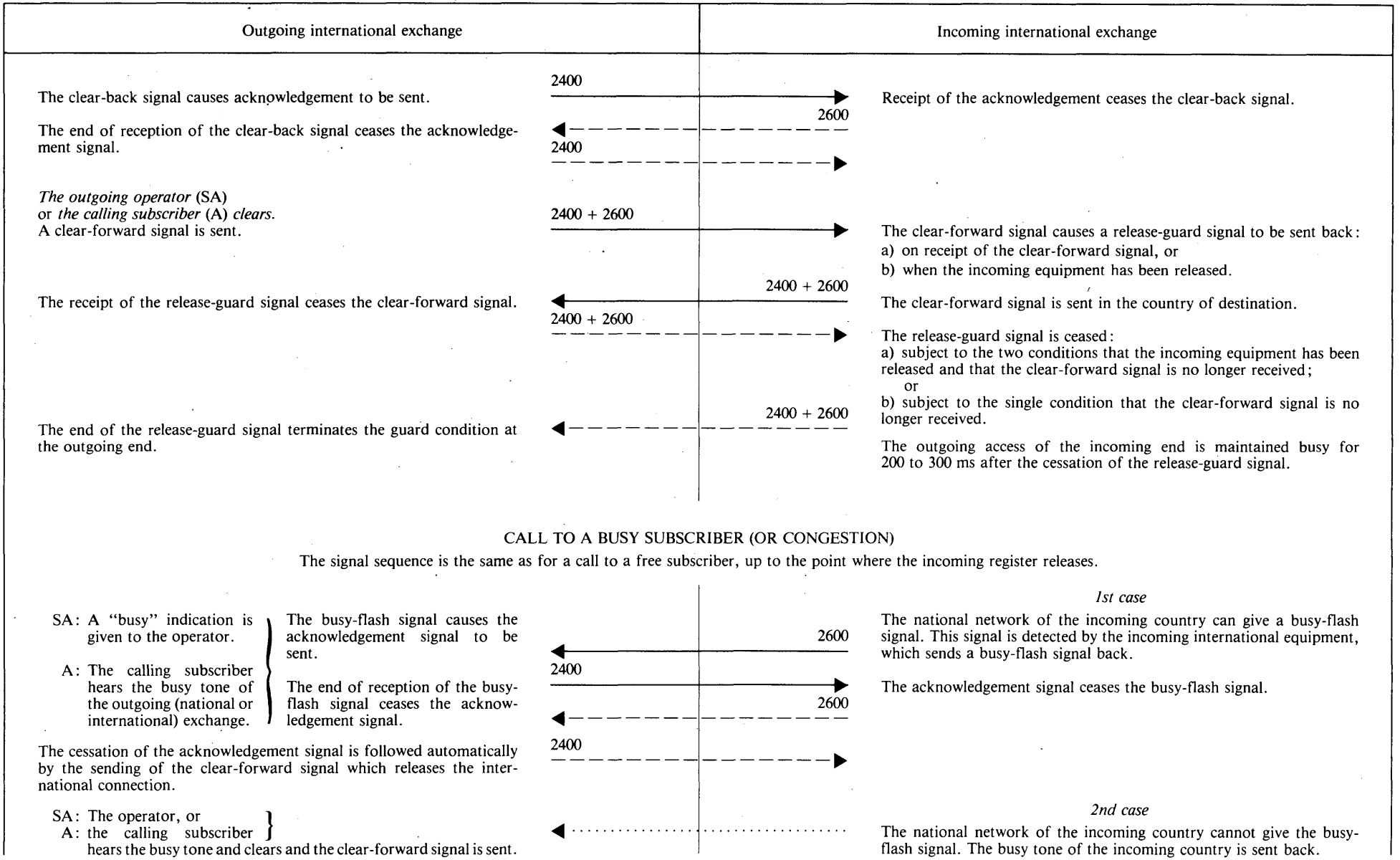


TABLE 1 *(continued)*



CALL TO A BUSY SUBSCRIBER (OR CONGESTION)

The signal sequence is the same as for a call to a free subscriber, up to the point where the incoming register releases.

ANNEX 1

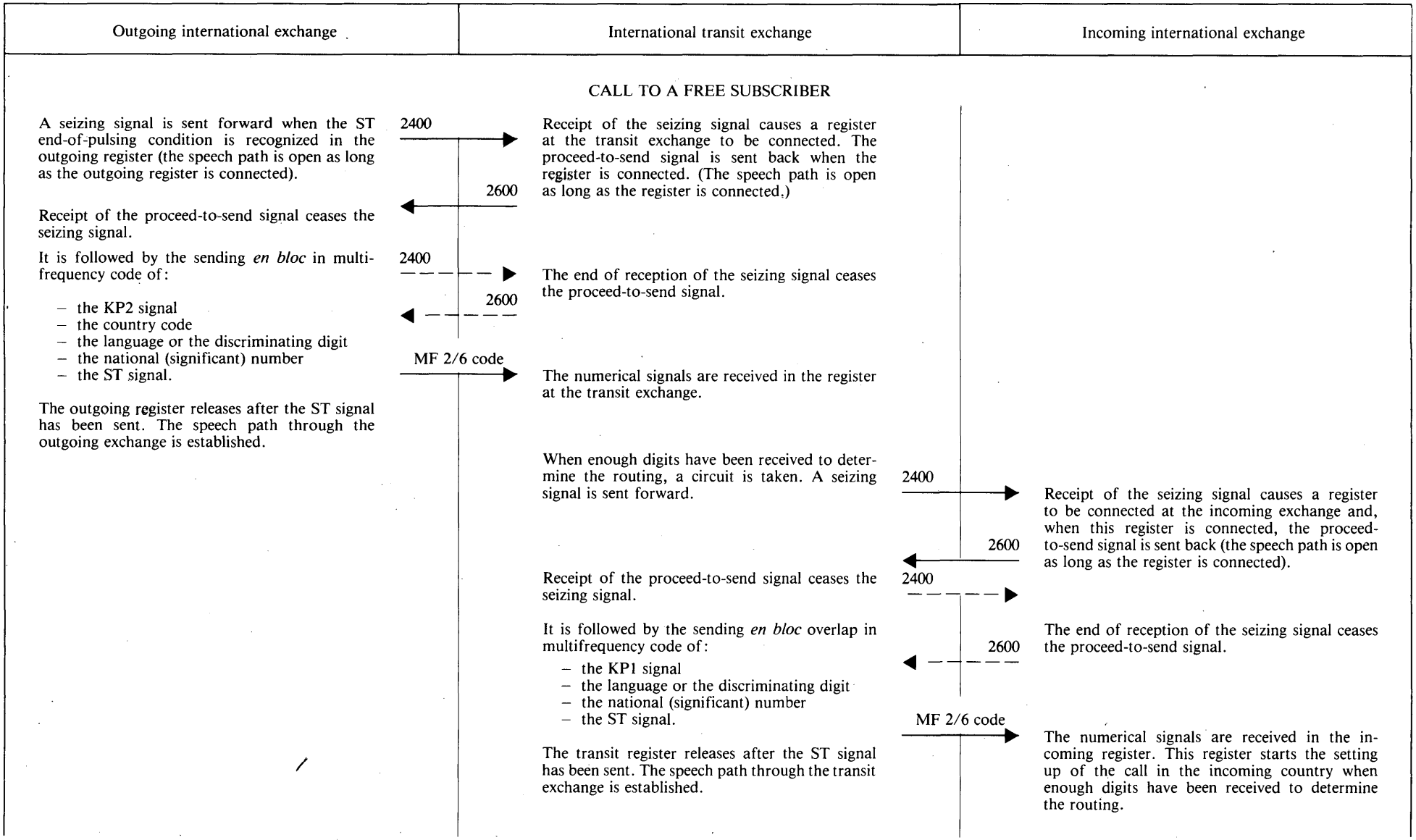
TABLE 1 *(concluded)*

Outgoing international exchange	Incoming international exchange
SPECIAL CONDITIONS	
1. FORWARD TRANSFER *1st Case* SA: Following a call switched automatically to a subscriber, or following a call established via a special number or an incoming, or delay operator, the controlling operator wishes to call in an assistance operator at the incoming international exchange. A forward-transfer signal is sent.	2600 → The forward-transfer signal causes an assistance operator to intervene at the incoming international exchange.
2nd Case SA: Following a call via code 11 or 12, the controlling operator wishes to recall the incoming operator at the incoming international exchange. A forward-transfer signal is sent.	2600 → Recalls the incoming operator on calls completed via the operator positions of this exchange.
2. DOUBLE SEIZING The outgoing end sends the seizing signal.	2400 → ← 2400 The incoming end also sends the seizing signal.
The two ends of the circuit send and receive the seizing signal for a sufficiently long time to ensure that the signal can be recognized at both ends. The two ends recognize the double seizing by this condition.	
The equipment is cleared at each end without the sending of a clear-forward signal; then: a) either a second automatic attempt to set up the connection takes place, or b) } SA: a re-order indication is given to the operator; A: a busy tone is sent to the subscriber.	

ANNEX 1

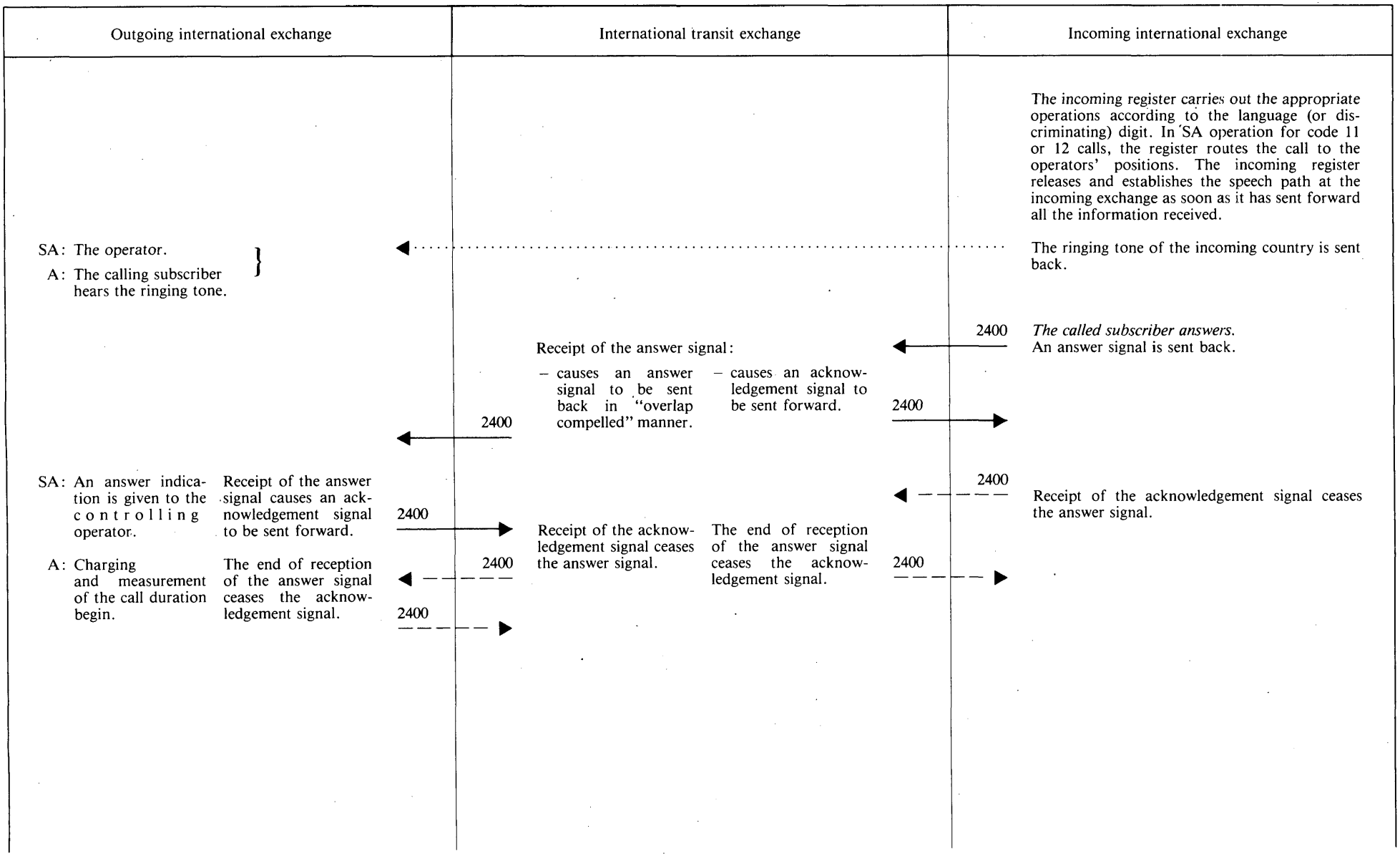
TABLE 2

Semi-automatic (SA) and automatic (A) transit traffic



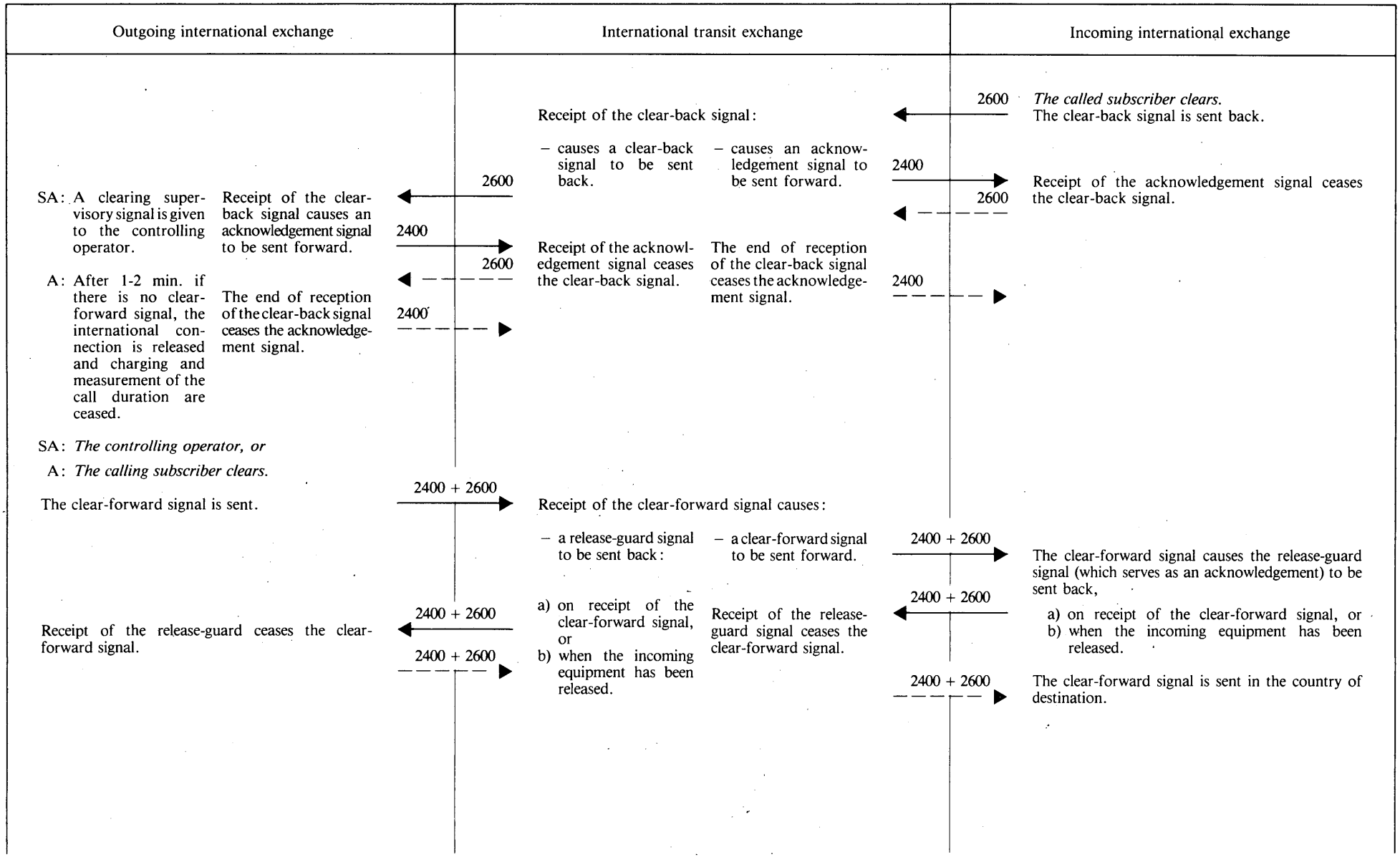
ANNEX 1

TABLE 2 *(continued)*



ANNEX 1

TABLE 2 *(continued)*



ANNEX 1

TABLE 2 *(continued)*

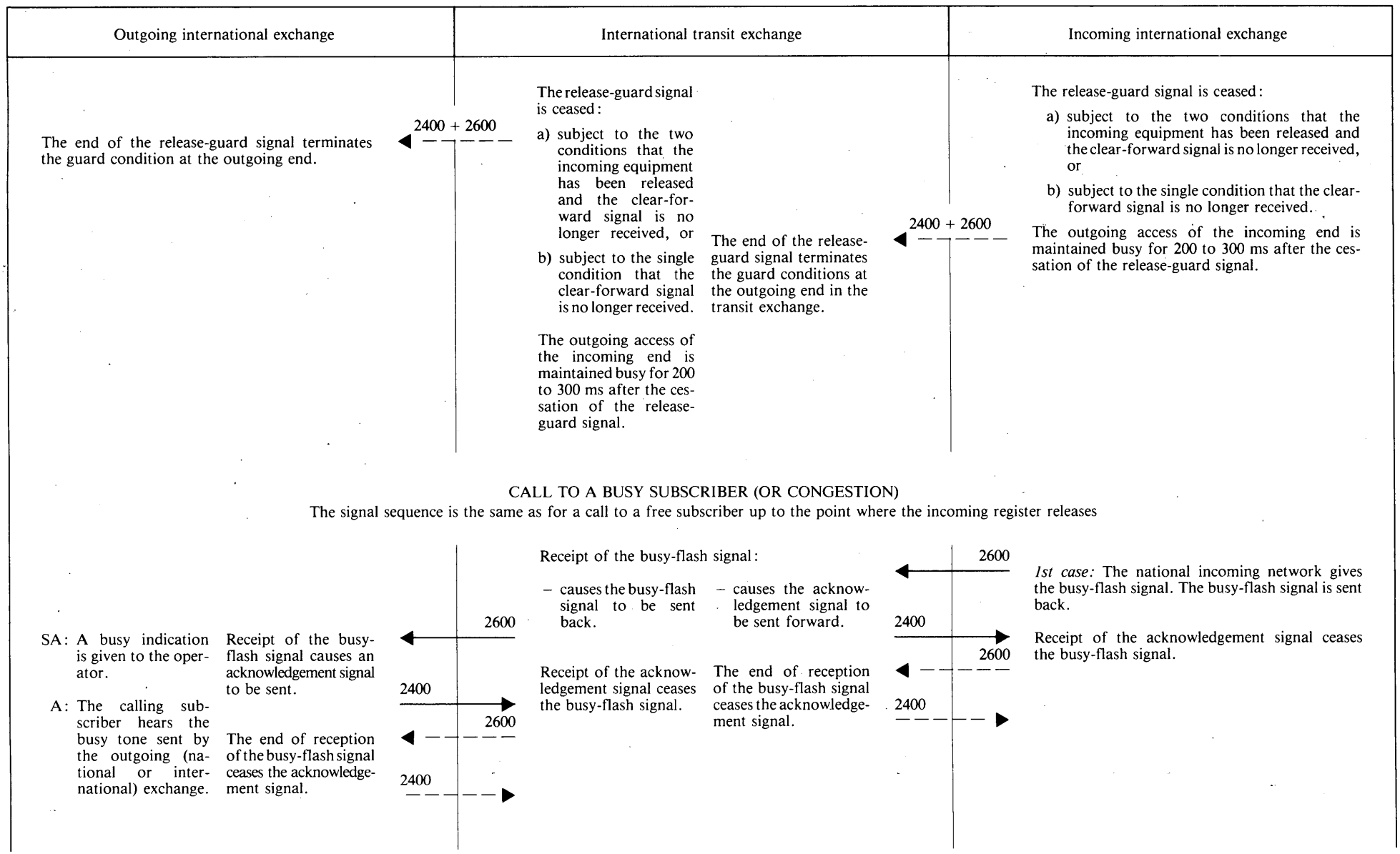


TABLE 2 *(concluded)*

Outgoing international exchange	International transit exchage	Incoming international exchange
The cessation of the acknowledgement signal is followed automatically by the sending of the clear-forward signal to release the international circuit, clearance being effected from the outgoing exchange. SA: The operator, or A: the calling subscriber hears the busy tone and clears. The clear-forward signal is sent.	◄	*2nd Case:* The national incoming network does not give the busy-flash signal. The busy tone of the incoming country is sent back.
SPECIAL CONDITIONS		
FORWARD-TRANSFER *1st Case* SA: Following a call switched automatically to a subscriber, or following a call established via a special number incoming or delay operator, the controlling operator wishes to call in an assistance operator at the incoming international exchange. A forward-transfer signal is sent.	2600 → The forward-transfer signal causes a forward-transfer signal to be sent over the following circuit.	2600 → The forward-transfer signal causes an assistance operator to intervene at the incoming international exchange on an established connection completed automatically.
2nd Case SA: Following a call via code 11 or 12, the controlling operator wishes to recall the incoming operator at the incoming international exchange. The forward-transfer signal is sent.	2600 → The forward-transfer signal causes a forward-transfer signal to be sent over the following circuit.	2600 → Recalls the incoming operator on calls completed via the operators' positions of this exchange.

ANNEX 2

TABLE 1

Outgoing exchange – Normal conditions

<table>
<tr><td colspan="2" rowspan="2">Conditions</td><td rowspan="2">Subscriber free</td><td colspan="2">Subscriber busy or national congestion</td><td rowspan="2">Congestion at a transit or an incoming exchange or on circuits immediately outgoing from that exchange (after register association)</td></tr>
<tr><td colspan="2">The busy-flash signal:</td></tr>
<tr><td rowspan="5">Operations effected</td><td>Release of register</td><td colspan="5">After sending the ST signal</td></tr>
<tr><td>Speech position</td><td colspan="5">After release of register</td></tr>
<tr><td>Action on the international circuit</td><td colspan="2"></td><td colspan="3">Release of the circuit after reception of a busy-flash signal</td></tr>
<tr><td>SA – Local signals given to the operator</td><td colspan="2"></td><td colspan="3">Busy</td></tr>
<tr><td>A – Transmission of an appropriate indication to the calling subscriber</td><td colspan="2"></td><td colspan="3">Busy tone</td></tr>
<tr><td rowspan="2">Information received from the international circuit</td><td>Signals received</td><td colspan="2"></td><td colspan="3">Busy-flash signal</td></tr>
<tr><td>Audible indication received</td><td>Ringing tone</td><td>Busy tone</td><td colspan="3"></td></tr>
<tr><td colspan="2">References</td><td>3.6.1</td><td>3.7</td><td colspan="3">3.6.1, 3.7, 1.6</td></tr>
</table>

SA = Semi-automatic service
A = Automatic service
} When there is no specific indication the clause is applicable to both services.

ANNEX 2

TABLE 2

Outgoing exchange – Abnormal conditions

Conditions		The outgoing register receives no more digits	Registration of unused numerical information	Non-receipt of a proceed-to-send signal after sending the seizing signal	The outgoing register not having detected an abnormality, the incoming register receives an incomplete number or a non-existing number and it detects the abnormality
Operations effected	Release of register	SA – (local sending-finished signal not received): 10-20 seconds [a] after seizure or receipt of last digit. A – 15-30 seconds [a] after seizure of no, or less than the minimum number of digits received. (When enough digits received, 4-6 seconds after the receipt of the last digit, normal ST condition is assumed)	Immediately the abnormality is recognized	10-20 seconds after the start of sending the seizing signal	After sending the ST signal
	Speech position	(A – After release of the register should ST condition be assumed)			After release of the register
	Action on the international circuit	(A – Seized in normal manner should ST condition be assumed)		Released by clear-forward signal	
	SA – Local signals given to the operator	Determined by each Administration, as this is a national matter			
	A – Indications given to the subscriber	Appropriate audible indication			
Signals received from the international circuit					Busy-flash
References		3.2		3.6.2, 1.9	2.1.6 d, 3.6.1

[a] Typical value.

ANNEX 2

TABLE 3

Incoming exchange – Normal conditions

<table>
<tr><td>Conditions
Operations effected</td><td>Called subscriber free</td><td colspan="2">Subscriber busy or national congestion</td><td>Congestion at the incoming exchange or on circuits immediately outgoing from that exchange (after register association)</td></tr>
<tr><td></td><td></td><td colspan="2">The busy-flash signal:</td><td></td></tr>
<tr><td></td><td></td><td>is not provided</td><td>is provided</td><td></td></tr>
<tr><td>Release of register</td><td colspan="3">After:
a) sending the numerical information to,
or b) sending an ST signal to,
or c) receipt of an end-of-selection signal from, the national network equipment</td><td>After sending the busy-flash signal</td></tr>
<tr><td>Speech position</td><td colspan="4">After release of the register</td></tr>
<tr><td>Sending of busy-flash signal on the international circuit</td><td colspan="2"></td><td>After receipt of the national busy-flash signal</td><td>0-10 seconds after receipt of the information necessary for determining the route</td></tr>
<tr><td>Sending of an audible indication</td><td>National ringing tone</td><td>National busy tone</td><td>National busy tone (if present)</td><td></td></tr>
<tr><td>References</td><td>3.6.1 b) 1.</td><td>3.6.1 b) 1.</td><td>2.1.6 d) 4.
3.6.1 b) 2.</td><td>1.6
2.1.6 d) 1.
3.6.1 b) 2.</td></tr>
</table>

ANNEX 2

TABLE 4

Incoming exchange – Abnormal conditions

Conditions / Operations effected	Non-receipt of numerical signals	Error detected in receipt of the numerical signals	ST signal not received	Receipt of an incomplete number or a non-existing number (ST signal received)
Release of register	4-9 seconds after the start of sending the proceed-to-send signal	Immediately the error is recognized	20-40 seconds [a] after the start of sending the proceed-to-send signal	After: a) sending the numerical information to, or b) sending an ST signal to, or c) receipt of an end-of-selection signal from, or d) receipt of a busy-flash signal from, the national network equipment or e) recognition of the abnormality by the incoming international register
Speech position	After release of the register			
Signals sent back on the international circuit	Busy-flash			d) Busy-flash e) Busy-flash
References	2.1.3.1 e) 2.1.6 d)	2.1.6 d)	2.1.6 d) 3.6.2 b) 1.	2.1.6 d) 3.6.2 b) 2.

[a] Typical value.

ANNEX 2

TABLE 5

Transit exchange – Normal conditions

Conditions / Operations effected	Successful attempt (as far as transit exchange is concerned)	Congestion at the transit exchange or on international circuits immediately outgoing from that exchange (after register association)
Release of register	After sending the ST signal	After sending the busy-flash signal
Speech position	After release of the register	
Sending of busy-flash signal back		0-10 seconds after the receipt of the information necessary for determining the routing
References	3.6.1c)1.	3.6.1c)2.

ANNEX 2

TABLE 6

Transit exchange – Abnormal conditions

Conditions / Operations effected	Non-receipt of numerical signals	Error detected in the receipt of the numerical signals	ST signal not received	Receipt of unused numerical information	Non-receipt of the proceed-to-send signal after sending the seizing signal
Release of register	10-20 seconds after the start of sending the proceed-to-send signal	Immediately the error is recognized	20-40 seconds [a] after the start of sending the proceed-to-send signal	After recognition of the abnormality	10-20 seconds after the start of sending the seizing signal
Speech position	After release of the register				
Signals sent back on the incoming international circuit	Busy-flash				
Action on the outgoing international circuit					Released by clear-forward signal
References	2.1.3.1 e) 2.1.6 d)	2.1.6 d)	2.1.6 d) 3.6.2 c)	2.1.6 d)	2.1.3.1 e) 2.1.6 d) 3.6.2 c)

a) Typical value.

PAGE INTENTIONALLY LEFT BLANK

PAGE LAISSEE EN BLANC INTENTIONNELLEMENT

PART III

Recommendation Q.180

INTERWORKING OF SIGNALLING SYSTEMS No. 4 AND No. 5

PAGE INTENTIONALLY LEFT BLANK

PAGE LAISSEE EN BLANC INTENTIONNELLEMENT

INTERWORKING OF SYSTEMS No. 4 AND No. 5

Recommendation Q.180

INTERWORKING OF SYSTEMS No. 4 AND No. 5

1. *General*

It is possible to ensure normal operation for both semi-automatic and automatic service when interworking takes place between signalling systems No. 4 and No. 5, in either the "4 to 5" or "5 to 4" direction.

The interworking is possible because:

- the line signals (i.e. the supervisory signals) generally have the same meaning and the same function in both systems;
- the numerical (address) information is sent in the same sequence in both systems;
- all conditions for the use of the language digit in the semi-automatic service and the discriminating digit in the automatic service are the same in both systems.

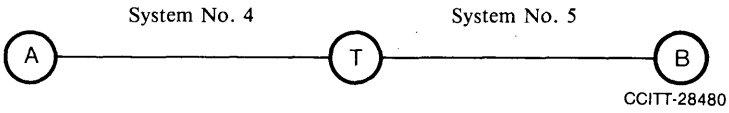
In general, the interworking of the two systems merely requires that a signal received in the code of one of the systems be converted into the corresponding signal of the code used by the other system. Nevertheless, in a transit exchange where there is interworking of systems No. 4 and No. 5, special precautions are necessary with regard to signals which are used differently in the two systems. These differences are as follows:

a) system No. 5 always uses a forward end-of-pulsing signal (the ST signal), whereas the end-of-pulsing signal (code 15) is not always given in system No. 4;

b) system No. 4 uses a backward number-received signal which is not provided in system No. 5.

2. *Calls from system No. 4 to system No. 5*

2.1 *Semi-automatic calls from system No. 4 to system No. 5*



1. In semi-automatic operation the outgoing exchange A of system No. 4 sends an end-of-pulsing signal over link AT and the outgoing register at A is released.
2. The end-of-pulsing signal of system No. 4, which is a numerical type signal (code 15), is acknowledged.

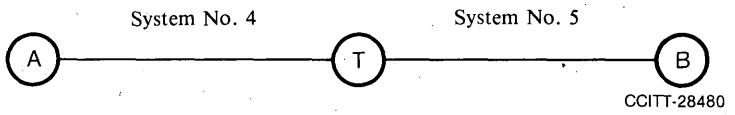
3. On receipt of an end-of-pulsing signal from A, the incoming part of system No. 4 at transit exchange T sends to A an acknowledgement of the end-of-pulsing signal and then sends to A a number-received signal.

4. At T, an end-of-pulsing signal ST is sent over link TB on system No. 5; this ST signal is obtained by converting the end-of-pulsing signal (code 15) of system No. 4.

5. At T, the outgoing register[1] of system No. 5 is released as soon as the signal ST has been sent over link TB on system No. 5. At T, the incoming register[1] of system No. 4 is released after the number-received signal of system No. 4 has been sent back to A.

Note – The number-received signal is sent from T over link TA in order to conform to the specifications of system No. 4. Since the outgoing register at A will be released as soon as A has sent the end-of-pulsing signal (in accordance with the specifications of system No. 4), the only possible role of the number-received signal at A is to indicate to the operator that the selection procedure has been effected. However, since the number-received signal relates only to operations on the link AT on system No. 4, this signal provides no information about the entire selection process from A to B; the indication to the operator is hence of little value.

2.2 *Automatic calls from system No. 4 to system No. 5*



1. The system No. 4 link AT does not provide for an end-of-pulsing signal from exchange A in automatic operation; the transit exchange T will therefore have to recognize that all the digits have been received in order to:

   a) send a forward ST signal to B in system No. 5; and

   b) send a backward number-received signal to A in system No. 4.

In this situation the system No. 5 register signalling at T will be *en bloc* non-overlap[2]. (See Recommendation Q.152, paragraph 3.2.1 b) (2) for the action to be taken by the system No. 5 register at T to recognize that all digits have been received.)

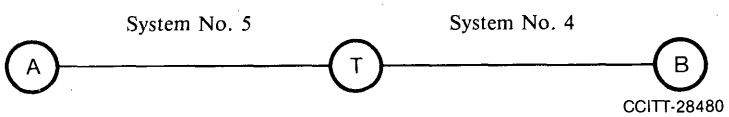
2. At A, release of the outgoing register of system No. 4 depends upon reception of the number-received signal.

At the incoming end of system No. 4 at T, the incoming register[3] of system No. 4 is released as soon as the number-received signal is sent backward and all the numerical information necessary for setting up the call is sent to B.

At T, an ST end-of-pulsing signal is sent to B by system No. 5 after the numerical information has been sent, and the outgoing register[3] of system No. 5 at T is then released.

3. *Calls from system No. 5 to system No. 4*

3.1 *Semi-automatic calls from system No. 5 to system No. 4*



1. In semi-automatic operation at transit exchange T the incoming register[3] part of system No. 5 receives an ST end-of-pulsing signal 55 ms after reception of the last numerical signal.

---

1) These register functions may be combined in a single register.

2) See for this term the footnote to Recommendation Q.151.

3) These register functions may be combined in a single register.

2. At T, the ST end-of-pulsing signal of system No. 5 is converted into an end-of-pulsing signal of system No. 4, which is sent to the incoming end B of this system.

3. The end-of-pulsing signal of system No. 4, which is a numerical type signal (code 15), is acknowledged.

4. At A, the outgoing register of system No. 5 is released after the ST signal has been sent.

5. At T, the outgoing register[1] of system No. 4 is released when the end-of-pulsing signal is sent.

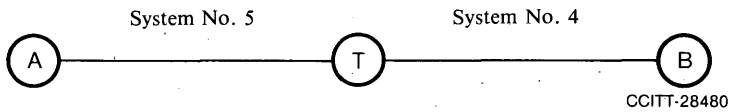
6. At B, the incoming register of system No. 4 is released as soon as the number-received signal is sent backward to T on system No. 4 and all the numerical information necessary for setting up the call in the incoming country has been sent forward.

7. The number-received signal is sent over link BT upon reception at B of the end-of-pulsing signal. It will be noted that number-received signal is sent over link BT solely in order to conform to the specifications of system No. 4, even though this signal is superfluous in this case as:

   a) the number-received signal is not needed to release the outgoing register of system No. 4 at T since it is released when it sends the end-of-pulsing signal:

   b) this signal cannot be used to give any information to the operator at A since it cannot be passed by system No. 5 on link AT.

3.2 *Automatic calls from system No. 5 to system No. 4*



1. This situation raises no difficulties since system No. 5 possesses the ST signal which, by determining the end-of-pulsing at T, places the outgoing register of system No. 4 at T in conditions that are comparable to those existing with semi-automatic operation in system No. 4.

2. At T, the ST signal of system No. 5 is converted into the end-of-pulsing signal (code 15) of system No. 4.

3. The specifications of system No. 4 require that the incoming exchange B of system No. 4 must send the number-received signal as soon as:

   a) an end-of-pulsing signal has been received, or

   b) it has recognized that all the digits have been received.

In this case of interworking, condition a) is generally fulfilled first. It may happen, however, that a complete national number is recognized before the end-of-pulsing signal is received (for example, when the number of digits in the national number of the incoming country is constant). The transit exchange T must hence be capable of receiving the number-received signal not only after emission of the end-of-pulsing signal but also when the last digit preceding that signal has been sent.

4. Exchange B must be capable of receiving the end-of-pulsing signal (code 15) on automatic calls.

4. *Overflow from system No. 5 to system No. 4*

4.1 In an exchange equipped with system No. 4 and system No. 5 it may be desirable to provide for overflow from a group of circuits operated by system No. 5 to a group operated by system No. 4. This may be the case for a call outgoing from an exchange A (Figure 1/Q.180) or for a call from an outgoing exchange K (Figure 2/Q.180) and arriving via a group of circuits in system No. 4 at transit exchange T where a choice must be made between a first-choice route operated by system No. 5 and an overflow route operated by system No. 4.

---

[1] These register functions may be combined in a single register.

4.2 There are two possible ways of arranging for the overflow, in particular in respect to the moment at which the decision is taken to use the overflow route:

- Single exploration;
- Double exploration;.

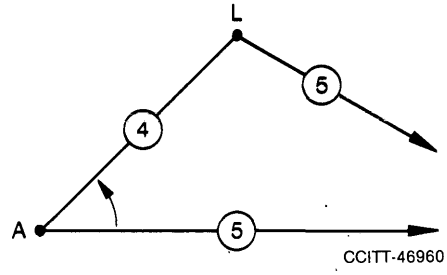


FIGURE 1/Q.180

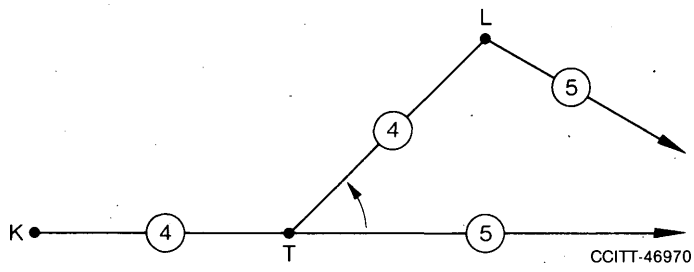


FIGURE 2/Q.180

4.2.1 *Single exploration*

With single exploration, the state of occupation, or availability, of the system No. 5 group at exchange A or exchange T is considered only when the condition ST is determined at this exchange in the system No. 5 outgoing register.

a) If the exploration at A or at T shows that no free circuit in the system No. 5 group is available, overflow to the system No. 4 group takes place.

For this overflow the register has all the numerical information (even in the case of a transit register like that of the T exchange mentioned above), and the end-of-pulsing indication ST. The register at the transit exchange T will be regarded, for successive selection operations, as an outgoing system No. 4 register. Thus, in this case, signalling between the three system No. 4 registers involved will be link-by-link and not end-to-end.

In the case of Figure 2, as soon as the ST condition is available (at the latest immediately after the 5 ± 1 seconds delay provided for in the specifications for system No. 5) the number-received signal will be sent back from T to K in system No. 4.

The ST condition will also be used to cause the end-of-pulsing signal (code 15) to be sent forward from T to L, even in automatic working. The code-15 signal will cause the number-received signal to be sent back from L to T, so that there will be no need to wait for five or ten seconds at L before it is known that a complete number has been received.

The number-received signal sent by T will be received at K and will, in the case of an automatic call, release the outgoing register at that exchange. The second number-received signal, which will be sent by L, will be received at T to release the register at that exchange, despite the fact that the register has transmitted an end-of-pulsing signal which could have been used for releasing the register. The establishment of the speech path at T takes place immediately after the release of the register.

If in the case of Figure 1/Q.180 the ST condition is recognized in the outgoing exchange A, this same condition will also be used to cause the sending of the end-of-pulsing signal (code 15) from A to L, even in automatic operation. This end-of-pulsing signal will in the same way cause the number-received signal to be sent back from L to A.

b) If the exploration at A or at T shows that a free circuit in the system No. 5 group is available, the *en bloc* numerical information has to be transmitted over this circuit, followed by the end-of-pulsing signal ST, in accordance with the specifications for system No. 5

In the case of Figure 2/Q.180, the conditions for the number-received signal and the release of the outgoing register are the same as under 4.2.1 a).

4.2.2 *Double exploration*

With double exploration the state of availability of the system No. 5 circuit group is examined twice, namely:

- as soon as the direction to be chosen is determined;
- after receipt of the complete numerical information.

With the double exploration, advantage is taken of the fact that, without awaiting condition ST, exchange A or exchange T can know that the direct route by system No. 5 is occupied as soon as the direction to be chosen is determined.

a) If the first exploration at A or at T shows that no free circuit in the system No. 5 group is available, overflow to the system No. 4 group should take place immediately; the use of the signals on the system No. 4 circuit(s) must be in accordance with the normal procedure of that system:
   - in the case of Figure 2, end-to-end working (K-T-L) for the numerical signals and the number-received signal;
   - the end-of-pulsing signal (code 15) only for semi-automatic calls.

The procedure of overflow at this first exploration reduces post-dialling delay in automatic working since there is no need to wait until all the digital information is assembled *en bloc* before proceeding with the setting up of the connection. On the other hand, there is a slight reduction in the efficiency of the first choice system No. 5 group.

b) After the first exploration has shown no congestion of the system No. 5 group, it may happen, during or after reception in the outgoing register at A (or transit register, in the case of T) of the digits following the digits necessary to determine the routing, that the system No. 5 group gets busy, more particularly because such a circuit group is a first-choice high-usage route with consequently a high probability of loss. When this happens, after noting by this second exploration that all circuits in the system No. 5 group are busy, overflow to the system No. 4 group takes place.

   For this case of overflow, the conditions can be considered to be the same as in 4.2.1 a).

c) If also the second exploration shows no congestion of the system No. 5 group, the conditions mentioned in 4.2.1 b) fully apply.

4.3 Line signalling for calls set up in overflow through two successive No. 4 systems will be done normally, that is, end-to-end. The number-received signal, however, will be sent as stated in 4.2.1 a), 4.2.2 a) or 4.2.2 b).

5. *Interworking line signalling conditions*

5.1 *Forward-transfer signal*

The forward-transfer signal, in the event of a transit call going from system No. 4 to system No. 5, or from system No. 5 to system No. 4, should cause the assistance operator to intervene in the country of arrival, and not at the transit exchange.

The incoming line relay set of the first system at the transit exchange is informed, e.g. by the transit register, that the call is a transit call. Hence, when a forward-transfer signal arrives on the first system, it causes the forward-transfer signal to be transferred to the outgoing line relay set of the second system without intervention by the operator at the transit exchange.

5.2 *Answer signal*

5.2.1 *System No. 4 to system No. 5 (traffic direction)*

The answer signal on the system No. 4 link should be sent only after complete recognition of the answer signal received from the system No. 5 link, i.e. overlap transmission should not be used.

The considerations for this requirement are:

- the overlap technique could give rise to troubles in signalling system No. 4 in case of imitation of the P signal;
- in the transfer of the answer signal from system No. 5 to system No. 4 the sending end line split (silent period) before starting P is a necessity due to the pulse type signals of system No. 4. The requirement for this sending-end line split period (40 ± 10 ms) would have meant little speed advantage of overlap operation in transferring the answer signal from system No. 5 to system No. 4 (about 50 ms);
- overlap operation would be contrary to the design characteristic of system No. 4 in that once the sending of a signal has begun it must be sent completely.

5.2.2 *System No. 5 to system No. 4 (traffic direction)*

In the interworking arrangements in a transit centre for transferring the answer signal backward from system No. 4 to system No. 5, overlap transmission should not be used.

In system No. 4 overlap operation is incompatible with the use of time measurement for recognition of the suffix signal (short suffix or long suffix). The overlap operation would not permit waiting for the end of a signal PY (answer signal), to determine that it is not a PYY signal release-guard signal).

5.3 *Busy-flash signal*

In the case of interworking at a transit point from system No. 4 to system No. 5 or vice versa, a busy-flash signal received at that transit point from the outgoing circuit is to be converted to a busy-flash signal on the incoming circuit.

In the case of interworking from system No. 5 to system No. 4, the busy-flash signal will cause the release of the international connection initiated from the outgoing exchange.

In the case of interworking from system No. 4 to system No. 5, the system No. 5 equipment at this transit exchange should function as an outgoing system No. 5 equipment on the receipt of a busy-flash signal and release the system No. 5 circuit from the transit point. It should be noted that the system No. 4 circuit is also released in the case of automatic calls.

Note – In the case of interworking from system No. 5 to system No. 4 it has been determined that no advantage is to be gained by the release of the international connection being initiated only by the outgoing exchange. Therefore in both cases of interworking, the transit exchange and the forward connection may be released immediately on receipt of the busy-flash signal. However, there is no need to modify existing equipment.

5.4 *Time-out delays to clear a connection in the event of signal failures*

5.4.1 *Non-reception of a clear-forward signal after a clear-back signal has been sent*

In the event of transit working from system No. 4 to system No. 5 at an exchange T, this latter represents the terminal for system No. 4.

The action to be taken at an international incoming exchange for system No. 4 holds good for the exchange T. After a time-out of 2 to 3 minutes, the system No. 4 incoming equipment at T should produce an effect forward on the circuit of system No. 5, so as to release the international circuit (for example, should there be some interruption in the system No. 4 circuit). This release should proceed in the same way as the release of the national part of the connection, when the incoming exchange is indeed the incoming international exchange of the international connection.

For symmetry's sake, the action at T to release the connection should also be undertaken when there is transit working from system No. 5 to system No. 4, since a time-out of 2 to 3 minutes exists in system No. 5 to release the connection forward.

5.4.2 *Delay in clearing by the calling subscriber in automatic working*

In the case of automatic calls with interworking from system No. 4 to system No. 5, or from system No. 5 to system No. 4, release of the international connection as brought about by the time-out of 1 to 2 minutes must take place *at the outgoing exchange only*, and not at the exchange T, the point of connection of the two systems. In exchange T, the outgoing line relay sets of the second system in the connection must accordingly be marked that they are acting, not as relay sets for the terminal outgoing end of the system in question, but as transit exchange relay sets.

5.4.3 *Non-reception of an answer-signal at the outgoing exchange after reception of a number-received signal or generation of the ST condition*

When a connection passes through system No. 4 towards system No. 5, or vice versa, release must be undertaken *at the outgoing exchange only*. Hence nothing must be done at the transit exchange T, the point at which systems Nos. 4 and 5 are connected.

In the case of system No. 4 towards system No. 5, exchange T represents the connecting transit exchange for both systems. Non-reception at T of an answer-signal within 2 to 4 minutes after condition ST has been determined must produce *no* effect at exchange T. It will be for the outgoing exchange to cause release (by sending the clear-forward signal) on the 2 to 4 minutes' time-out after reception of the number-received signal from exchange T.

In the case of system No. 5 towards system No. 4, exchange T represents the connecting transit exchange for both systems. Non-reception at T of an answer-signal within 2 to 4 minutes after reception of the number-received signal from the incoming exchange must *not* affect exchange T. It will be for the outgoing exchange to cause release of the connection (by sending the clear-forward signal) after the delay of 2 to 4 minutes following the generation of the ST condition at that exchange.

ANNEXES TO INTERWORKING SPECIFICATIONS OF SYSTEMS No. 4 AND No. 5

ANNEX 1

Signalling sequences in interworking from system No. 4 to system No. 5

ANNEX 2

Signalling sequences in interworking from system No. 5 to system No. 4

In these tables the arrows have the following meanings:

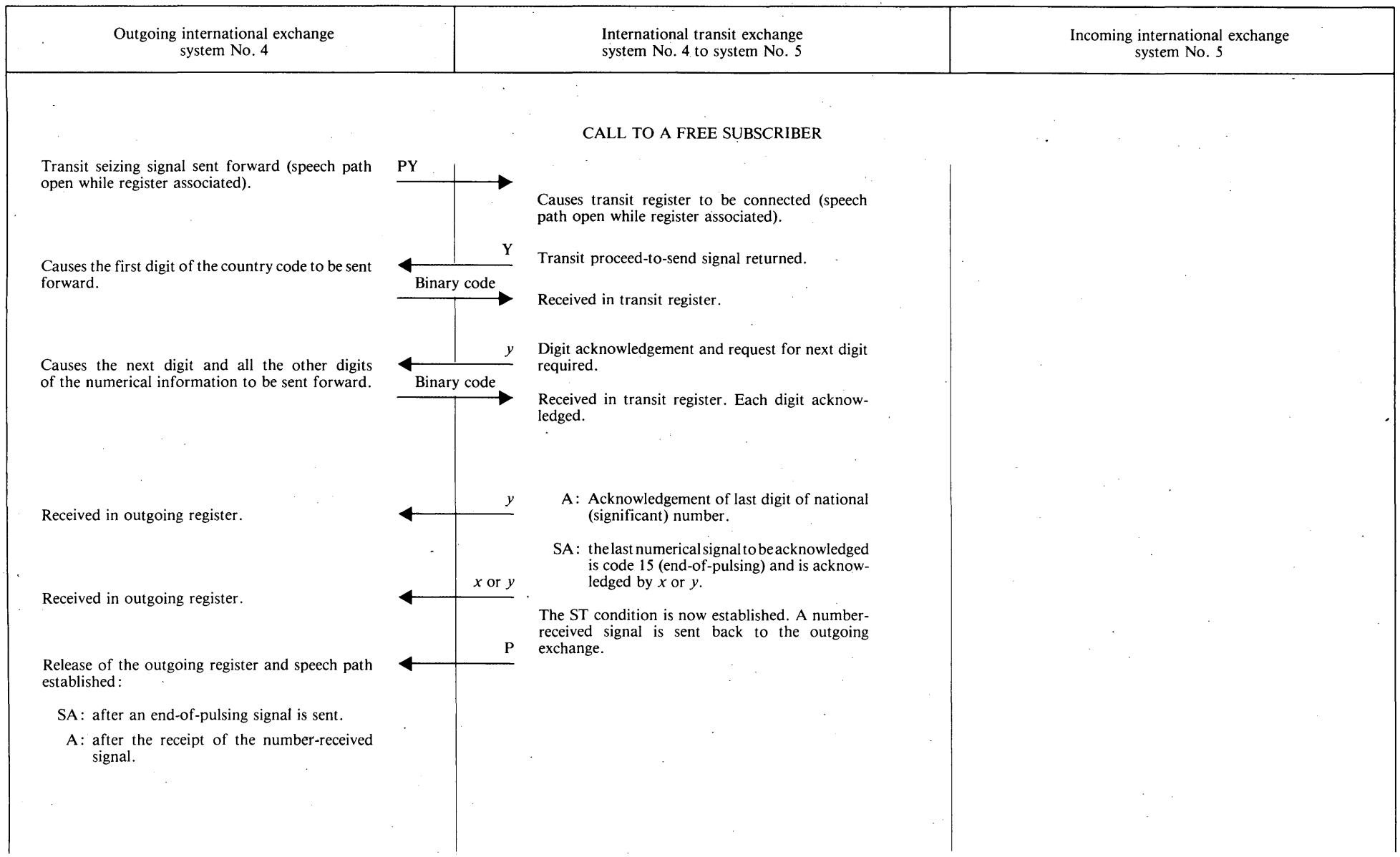
——▶ transmission of a signalling frequency (permanent or pulse emission).

- - - - -▶ end of transmission of the signalling frequency in the case of its permanent transmission.

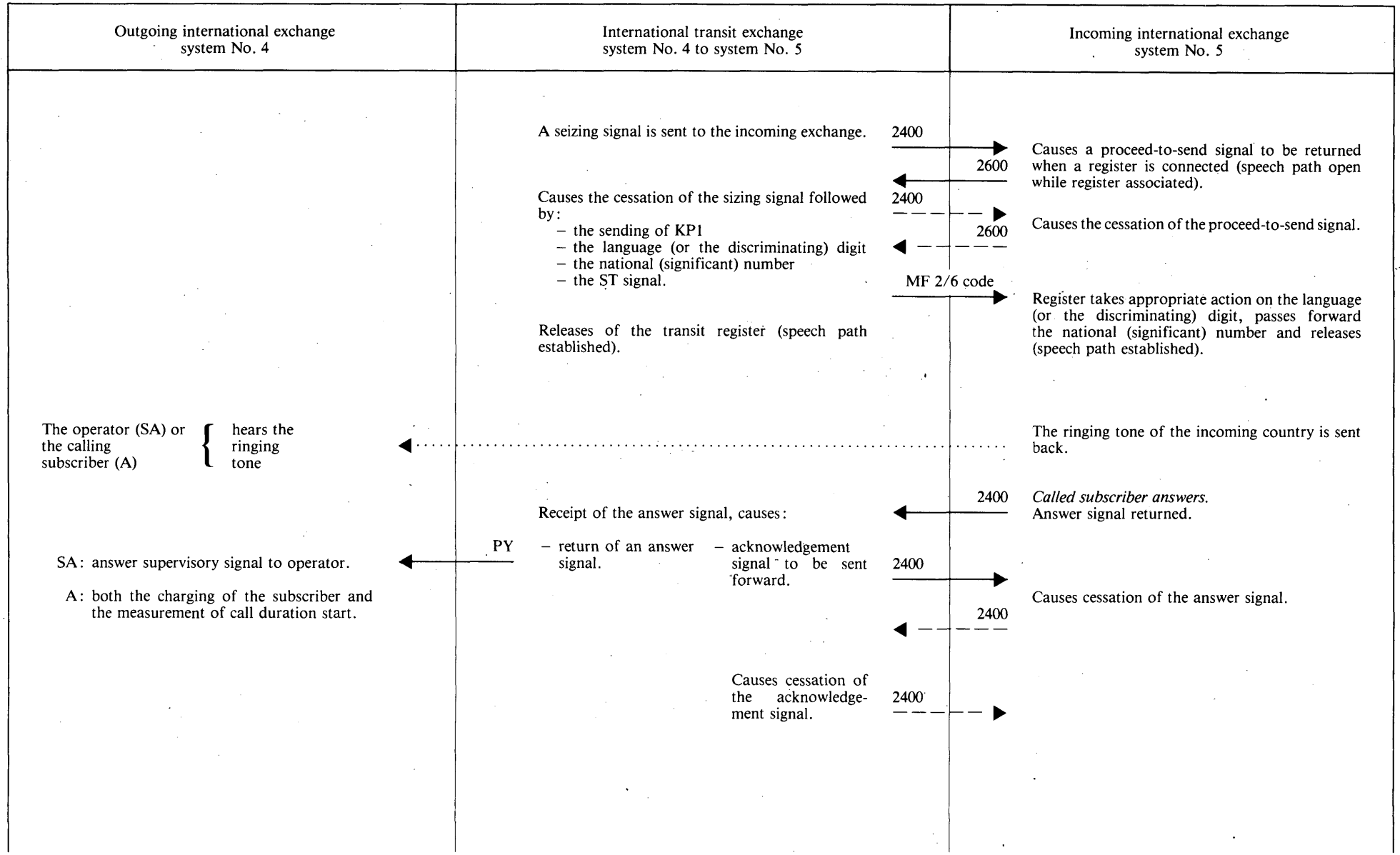
·····▶ transmission of an audible tone.

ANNEX 1

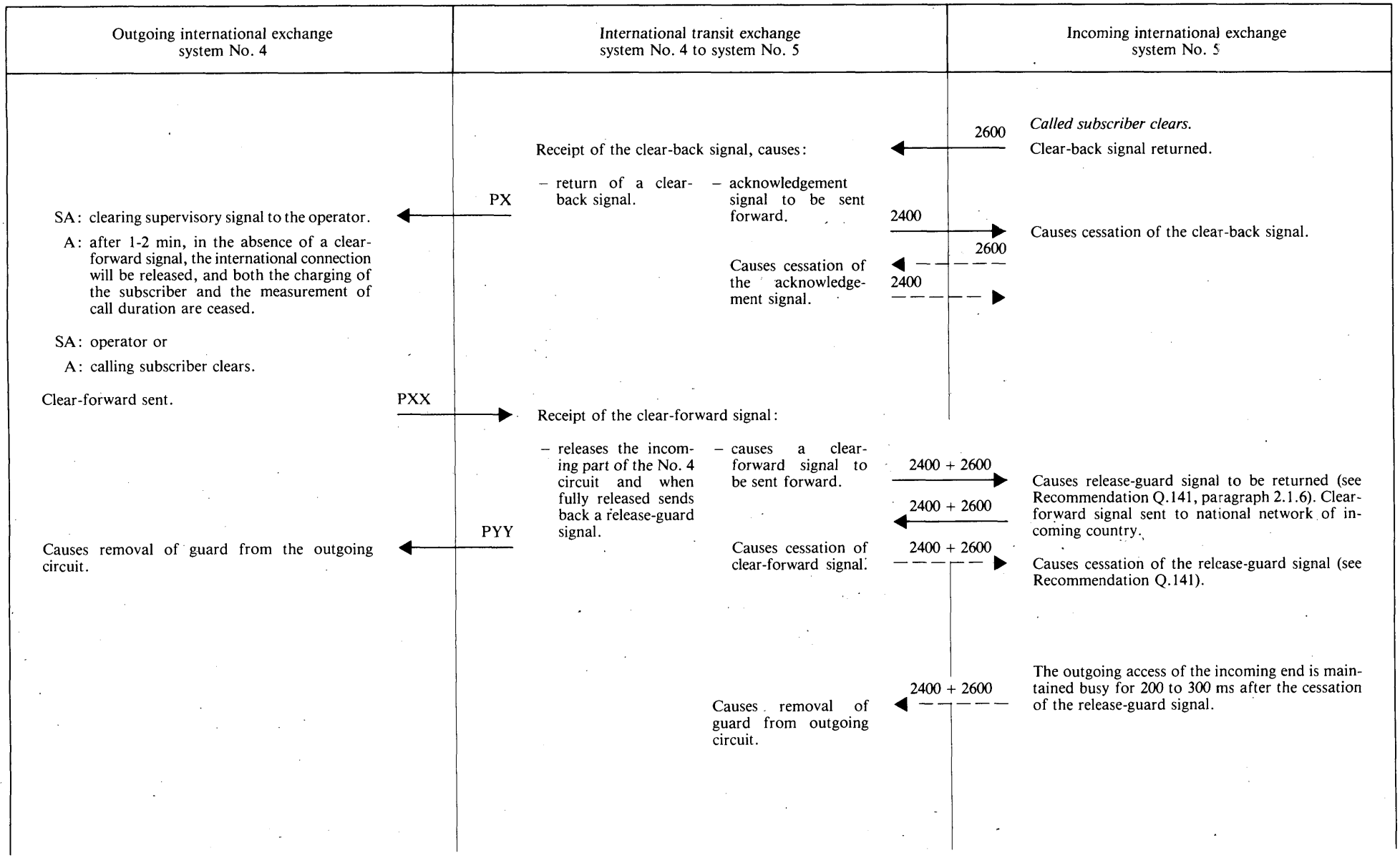
Signalling sequences in interworking from system No. 4 to system No. 5



ANNEX 1 *(continued)*



ANNEX 1 *(continued)*



Outgoing international exchange system No. 4	International transit exchange system No. 4 to system No. 5	Incoming international exchange system No. 5

CALL TO A BUSY SUBSCRIBER (OR CONGESTION)

The sequence of signals is the same as for a call to a free subscriber up to the point at which the incoming register releases.

Outgoing international exchange system No. 4	International transit exchange system No. 4 to system No. 5	Signals	Incoming international exchange system No. 5
			1st Case
	Receipt of the busy-flash signal, causes:	◄ 2600	The national network of the incoming country can give a busy-flash signal. This is detected by the incoming international exchange which returns the busy-flash signal.
SA: the operator is given a busy indication, the operator then releases the connection. ◄ PX	– the sending back of a busy-flash signal. – the sending of the acknowledgement signal.	2400 ►	Causes the cessation of the busy-flash signal.
A: the clear-forward signal is sent forward to automatically release the system No. 4 circuit. The calling subscriber hears the busy tone from the outgoing (national or international) exchange.	Causes the cessation of the acknowledgement signal.	◄ 2600 (dashed)	
	The cessation of the busy-flash acknowledgement signal is followed by the sending forward of the clear-forward signal to the incoming international exchange to automatically release the system No. 5 circuit.	2400 ► (dashed)	
			2nd Case
The operator and/or the calling subscriber hears the busy tone and releases the connection. ◄ · · · · ·	· · · · ·	· · · · ·	The national network of the incoming country cannot give a busy-flash signal. The busy tone of the incoming country is sent back.

ANNEX 1 *(concluded)*

Outgoing international exchange system No. 4	International transit exchange system No. 4 to system No. 5	Incoming international exchange system No. 5

SPECIAL CONDITIONS

1st Case:

SA: Following a call switched automatically to a subscriber, or following a call established via a special number incoming or delay operator, the controlling operator wishes to call in an assistance operator at the incoming international exchange. A forward-transfer signal is sent.

PYY → Causes the sending of a forward-transfer signal on the next circuit.

2600 → Causes an assistance operator to intervene at the incoming international exchange.

2nd Case:

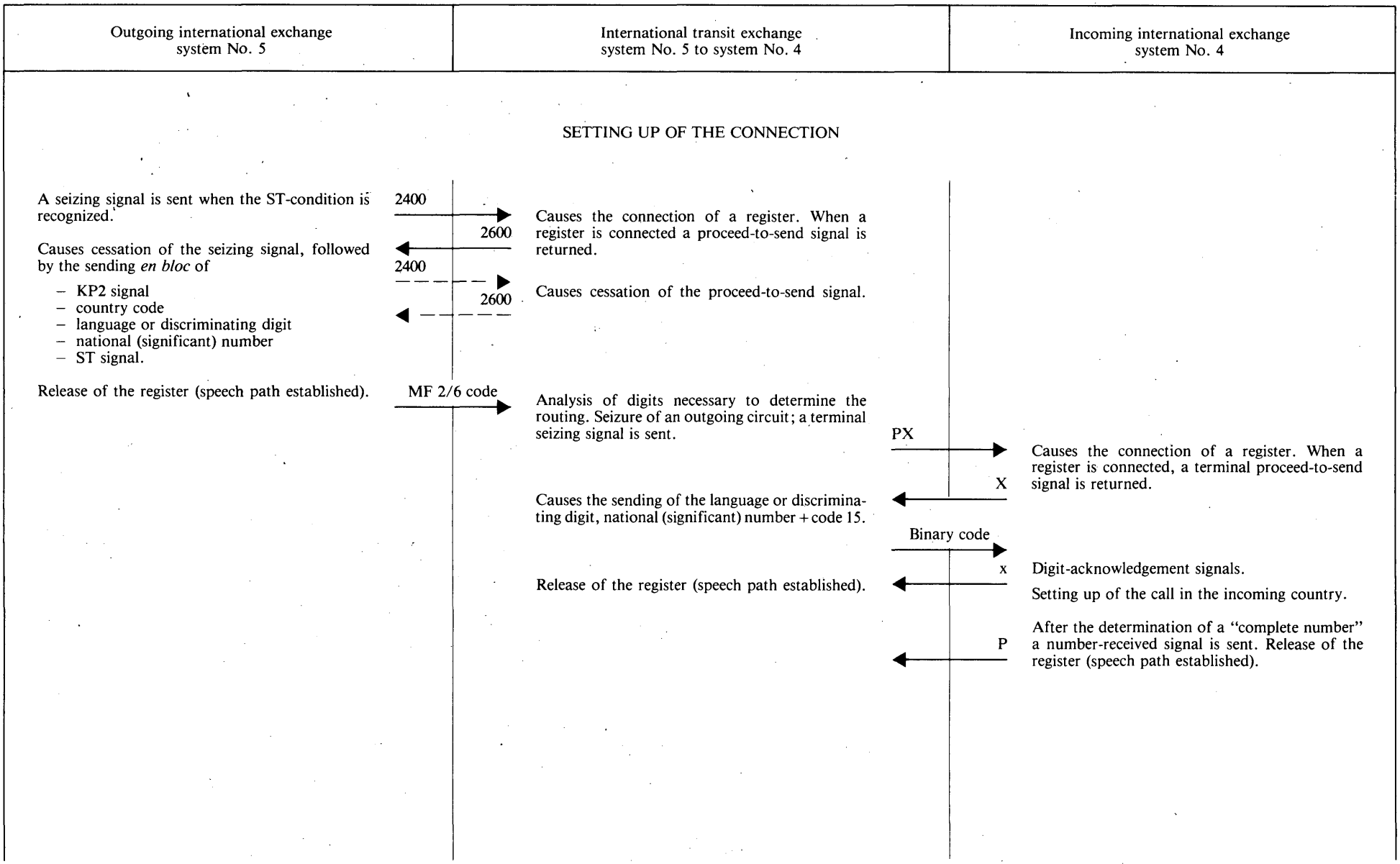
SA: Following a call via code 11 or 12, the controlling operator wishes to recall the incoming operator at the incoming international exchange. A forward-transfer signal is sent.

PYY → Causes the sending of a forward-transfer signal on the next circuit.

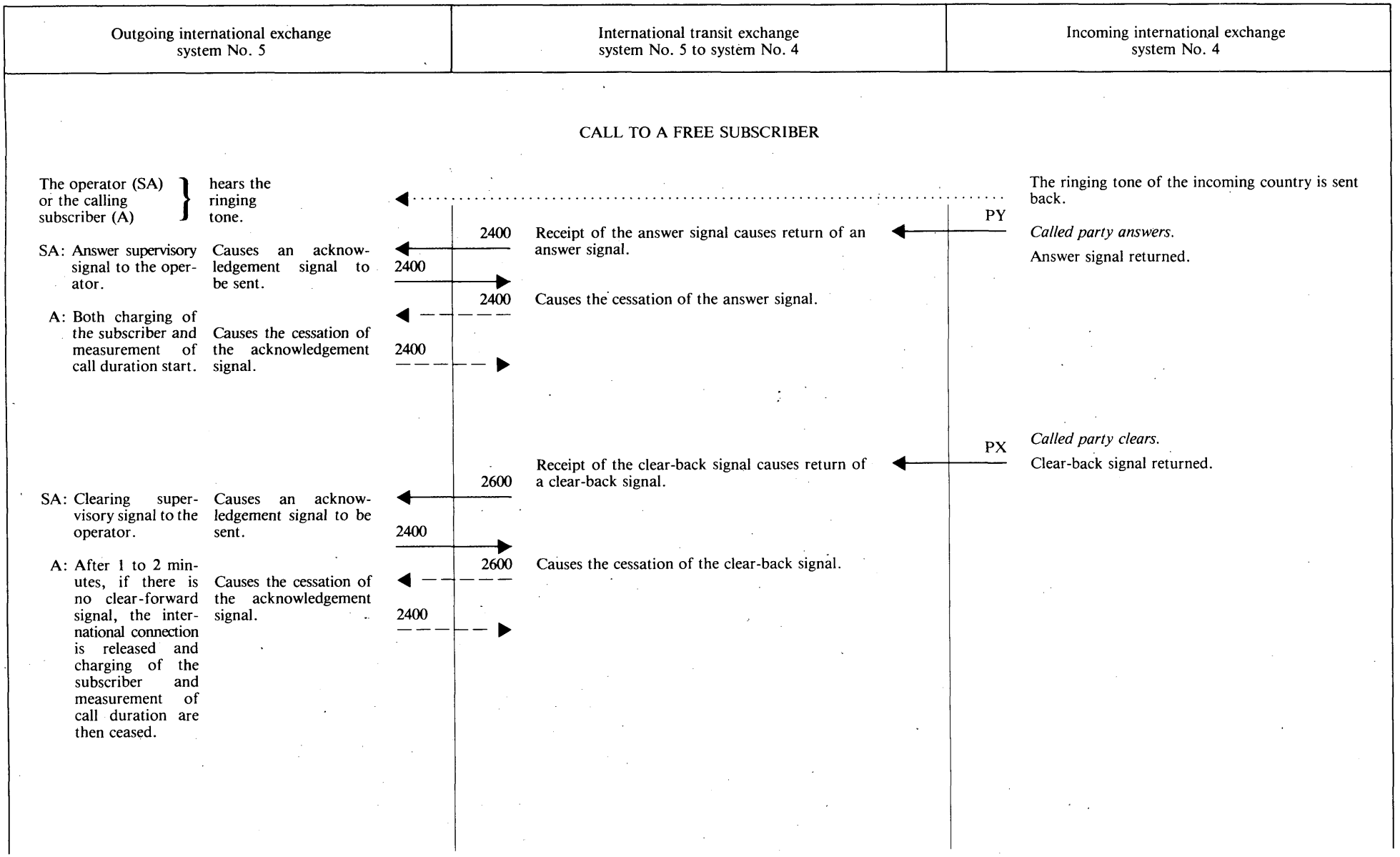
2600 → Recalls the incoming operator on calls completed via the operator positions of this incoming international exchange.

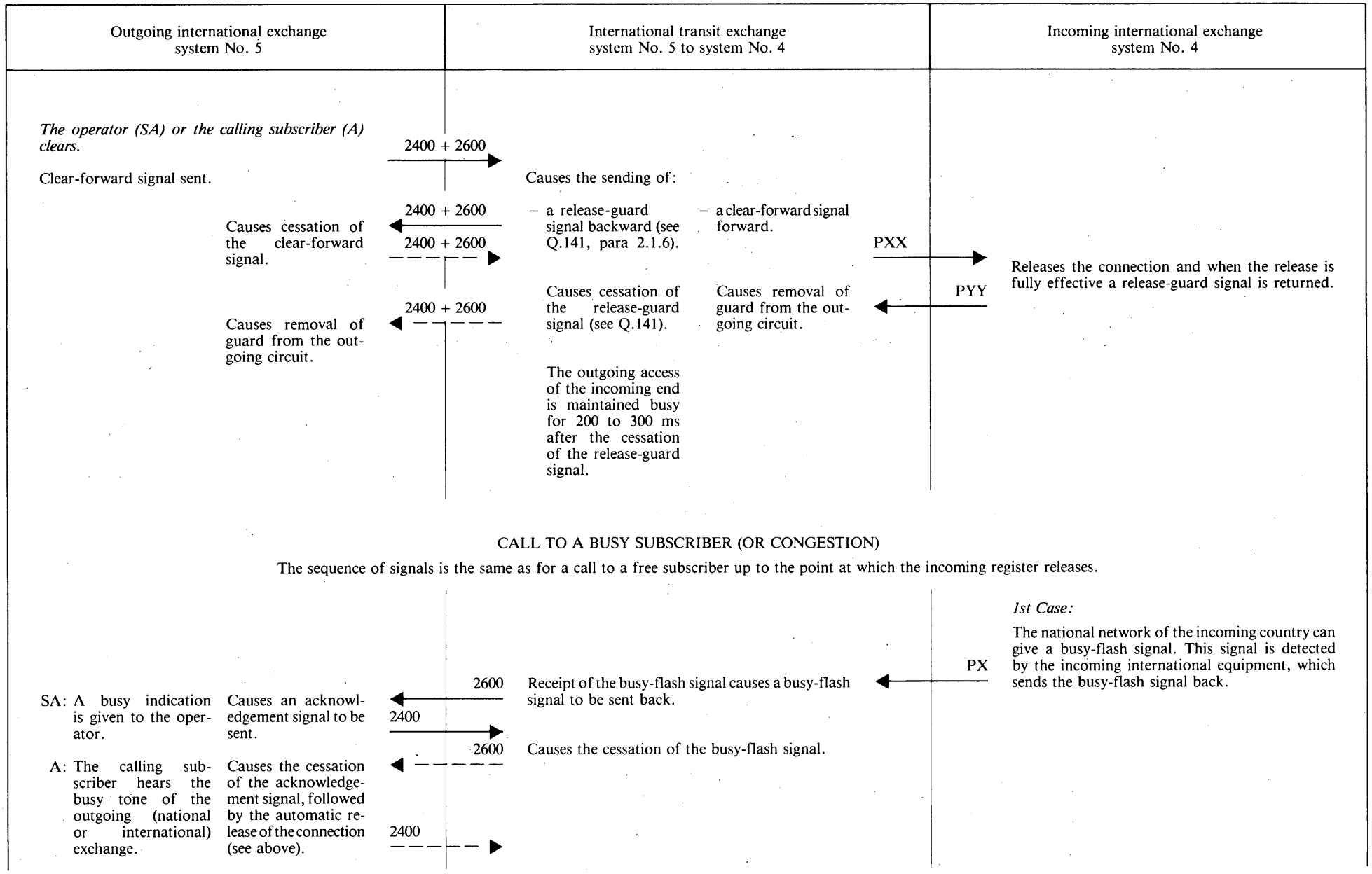
ANNEX 2

Signalling sequences in interworking from System No. 5 to System No. 4



ANNEX 2 *(continued)*




Outgoing international exchange system No. 5
International transit exchange system No. 5 to system No. 4
Incoming international exchange system No. 4
The operator (SA) or the calling subscriber (A) clears.
2400 + 2600
Clear-forward signal sent.
Causes the sending of:
– a release-guard signal backward (see Q.141, para 2.1.6).
– a clear-forward signal forward.
2400 + 2600
Causes cessation of the clear-forward signal.
2400 + 2600
PXX
Releases the connection and when the release is fully effective a release-guard signal is returned.
PYY
Causes cessation of the release-guard signal (see Q.141).
Causes removal of guard from the outgoing circuit.
2400 + 2600
Causes removal of guard from the outgoing circuit.
The outgoing access of the incoming end is maintained busy for 200 to 300 ms after the cessation of the release-guard signal.
CALL TO A BUSY SUBSCRIBER (OR CONGESTION)
The sequence of signals is the same as for a call to a free subscriber up to the point at which the incoming register releases.
1st Case:
The national network of the incoming country can give a busy-flash signal. This signal is detected by the incoming international equipment, which sends the busy-flash signal back.
PX
2600
Receipt of the busy-flash signal causes a busy-flash signal to be sent back.
SA: A busy indication is given to the operator.
Causes an acknowledgement signal to be sent.
2400
2600
Causes the cessation of the busy-flash signal.
A: The calling subscriber hears the busy tone of the outgoing (national or international) exchange.
Causes the cessation of the acknowledgement signal, followed by the automatic release of the connection (see above).
2400

ANNEX 2 *(concluded)*

Outgoing international exchange system No. 5	International transit exchange system No. 5 to system No. 4	Incoming international exchange system No. 4
The operator and/or the calling subscriber hears the busy tone and releases the connection (see above). ◄	.....	*2nd Case:* The national network of the incoming country cannot give a busy-flash signal. The busy tone of the incoming country is sent back.
SPECIAL CONDITIONS		
1st Case: SA: Following a call switched automatically to a subscriber, or following a call established via a special number incoming or delay operator, the controlling operator wishes to call in an assistance operator at the incoming international exchange. A forward-transfer signal is sent.	2600 → Causes the sending of a forward-transfer signal on the next circuit.	PYY → Causes an assistance operator to intervene at the incoming international exchange.
2nd Case: SA: Following a call via code 11 or 12, the controlling operator wishes to recall the incoming operator at the incoming international exchange. A forward-transfer signal is sent.	2600 → Causes the sending of a forward-transfer signal on the next circuit.	PYY → Recalls the incoming operator on calls completed via the operator positions of this exchange.

Printed in Switzerland — ISBN 92-61-01061-X