ANNEX III

MODIFIED CCITT R2 SIGNALLING

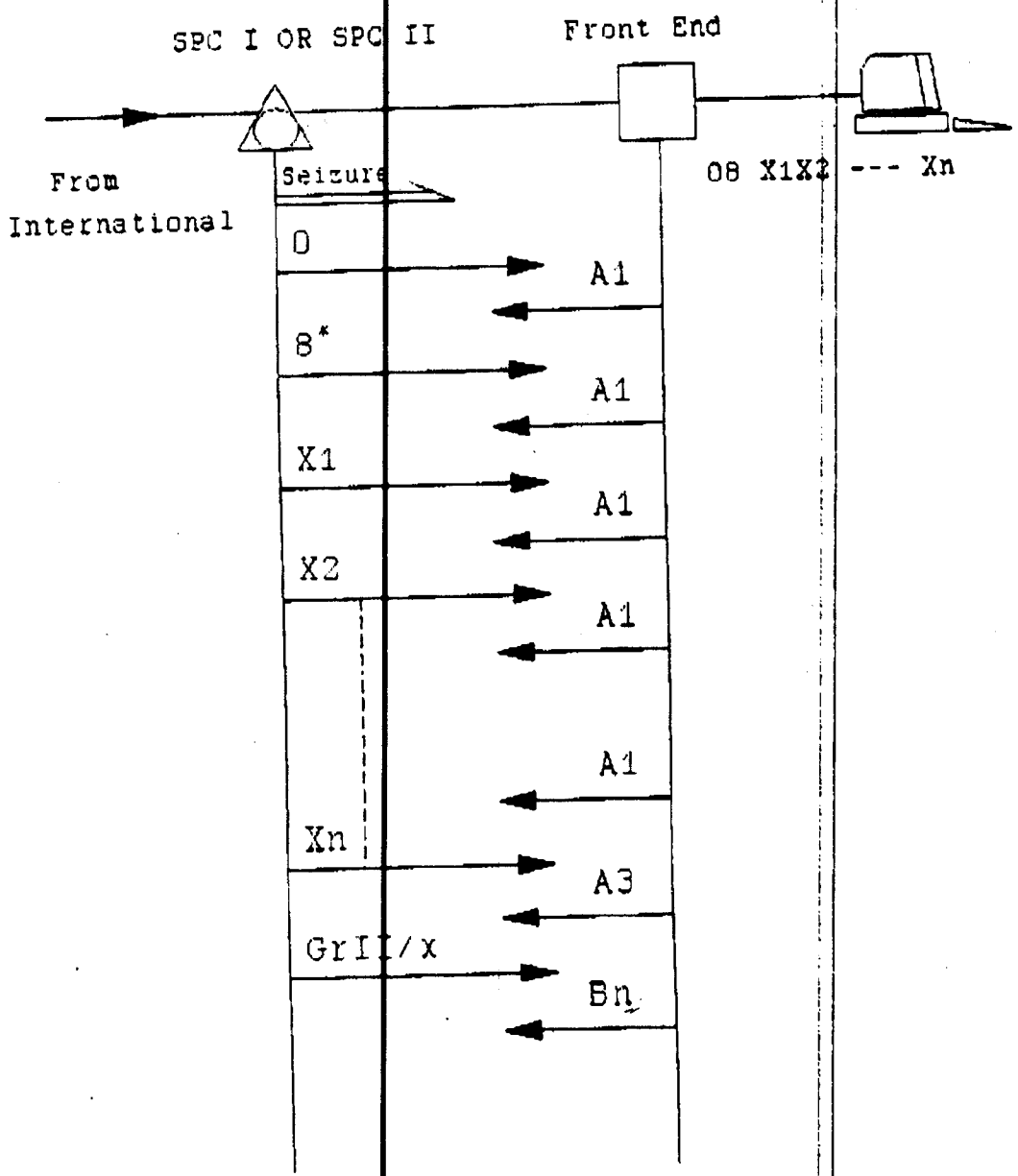
1. DIGITAL LINE SIGNALLING

Codes, Time Requirements and sequence of the digital line signals shall be according to the following charts :

Signal		Code				Direction
		Forward		Backward		
No.	Name	af	bf	ab	bb	
1	Idle	1	0	1	0	
2	Seizure	0	0	1	0	Forward
3	Seizure Acknowledgement	0	0	1	1	Backward
4	Answer	0	0	0	1	"
5	Clear-back	0	0	1	1	"
6	Forced release	0	0	0	0	"
7	Clear-forward	1	0	0	1	Forward
				or		
				1	1	
8	Release-guard	1	0	1	0	Backward
9	Blocking	1	0	1	1	"
10	Operator signal	0	0			Forward
		1	0(	150ms)		
		0	0			

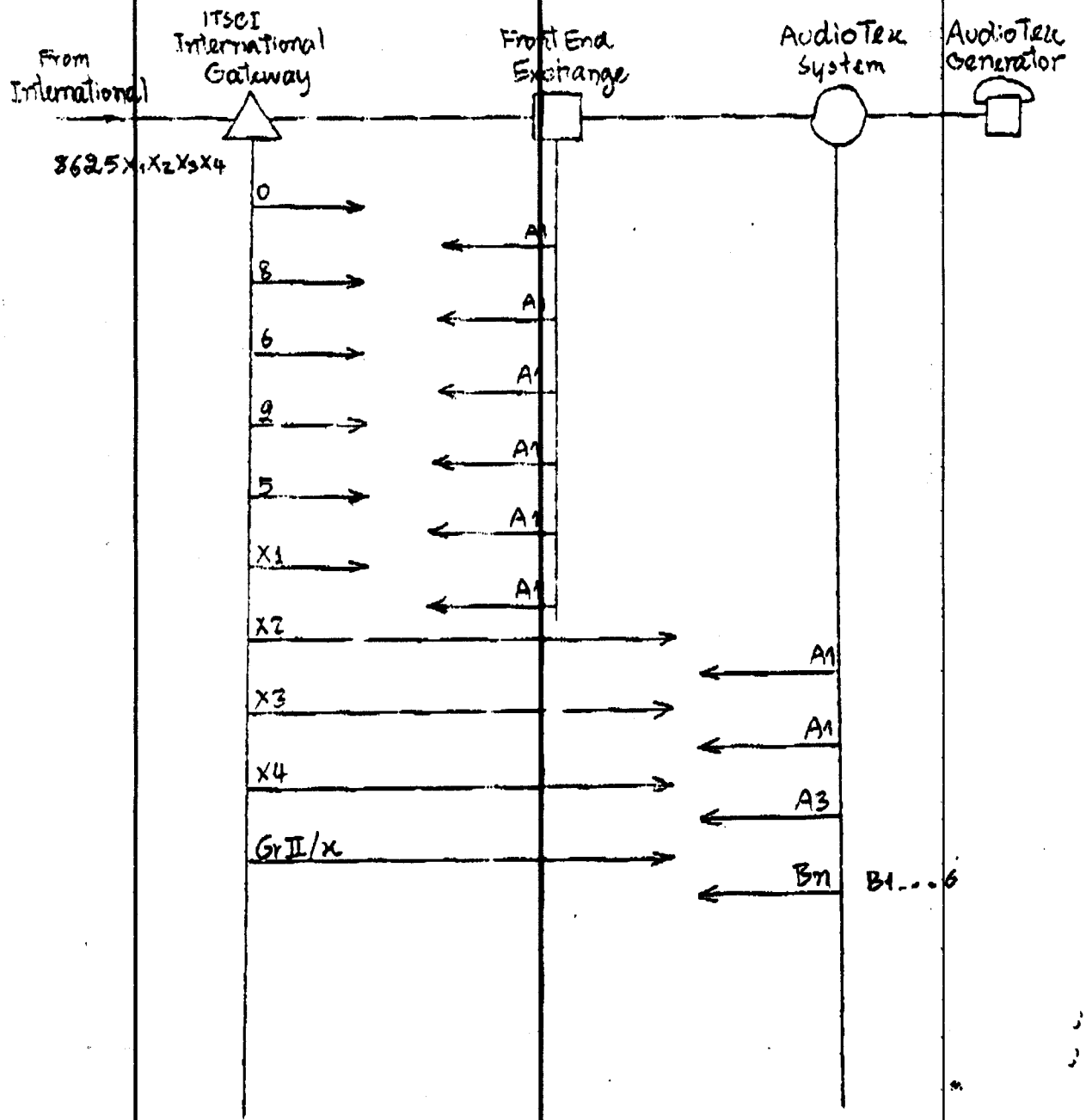
af, bf - Signalling channels in forward direction
ab, bb - Signalling channels in backward direction

Case 3 Call from SPC I or SPC II to Front-End Subcriber

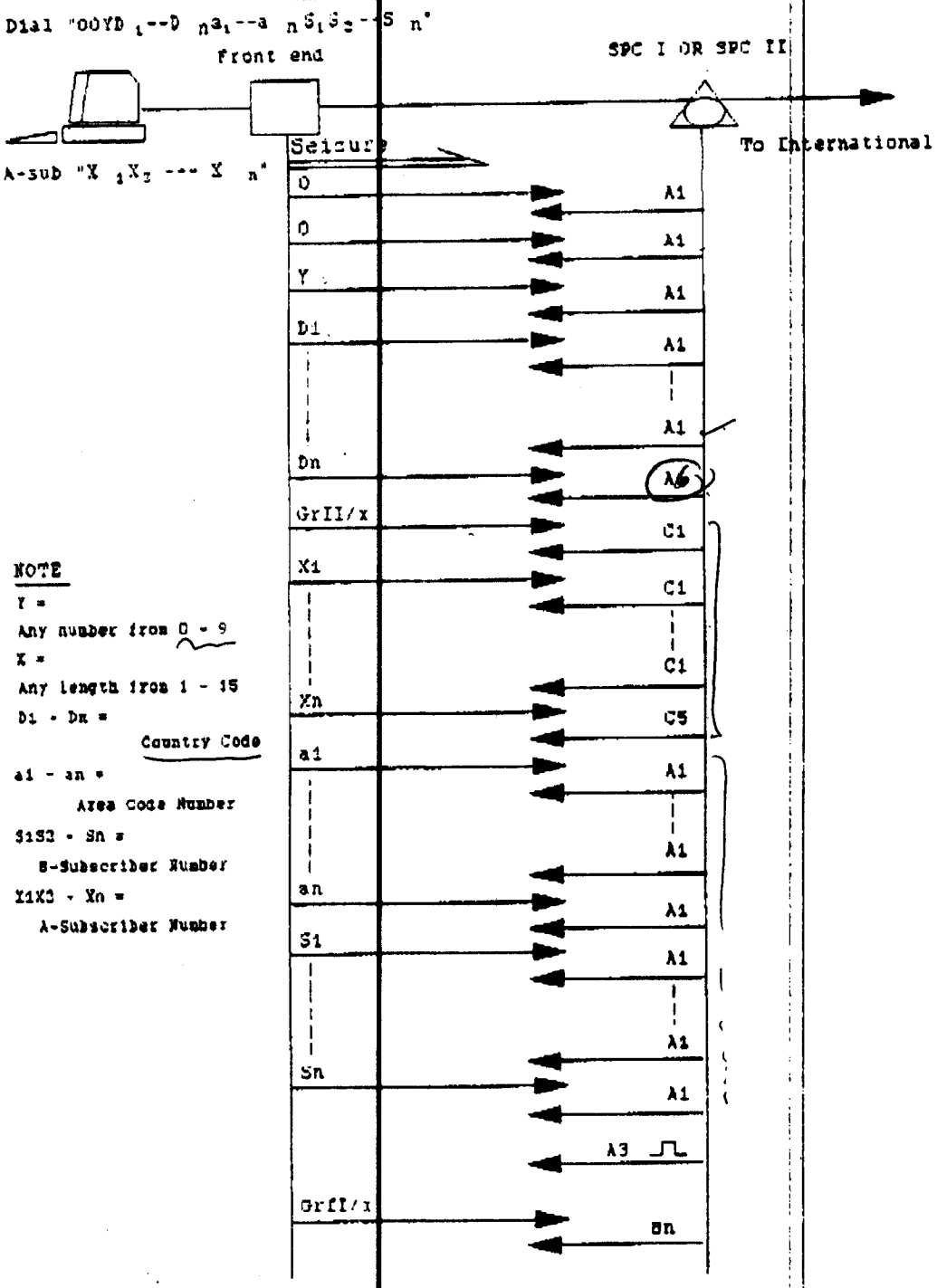


* "8" TENTATIVE DIGIT

Incoming Call from Oversea



Case 2 ISD Call From Front-End Subscriber to SPC I or SPC II



NOTE

Y =
Any number from 0 - 9

X =
Any length from 1 - 15

D1 - Dn =
Country Code

a1 - an =
Area Code Number

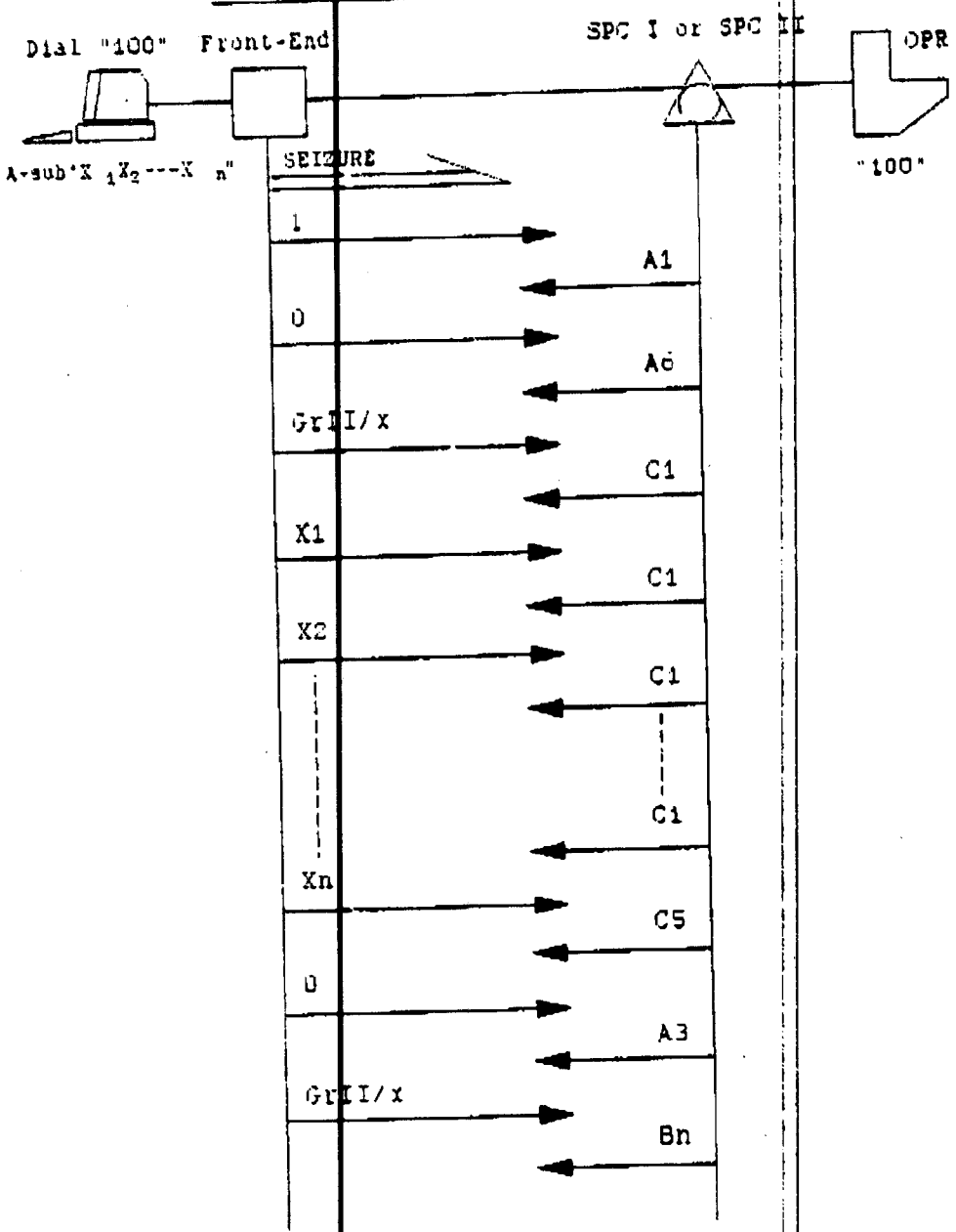
S1S2 - Sn =
S-Subscriber Number

X1X2 - Xn =
A-Subscriber Number

(2)

3. Traffic Cases

Case 1 Call from Front-End subscriber to operator of SPC I or SPC II



d) Technical fault.

B-5 : Called subscriber free, no charge

Speech conditions are set up as with signal B-1, but the charging is suppressed.

B-6 : Called subscriber free, last party release

This signal is used to indicate that the circuit chain must remain under the control of the incoming equipment. This signal is used mainly for malicious call tracing.

V Backward Signals of Group C

These signals are used for requesting the calling subscriber's number

C-1 : Send next digit of calling number

On receipt of this signal the calling exchange shall transmit the next digit of the calling subscriber number. The first C-1 signal shall mean send the first digit of the calling subscriber number. The request for the calling subscriber's number can be terminated in one of the following ways.

a) The outgoing register terminates an identification by answering a C-1 signal with the signal I-15 when all the digits of the calling subscriber have been sent.

b) The incoming register terminates an inquiry sequence by sending one of the signals C-2, C-5.

C-2 : The meaning of this signal is the same as A-2.

C-3 : Spare

C-4 : The meaning of this signal is the same as A-4.

C-5 : The meaning of this signal is the same as A-1.

C-6 : Spare.

A-2 : Send First Digit of Called Number

The EXCHANGE shall transmit the first digit of the called subscriber's address digit.

A-3 : Send Nature of Calling Number and Change to B-Signal

The EXCHANGE shall transmit the calling party's category using forward signals of group II. The particular signal transmitted shall be related to the calling subscriber's originating classification. Subsequent backward signals shall be interpreted as group B signal.

A-4 : Congestion

This signal is sent when the called exchange encounters link busy, all trunk busy or other trouble conditions. If this signal is received, the calling exchange shall release all the switching equipment engaged in the connection.

A-5 : Spare

A-6 : Send Nature of Calling Number and Change to C-Signal

This signal is sent when the identity of the calling subscriber is required. The calling exchange shall transmit the calling party's category using forward signal of group II. Subsequent backward signals shall be interpreted as group C-signal.

IV Backward Signals B series

This signal is received on a call to a called subscriber connected to a distant exchange. These signals indicate the condition of the called subscriber. Upon receiving these signals the originating exchange shall perform the following action.

B-1 : Called subscriber free, with metering

This signal indicates that the called subscriber's line is idle. The originating exchange shall set up the speech condition. In this case, the subsequent answer signal shall start the call-charging.

B-2 : Called subscriber's line busy

This signal indicates that the called subscriber's line is busy. The originating exchange shall release the circuit chain and transmits the busy tone to the calling subscriber. When the call is set up by an operator with trunk offering facility, the operator register shall not release the circuit chain.

B-3 : Called subscriber's line intercepted

This signal indicates that the called subscriber's line is intercepted. The originating register shall release the circuit chain and shall re-route the call to the terminating area interception center using forward signal 11 of group I followed by the called number.

B-4 : Congestion

This signal indicates :

a) Congestion in the final selector stage.

b) Called subscriber's line supervised by operator.

c) Line lock-out of the called subscriber's line.

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(a) If the line is free, one of the signal B-1, B-3 or B-6 shall be sent according to the classification of the called subscriber and the call shall be switched through.

(b) If the line is busy, a B-2 signal shall be sent.

(c) If congestion occurs, a B-4 signal shall be sent.

II-3 : This signal indicates that the call is originated from coin telephone. On receipt of this signal, the operation shall be as for signal II-2.

II-4 : This signal is reserved for multi-coin telephone.

II-5 : This signal indicates that the call is originated from STD coin telephone. On receipt of this signal, the operation shall be as for signal II-2.

II-6 : This signal indicates that the call is originated from test equipment. On receipt of this signal, the operation shall be as for signal II-2.

II-7 : This signal indicates that the call is originated from line test desk. The call shall be connected through or the called line even if it is busy, or line-lock-out. In other respects, action shall be as for signal II-2.

II-8 : This signal indicates that the call is originated from intercepted operator. The call shall override the interception classification (if encountered) and obtain connection to the called line if idle. In other respects, action shall be as for signal II-2.

II-9 : This signal is reserved for call originated from data terminal.

II-10: This signal indicates that the subscriber requires immediate charge information about the long distance call.

II-11 to II-14 : Spare.

II-15: This signal is sent forward by the originating exchange in response to backward signal A-6 (send category of calling subscriber) signal II-15 indicates that the category of the calling subscriber is not available.

III Backward Signals of Group A

These signal are sent backward in response to the forward signal of group I. These signals control the transmission of the called subscriber numbers and at the same time serve as an acknowledgement signal. The calling exchange shall be able to respond to a "Time-Limited" A-3 backward signal when the EXCHANGE is not sending a forward signal. If a "Time-Limited" A-3 backward signal is received, the EXCHANGE shall respond in the same way as for a continuous A-3 signal. The following action is required in response to these signals:

A-1 : Send Next Digit of Called Number

On receipt of this signal the calling exchange shall transmit the next digit of the called subscriber's address digit. If all the called subscriber address digits have been transmitted, the EXCHANGE shall stop sending a forward signal and wait for a "Time-Limited" A-3 backward signal.

I Forward Signals of Group I

Forward signals of group I are used for the transmitting of the called subscriber's address digits and/or special routing information.

I-1 to I-10

These signals are used for transmitting :

a. The called subscriber's address digit.

b. The number of the calling subscriber's line.

I-11 to I-14

These signals are used for routing information when one of the signals is sent out as the prefix signals over the circuit.

I-11 : This signal is used for routing a call to interception service center. The EXCHANGE shall prefix the called subscriber's address digits by this signal when the call is to be re-routed to the interception center.

I-12 : Spare.

I-13 : The signal is used as a prefix for routing calls to Automatic Maintenance Testing Equipments.

I-14 : Spare.

I-15 : This signal is sent forward by the originating exchange in response to backward signal C-1 (send next digit of calling subscriber's number). Signal I-15 indicates that :

a. Last digit of the calling subscriber's number has been removed.

b. The number of calling subscriber's number is not available (e.g. call from test equipment).

The use of signal I-15 shall also mean change to group A signal.

II Forward Signals of Group II

The forward signals of group II shall be sent forward by the originating exchange in response to the A-3 or A-6 signals. These signals indicate several broad categories of the calling subscriber. On receipt of group II signals the terminating exchange shall operate in the following manner.

II-1 : This signal indicates that the call is originated from operator with trunk offering facility. On receipt of this signal, the terminating exchange shall continue the signalling sequence as follows:

(a) If the line is free, signal B-1, B-3, B-5 or B-6 shall be sent backward according to the classification of the called subscriber and the call shall be switched through.

(b) If the line is busy, the B-2 signal shall be sent to the operator register, which does not release the connection in this case. On receipt of trunk offering signal, the call shall be switched through.

(c) If congestion occurs, the B-4 signal shall be sent.

II-2 : This signal indicates that the call is originated from ordinary subscriber. On receipt of this signal, the terminating exchange shall continue the signalling sequence as follows :

Register Signalling
Backward Signals

Signal No.	Group A	Group B	Group C
1	Send next digit of called number	Called subscriber free with metering	Send next digit of calling number
2	Send first digit of called number	Called Subscriber's line busy	Send first digit of called number (1)
3	Send nature of calling number and change to Group B signals	Called Subscriber's line intercepted	Spare
4	Congestion	Congestion	Congestion
5	Spare	Called subscriber's line free without metering	Send next digit (n+1) of called number (1),(2)
6	Send nature of calling number and change to Group C signals	Last party release	Spare

Note : 1) Return to A-signals after C2 and C5

2) n is the digit being sent when the identification started

(15)

Table 2
Register Signalling
Forward Signals

Signal No.	Group I	Group II
1	Digit 1	Operator
2	" 2	Ordinary subscriber
3	" 3	Coin box unit fee
4	" 4	Reserve for multi-coin box
5	" 5	STD coin box
6	" 6	Test equipment
7	" 7	Line test desk
8	" 8	Intercepted operator
9	" 9	Reserve for data transmission
10	" 0	Immediate charge information Service
11	Access to interception center	Spare
12	Spare	Spare
13	Access to maintenance equipment	Spare
14	Spare	Spare
15	a) End of A-number or b) Number not available	No information about the A-party's category

Note : On receipt of the B-3 signal, the originating register re-routes the call to the terminating area interception center using forward signal 11 of group I followed by the called number.
Immediate Charge Information means that A-party requests long distance telephone call charge immediately after the call is finished.

Table 1

Composition of the Multi-frequency Code

Combinations		Frequencies (Hz.)						
Signal No.	Numerical Values (x + y)	Forward direction (signals of group I&II)	1380	1500	1620	1740	1860	1980
		Backward direction (signals of group A,B&C)	1140	1020	900	780		
		Index (x)	f0	f1	f2	f3	f4	f5
		Weight (y)	0	1	2	4	7	11
1	0+1		x	y				
2	0+2		x		y			
3	1+2			x	y			
4	0+4		x			y		
5	1+4			x		y		
6	2+4				x	y		
7	0+7		x				y	
8	1+7			x			y	
9	2+7				x		y	
10	3+7					x	y	
11	0+11		x					y
12	1+11			x				y
13	2+11				x			y
14	3+11					x		y
15	4+11						x	y

(13)

collect all the address digits of called number for controlling the setting up of call within the secondary area. The transit register will acknowledge the digit that it received from the originating register by sending A-1 signal. When the originating register has run out of digit to send, no signal is transmitted between the originating register and the transit register until the latter receives the end of selection signal (A3). The transit register will send an A3 signal of specified length (nominally 150 ms.) to the originating register where upon the signalling will be continued in the normal compelled fashion.

2.6 SENDING CONDITIONS

2.6.1 Sending Level

The nominal sending level shall be -8 dBm0 for each frequency.

2.6.2 Tolerances at the Sending End

The allowed deviations are ± 1 dB in signal level and ± 4 Hz. in frequency from the nominal values. The difference in level between the two-frequency components of the signal shall not exceed 1 dB.

2.6.3 Signal supply Continuity

Two sets of signalling generators equipped with automatic change-over and alarm indications shall be provided. The standby set shall be automatically switched in and an urgent alarm shall be initiated, when the operating set supplies a signal with a level drop of 3 dB or more.

2.7 RECEIVING CONDITIONS

2.7.1 Working Range

The receiver shall function correctly under the following limits :

2.7.1.1 Signal frequency variation of ± 10 Hz. from nominal values.

2.7.1.2 Signal level variation lies between -5 dBm and -35 dBm for each single frequency provided that the difference in level between two simultaneous frequencies shall not exceed 5 dB.

2.7.2 Receiver Response Time

For all frequencies, each of the operate and release times shall be less than 20 ms. and the sum of the operate and release times should be less than 80 ms.

2.7.3 Sensitivity to Disturbances

Relays receiving signal of a level lower than -50 dBm shall neither operate nor be held.

2.8 TIME SUPERVISION

Time supervision of the MFC signalling system is required as follow:

2.8.1 Forward Signals

If the forward MFC signal is not acknowledged within approximately 10 seconds, the MFC sender unit will normally cause the connection to be broken down and the congestion tone will be connected to the calling line.

2.8.2 Backward Signals

The receipt of an MFC backward control signal causes the MFC forward signal to be disconnected and this in turn removes the backward signal. If the compelled sequence operation following the receipt of a control signal is not completed within 300 ms. an alarm shall be given. No time supervision is provided on the transmission of control signals except the A-3 signal which time-limited in certain circumstances. For example, in case of STD call, the incoming trunk register situated at the entry point to the secondary area will

2.4.2 Meaning of the forward Frequency Combinations
Group I represents the primary meanings of the forward frequency combinations, Group II the secondary meanings. The change from primary to secondary meanings is commanded by the backward signal A-3 or A-6. In case of the identitication of the A-subscriber is necessary, a change back from the secondary meaning to the primary meaning shall be possible and be commanded by a backward signal series C. The meaning of the forward Group I and Group II signals shall be according to Table 2.

2.4.3 Meaning of the Backward Frequency Combinations
Group A represents the primary meaning of the backward frequency combinations, Group B and C the secondary meanings. The change from the primary meaning to secondary meaning Group B and C is followed by the backward signals A3 and A6 respectively. The meaning of the backward Group A, B and C signals shall be according to Table 3.

2.5 **AUTOMATIC NUMBER IDENTIFICATION (ANI)**
Identification of the calling line including area code is required in case of long distance call which will be recorded for charging by the Call Detail Recording device (CDR).

2.5.1 A-party's Category
The A-party's category shall be forwarded in response to the A-6 signal, using group II of the forward signal.

2.5.2 A-party's Number
The A-party's number shall be forwarded in response to the C-series signals, using group I of the forward signals. The group I/15 signal "end of number" shall be forwarded when all the available digits of the A-party's number have been sent.

2.5.3 Call from Test Equipment and Operator Switchboard
Test equipment and operator switchboard need not have the A-party number. In these cases, the group I/15 "Number Not Available" shall be forwarded when the A-party's category has been sent in response to "next digit" backward signals.

2.5.4 Special Requirements
If due to a fault condition

2.5.4.1 The A-party's category is not available; then the group II/15 signal "No information about the A-party's category" shall be forwarded in response to a backward signal A-6 "send A-party's Category".

2.5.4.2 The A-party's number is not available, then the group I/15 signal "number not available" shall be forwarded in response to a backward signal C-1 "send next digit of A-party's".

2.5.5 It shall be possible to make an inquiry concerning the calling line's identity at any phase of the call establishment.

2. REGISTER SIGNALLING

2.1 GENERAL

The compelled sequence multi frequency code signalling shall be used when establishing a connection through one or more automatic exchanges for transmitting the numerical information from the originating exchange to the switching stages along the route or to incoming or transit registers at the various switching points. This information in the forward direction shall be combined with backward signalling to control and supervise the setting up of the connection.

2.2 SYSTEM REQUIREMENTS

The offered system shall fulfil the following requirements :

2.2.1 Rapid digit transmission, at least 6 digits per second.

2.2.2 Reliable and self-checking code

2.2.3 Insensitive to transmission disturbance.

2.3 SIGNALLING PRINCIPLE

The system shall employ V.F. signals consisting of two simultaneous frequencies each. For a receiver to react, it must identify exactly two frequencies.

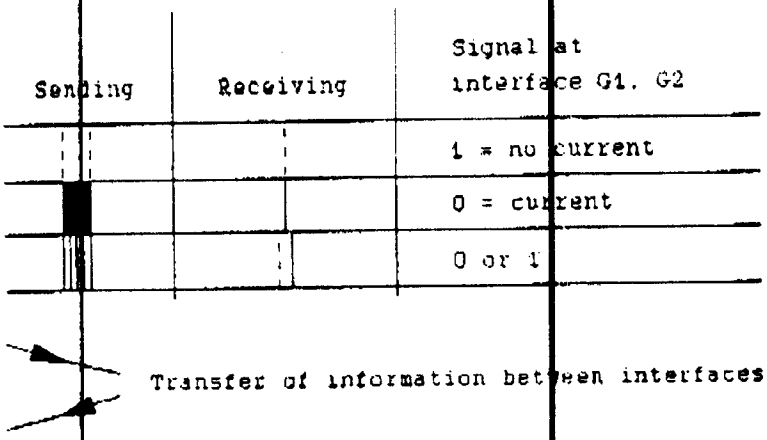
The system shall provide six frequencies for the forward direction and up to four frequencies for the backward direction as shown in Table 1. The scheme thus allows 15 forward and 6 backward code signals. The frequencies used in the forward direction shall be 1380, 1500, 1620, 1740, 1860, 1980 Hz. and in the backward direction 1140, 1020, 900, 780 Hz. The signalling shall be performed with continuous compelled sequence signals. The outgoing register may start the transmission of the first forward signal immediately after the seizure of the circuit and the signal persists until the incoming device has been connected and sent backward signal which has its own meaning and at the same time serves as an acknowledgement signal. It is preferable for the incoming device not to send a backward signal if the received forward signal is required by the subsequent incoming device. Thus the sending register needs not repeat this forward signal but continues to transmit until it receives a backward signal. Under certain conditions it may be necessary to send the signal A3 without prior reception of a forward signal. This condition is described in more detail in paragraph 8.2

2.4 MEANING OF THE SIGNALS

2.4.1 Multiple Meaning

The primary meaning of both the forward and backward frequency combination can change in response to certain backward signals. The changed meaning, or secondary meaning is specific to the signal which causes the change.

EXPLANATION OF SYMBOLS



G1,G2 Designation of interfaces
OT Outgoing trunk
IT Incoming trunk
BT Both-way trunk

EXPLANATORY COMMENTS

State No.1 : In the IDLE state, on both-way circuits, the a- and b-channels are not defined relative to the forward or backward direction.

Signal No.4 : The MFC-signalling starts preferably after signal No.3

Signals No.5c,5d : The signal shall preferably be interpreted when the trailing edge of the first signal element is recognized. The second signal element is ignored.

Signal No.10 : At last party release (used for malicious call tracing) the CLEAR-FORWARD signal is only sent after signals No.2-6 and 9. Last party release is initiated by a register signal.

TIME REQUIREMENTS

Sending requirements :

$t_{10} \rightarrow t_{11}$ $t_{12} \rightarrow t_{13}$ $t_{16} \rightarrow t_{17}$ $t_{18} \rightarrow t_{19}$ $t_{24} \rightarrow t_{25}$ $t_{26} \rightarrow t_{27}$	= 150 ± 30 ms
$t_{11} \rightarrow t_{12}$ $t_{17} \rightarrow t_{18}$ $t_{35} \rightarrow t_{36}$	≥240 ms when sent from the operator desk. When the pause is repeated through transit exchanges, it may be shortened.
$t_{64} \rightarrow t_{65}$	= 150 ± 30 ms
$t_{80,82} \rightarrow t_{00,33}$	
$t_{33} \rightarrow t_{35}$ $t_{35} \rightarrow t_{00,33}$	> 100 ms

Receiving requirements :

Recognition time for transition from state 0 to 1

$T_{0 \rightarrow 1}$ = 20±10 ms

Recognition time for transition from state 1 to 0

$T_{1 \rightarrow 0}$ = 20±10 ms

The signals are recognized within $T_{0 \rightarrow 1}$ /$T_{1 \rightarrow 0}$ except for the following :

Recognition time for CLEAR-FORWARD signal

$t_{79} \rightarrow t$ = 240-450[1] ms

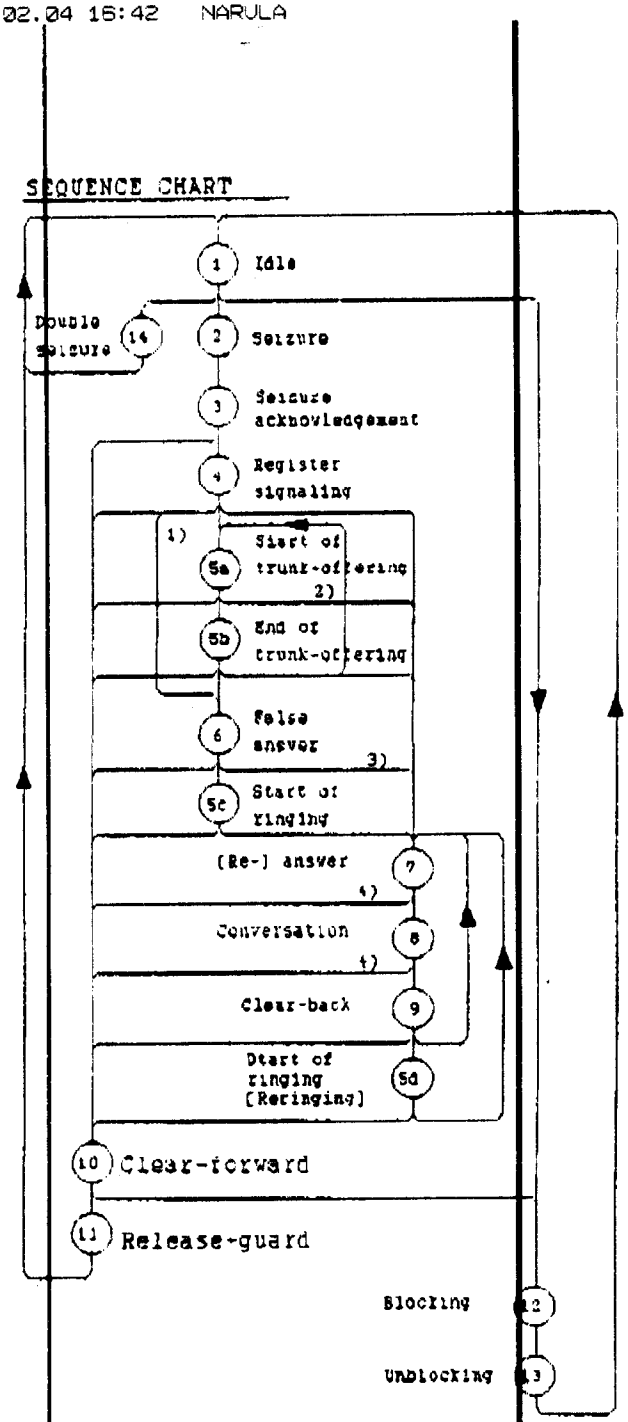
If the BLOCKING signal is received immediately after CLEAR-FORWARD signal has been sent, it may not be recognized until supervision of the received RELEASE-GUARD signal has time-out.

The OPERATOR signals are not recognized until the end of the signal is recognized.

Note: 1) The upper limit is not a firm requirement, but it is recommended that the recognition time is as short as possible.

(7)

SEQUENCE CHART



Notes :

1) Only for continuous supervision by the operator

2) For automatic start of ringing, sinal No.7 can be received after No.5a

3) Ringing can be started automatically, signal No.5c is not used

4) At last party release [used for malicious call tracing] the signal No.10 [CLEAR-FORWARD] is not sent after signals No.7 and 8. Last party release is initiated by a register signal

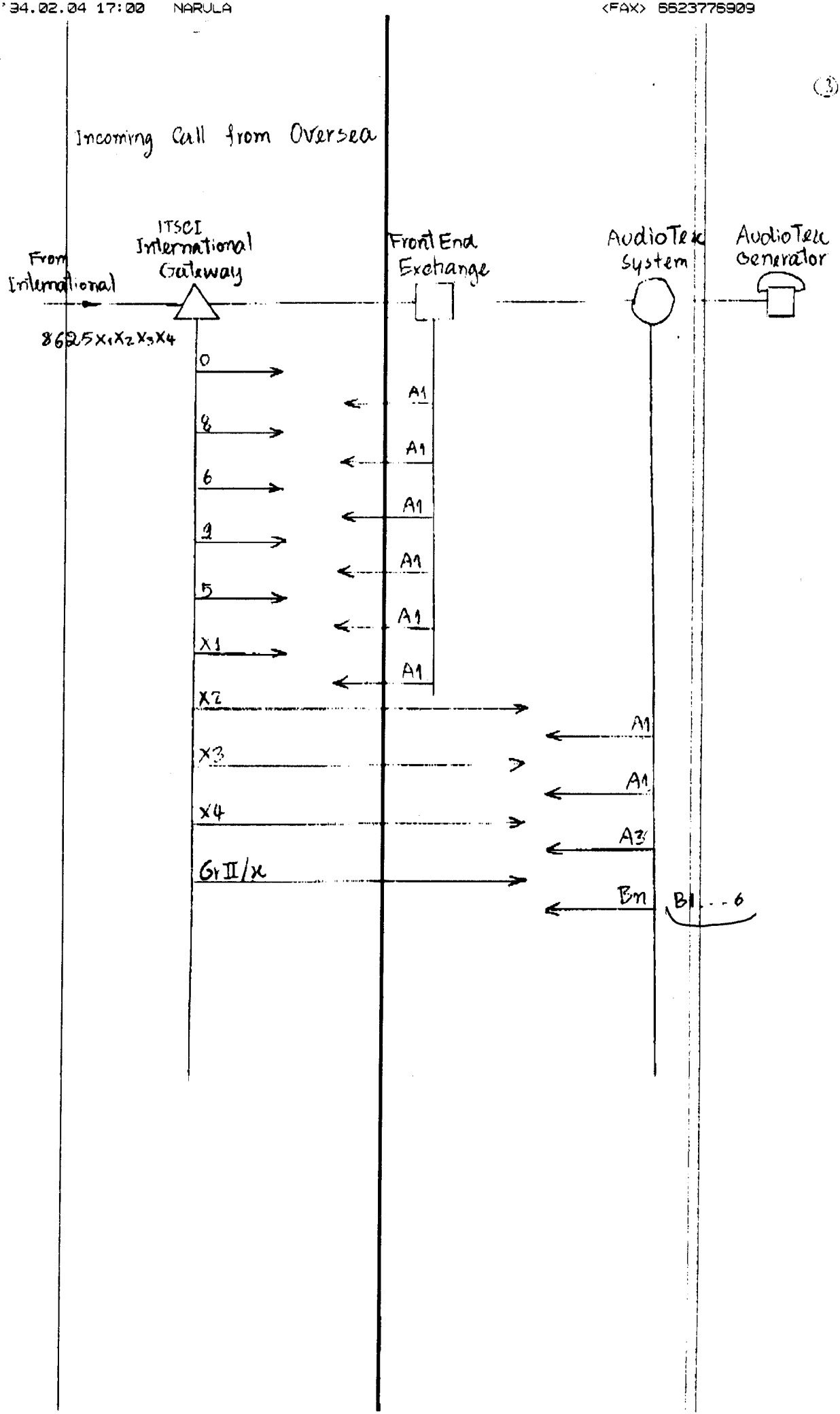
NO.	Signal or state	G1 at OT Send a_f b_f	G1 at OT Rec. a_b b_b	G2 at IT Rec. a_f b_f	G2 at IT Send a_b b_b
5d	OPERATOR signal : reringing after No. 9	24			74
		25			75
		26			76
		27			77
10	CLEAR FORWARD after No. 3-9	29			79
11	RELEASE-GUARD	30			80
12	BLOCKING after No. 1,10	31			81
13	UNBLOCKING	32			82

DOUBLE SEIZURE ON A BOTH-WAY LINE

NO.	Signal or state	G1 at BT Send a_f b_f	G1 at BT Rec. a_b b_b	G2 at BT Rec. a_f b_f	G2 at BT Send a_b b_b
14	Double SEIZURE after No. 1	33			33
		34			34
		35			35
		36			36

(3)

Incoming Call from Oversea



NO.	Signal or state	G1 at OT Send a_f b_f	G1 at OT Rec. a_b b_b	G2 at IT Rec. a_f b_f	G2 at IT Send a_b b_b
1	IDLE				
2	SEIZURE				50
3	SEIZURE ACKNOWLEDGEMENT				51
4	Register signalling		MFC		
5a	OPERATOR signal : start of trunk-offering after No. 4, 5b				60 61
5b	OPERATOR signal : end of trunk-offering after No. 5a				62 63
6	FALSE ANSWER after No. 4, 5b				64 65
5c	OPERATOR signal : start of ringing after No. 6				66 67 68 69
7	[RE-]ANSWER after No. 4, 5a, 5b, 5c, 5d, 6, 9				70
8	CONVERSATION				
9	CLEAR-BACK				73