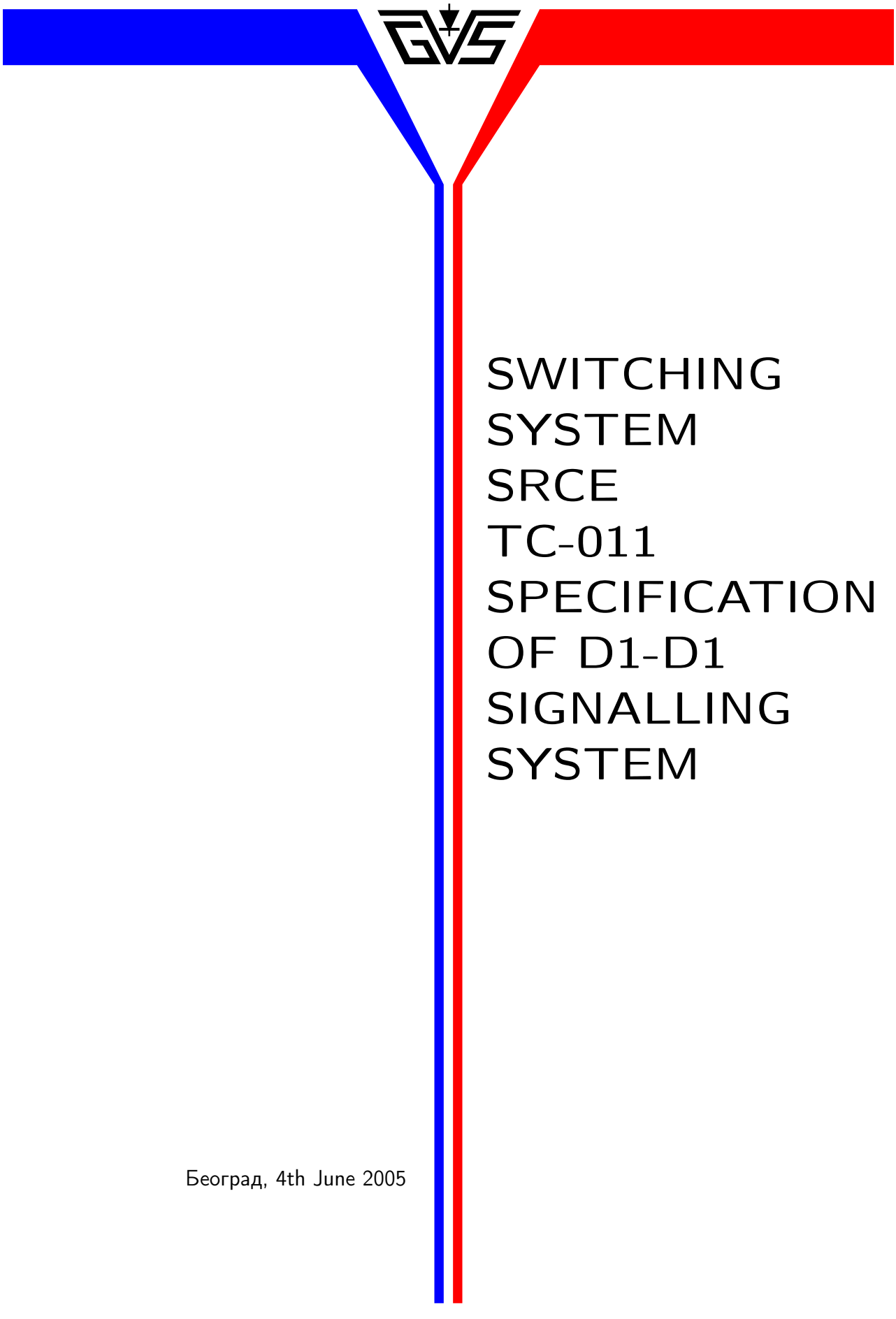

SWITCHING SYSTEM SRCE TC-011 SPECIFICATION OF D1-D1 SIGNALLING SYSTEM

Београд, 4th June 2005

Contents

1 INTRODUCTION

This document presents Signalling System D1-D1 specification on Switching system SRCE TC 011. The presentation and structure of the document are similar to the original ITU-T Recommendations Q.4xx text.

2 DEFINITIONS AND FUNCTIONS OF SIGNALS

2.1 Forward line signals

2.1.1 Seizing Signal

Seizing signal is sent at the beginning of the call to initiate the transition of the circuit at the incoming end from the *idle state* to the *seized state*. At the incoming exchange it causes the association of equipment capable of receiving register signals.

2.1.2 Clear-Forward Signal

The clear-forward signal is sent to terminate the call or call attempt and to release in the incoming exchange and beyond it all switching units held on the call. This signal is also sent by outgoing exchange in the case of forced release of the connection.

2.1.3 Trunk Offering Signal

Trunk offering signal is sent forward by the operator in order to enter a connection due to a new call.

2.1.4 Trunk Disconnect Signal

Trunk disconnect signal is sent forward by the operator in order to leave a connection.

2.1.5 Reringing Signal

Reringing signal is sent to the called subscriber incoming end by the operator, after receipt of clear-back after offering signal, in order to establish the new connection.

2.1.6 Address Signal

Address signals represents a called party number's digits (0..9). These signals are transmitted forward during sending address signals.

2.2 Backward line signals

2.2.1 Seizing acknowledgement signal

Seizing acknowledgement signal is sent to the outgoing exchange indicating that the equipment at the incoming end is ready to receive the address signals.

2.2.2 Congestion Signal

Congestion signal is sent to the outgoing exchange, indicating that the called subscriber's line is blocked due to congestion.

2.2.3 Signals Indicating the Condition of the Called Subscriber's Line

Signals, sent to the outgoing exchange, are provided to give an information about the called subscriber's line at the end of sending address signals. These signals are:

a) Subscriber line free, indicating that the subscriber's line is free

b) Subscriber line busy, indicating that the line or lines connecting the called subscriber to the exchange are busy.

2.2.4 Answer Signal

Answer signal is sent to the outgoing exchange to indicate that the called party has answered the call.

2.2.5 Clear-back Signal

The clear-back signal is sent to the outgoing exchange to indicate that the called party has cleared.

2.2.6 Forced Release Signal

Forced release signal is sent by the charge controlling exchange to any preceding exchange, in order to release the connection, under the following conditions:

- When the answer signal is not received within a defined period of time.
- When the called party clears back, but the calling party does not clear forward within a defined period of time.

2.2.7 Release Guard Signal

Release-guard signal is sent to the outgoing exchange in response to clear-forward signal to indicate that the latter has been fully effective in returning switching units at the incoming end of the circuit to idle condition. An international circuit is protected against subsequent seizure as long as the release operations initiated by clear-forward signal have not been completed at the incoming end.

2.2.8 Blocking Signal

Blocking signal is sent on an idle circuit to the outgoing exchange to cause engaged conditions (blocking) to be applied to this circuit, guarding it against subsequent seizure.

2.2.9 Unblocking Signal

Unblocking signal is sent on a blocked circuit to restore it to the *idle state*.

2.2.10 Clear-back After Offering Signal

The clear-back after offering signal is sent to the calling operator in the case of trunk offering, after the primary connection has been cleared.

2.2.11 Meter Signal

Meter signals are signals transmitted backwards during the conversation from the call charging point to the subscriber's call meter in the originating exchange.

2.3 Digital line signalling code

2.3.1 General

The digital version of System D1-D1 line signalling uses two signalling channels in each direction of transmission per speech circuit. These signalling channels are referred to as a_f and b_f for the forward direction (i.e. the direction of call set-up) and a_b and b_b for the backward direction. When transmitted channels b_f and b_b is permanently set to 0, but on receipt they are simply ignored. In the *idle state* of transmission circuit $a_f = 1$ and $b_f = 1$.

2.3.2 Pulsed Signals

All line signals, used in D1-D1 line signalling system could be classified to *dial pulse, short*, *long* and *continuous*, as illustrated in Table 1. Signals are implemented as defined duration pulses. For forward direction, pulses are formed when the signalling channel a_f changes the state from $a_f = 1$ to $a_f = 0$, remains in that state for a defined period of time and then changes to state $a_f = 1$. For backward direction, pulses are formed when the signalling channel a_b changes the state from $a_b = 1$ to $a_b = 0$, remains in that state for a defined period of time and then changes to state $a_b = 1$. When receiving, signals are recognised within the limits given in the column "tolerance" of the Table 1.

Dial pulses are used to make address signal, see 2.3.2.1.

Table 1

signal	nominal	tolerance
dial pulse	50 ms	20 - 80 ms
short	150 ms	100 - 200 ms
long	600 ms	450 -1750 ms
continuous	>1750 ms	-

The line signals are transmitted link-by-link.

The signalling system D1-D1 is specified for one-way operation, but both-way operation is also possible see (3.5 below).

The digital version of System D1-D1 line signalling also specifies a means for appropriate action in the case of faulty transmission conditions on the PCM multiplex, see below.

2.3.2.1 Address Signal

Address signal is made as sequence of dial pulses followed by an interdigit pause. Pause between two consequent dial pulses within a sequence is as long as dial pulse (50 ms). The sequence, representing an address signal must not consist of more than ten dial pulses (digit 0). The interdigit pause should be longer than 300 ms to be recognised as the end of the address signal.

2.3.2.2 Distinction Between Two Consecutive Pulse Signals

In some situations, two consecutive pulse signals, if the pause between them is too short, could be recognised on the receiving end of the circuit as one pulse signal, e.g. two consecutive short signals could be treated as one long signal. This is potentially dangerous situation so, a restriction explained in the following paragraph is applied during pulse signals sending.

Before sending a pulse signal, at least 180 ms must elapse after the previous signal has been finished, i.e. signalling channel a_f (in forward direction) or a_b (in backward direction) restored to value 1. This guarantees that the receiving end of the circuit will not "stick together" these signals and recognises them as one.

2.3.3 Signalling Code

Table 2, shows the signalling code on the PCM line under normal conditions.

Table 2

Signal	Signalling code				Direction	Duration
	Forward		Backwards			
	a_f	b_f	a_b	b_b		
Seizing	0	0	1	0	$\longrightarrow$	short
Seizing acknowledgement	1	0	0	0	$\longleftarrow$	short
Address signal	0	0	1	0	$\longrightarrow$	dial pulse
Congestion	1	0	0	0	$\longleftarrow$	long
Subscriber state	1	0	0	0	$\longleftarrow$	
a) free						short
b) busy						long
Answer	1	0	0	0	$\longleftarrow$	short
Clear-back[1]	1	0	0	0	$\longleftarrow$	long
Forced release[2]	1	0	0	0	$\longleftarrow$	long
Clear-forward	0	0	1	0	$\longrightarrow$	long
Release guard	1	0	0	0	$\longleftarrow$	long
Blocking	1	0	0	0	$\longleftarrow$	continuous
Unblocking[3]	1	0	1	0	$\longleftarrow$	-
Trunk offering	0	0	1	0	$\longrightarrow$	short
Trunk disconnect	0	0	1	0	$\longrightarrow$	short
Clear-back after offering	1	0	0	0	$\longleftarrow$	long
Reringing	0	0	1	0	$\longrightarrow$	short
Meter	1	0	0	0	$\longleftarrow$	short[4]

[1]The clear back signal can be sent only by the incoming end of the circuit beyond the charging point.

[2]The forced release signal can be sent only by the incoming end of the circuit prior to the charging point.

[3]This signal can be recognised/sent only if the blocking signal has already been sent/recognised. It is implemented as restoration of signalling channels to idle state.

[4]In order to assure proper recognition of two consecutive meter signals at the outgoing analogue exchange, delay between sending them must be at least 330 ms. i.e. no more than 3 meter signals may be sent during one second period.

3 CLAUSES FOR EXCHANGE LINE SIGNALLING EQUIPMENT

3.1 Recognition of a change of signalling code

3.1.1 Signalling Channel Transitions

The recognition time for a transition from 0 to 1 or vice versa on a signalling channel is 20 ± 10 ms. This value presupposes the existence of protection against the effects of faulty transmission conditions on the PCM multiplex.

The recognition time is defined as the duration that the signals representing 0 or 1 must have at the output of the terminal equipment of a signalling channels a_f and a_b in order to be recognised by the exchange equipment.

3.2 States and procedures under normal conditions (see Table 2)

In the forward direction $b_f = 0$ is established permanently. In the backward direction $b_b = 0$ is established permanently.

3.2.1 Idle State

This state denotes the availability of the circuit for the seizure for a new call set-up.

3.2.2 Seizing procedure

i) *Seizure*

The seizing procedure should occur only if the transmission circuit is idle at the moment. The outgoing end sends seizing signal, and the *seized state* of the circuit is established. At that state, timer defined as vkPTS is started and the seizing acknowledgement should be recognised within this time-out period.

ii) *Seizure acknowledgement*

After having recognised the seizing signal, the incoming end of the circuit sends the seizing acknowledgement. The receipt of the seizing acknowledgement at the outgoing end change the state of the circuit to the *seizure acknowledged state* and the sending address signals procedure can start. If the seizing acknowledgement signal has not been recognised within time-out period vkPTS, the faults resolving procedure 3.3.1 is carried out.

3.2.3 Sending address signals procedure

Sending address signals procedure starts when the circuit is in the *seizure acknowledged state,* and then the outgoing end begins to send decade digits as address signals to identify called subscriber. When a number of digits, needed to rich the called subscriber, is recognised, the incoming end returns a signal indicating the condition of called subscriber's line (free, busy or congestion). If subscriber's line free signal has been received, the state of the circuit is changed to *waiting for answer.* Otherwise, the clear-forward procedure, described in 3.2.7 is carried out.

3.2.4 Answering

In the *waiting for answer state* of the circuit, the off-hook condition of the called subscriber's line provokes the incoming switching equipment to send answer signal and the *answered state* of the circuit is established.

The *answered state* is established on the preceding link immediately after the answer signal is recognised; see also 3.2.8.

3.2.5 Clear-back procedure

The on-hook condition of the called subscriber's line provokes the incoming switching equipment to send the clear-back signal and the *cleared-back state* of the circuit is established. The *cleared-back state* is established on the preceding link immediately after the clear-back signal is recognised; see also 3.2.8.

3.2.6 Reanswering

The off-hook condition of the called subscriber's line in the *cleared-back state* of the circuit provokes the incoming switching equipment to send the answer signal and the *answered state* of the circuit to be re-established. If the forced release procedure described in §3.2.12 has been started, it is stopped and timer vkPJ is cancelled.

3.2.7 Clear-forward Procedure

The clear condition of the calling subscriber's line or the release of the outgoing switching equipment will normally result in sending clear-forward signal and establishing the *cleared-forward state* of the circuit. The outgoing switching equipment will not be restored to the *idle state* until the release guard signal is recognised, see also 3.2.7 and Table 3. On the incoming end receipt of the clear-forward signal initiates the release procedure, described below.

3.2.8 Release Procedure

Recognition of the clear-forward signal in the incoming switching equipment initiates the release of the succeeding link even though answering or clearing by the called party has occurred. Upon complete release of the incoming switching equipment, release guard signal is sent backward. This will cause the circuit to be restored to the *idle state* and the outgoing switching equipment to become available for another call.

If the clear-forward signal is not acknowledged by release-guard within a period defined as vkOSL, the fault resolving procedure 3.3.1 will be initiated.

3.2.9 Blocking and Unblocking Procedure

Blocking signal is sent on an idle circuit to the outgoing exchange to cause engaged conditions (blocking) to be applied to this circuit, guarding it against subsequent seizure.

Recognition of the blocking signal at the outgoing end indicates that transmission circuit is in the *blocked state*. In the *blocked state*, recognition of unblocking signal at the outgoing end, restores the circuit to the *idle state*.

3.2.10 Trunk Offering Procedure

In the case of called subscriber's busy state, whether he is calling or called party in the primary connection, new calling subscriber could ask the operator for trunk offering. The operator sends the trunk offering signal in order to enter the connection and offer new call to called subscriber. *Trunk offered state* of the circuit is established. After that, the operator sends trunk disconnect signal to leave the connection. *Trunk disconnected state* of the circuit is established This sequence could be repeated any number of times. After the primary connection has been cleared and used equipment has been released, the clear-back after offering signal is sent to the operator. *Cleared back after offering state* of the circuit is established The operator can then send the reringing signal. This will be manifested as ringing at the called subscriber's side. After called subscriber's answer, operator connects calling and called subscriber. In the case of repeated called subscriber's busy state, trunk offering procedure could be repeated.

3.2.11 Metering Procedure

Metering signals are pulse type signals transmitted backward during the conversation from the call charging point to the subscriber's call meter in the originating exchange.

3.2.12 Forced Release Procedure

Prior to answer and after the time-out period defined as timer vkANU, the charge controlling exchange transmits the forced release signal to the preceding exchange and clears forward the succeeding part of the connection.

When the called subscriber clears at the end of the call, the exchange which controls call charging will receive the clear-back signal from the called subscriber's end. If the calling subscriber does not clear within a period defined as timer vkPJ, the charge controlling exchange stops metering, transmits the forced-released signal to the preceding exchange and clears forward the succeeding part of the connection.

On recognition of forced release signal in a preceding exchange the connection is released, the forced release signal repeated to any other preceding exchanges and clear forward procedure 3.2.7 is initiated.

3.3 Actions appropriate to various signalling conditions

3.3.1 Faults Resolving Procedure

In addition to normal conditions described in Table 2 other conditions due to faults may be encountered. The possibly fault conditions initiated by wrong bit states are avoided by strict definitions of signals, which can be recognised. Therefore, faults can be provoked by some inconsistent state of the circuit, non recognition of an expected signal or recognition of an unexpected signal. The procedure which provides return from undefined state, faults resolving procedure, is the following:

1. The seizing signal is sent by the outgoing end. If the incoming end is idle, this signal will be recognised as seizing signal and the *seized state* will be established, but if it is not the signal will be ignored. The purpose of this signal is to set the *seized state* of the circuit and makes the incoming end to be able to receive clear-forward signal.

2. The clear-forward signal is sent to the incoming end.

3. If the release-guard signal is not received within a period defined as timer vkOSL, the sequence seizing/clear forward signal will be repeated until the release-guard signal is received.

4. After the release guard signal has been received, normal release procedure is carried out, as described in 3.2.8.

In order to recognise the seizing signal properly at the incoming end of the circuit, delay between sending seizing and clear forward signal must be at least 600 ms.

3.3.2 Outgoing end

Table 3

State of the circuit	Received signal			
	short	long	continuous	
idle	Ignored	Ignored	Blocking see 3.2.9	
seized	seizing acknowledgement	Congestion see Note Note 1	see Note 3	
seizure acknowledged	Ignored	Congestion see Note Note 1	see Note 3	
sending address signals	subscriber free	Congestion or subscriber busy	see Note 3	see Note 4
waiting for answer	answer	Congestion see Note Note 1	see Note 3	
answered	Meter signal see Note 5	Clear-back or Forced release see Note 2	see Note 3	
cleared-back[5]	Reanswering see Note 6	Ignored	see Note 3	
forced released [6]	Ignored	Ignored	see Note 3	
cleared-forward	Ignored	Release guard	see Note 3	
blocked	see Note 2	see Note 2	Ignored	

In the case of the trunk offering procedure, line signalling taking place on the circuit between operator exchange and called subscriber's exchange, is described in the Table 4 below.

[5]Appllicable only for the circuit beyond the charging point.
[6]Applicable only for the circuit prior to the charging point.

Table 4

State of the circuit	Received signal		
	short	long	continuous
trunk offered	Ignored	Clear-back after offering	see Note 3
trunk disconnected	Ignored	Clear-back after offering	see Note 3
cleared back after offering	Ignored	Ignored	see Note 3

Note 1.
In the case of the congestion signal recognition, the clear forward procedure, described in 3.2.7, is started.

Note 2.
For the circuit beyond the charging point, this signal is recognised as the clear-back. Otherwise, for the circuit prior to the charging point, this signal could only be the forced release. Anyway, the clear-forward procedure, described in 3.2.7, is started.

Note 3.
The receipt of the continuous signal in all state except the *idle state* of the circuit causes the outgoing end to send the clear-forward signal, trying to clear the connection. After the recognition of the unblocking signal, the clear forward procedure, described in 3.2.7, is started again. Delayed alarm for technical staff is given.

Note 4.
The receipt of the short signal at the outgoing end is assumed as called subscriber free, provoking the state of the circuit to change to *waiting for answer.* If the last digit has been sent, the receipt of the long signal at the outgoing end is assumed as called subscriber busy [7]. Otherwise, the receipt of the long signal at the outgoing end is treated as congestion. In the both cases the clear forward procedure, described in 3.2.7, is started.

Note 5.
The *blocked state* is suspended immediately after the unblocking signal has been recognised.

Note 6.
For the circuit prior to the charging point, the short signal during conversation is recognised as meter pulse. Otherwise, the signal is ignored.

Note 7.
For the circuit beyond the charging point, the receipt of the short signal in the *cleared-back state* is recognised as reanswering. The timer vkPJ is cancelled.

[7] If the subscriber's line is busy, the cleared forward procedure will be delayed for a 10 seconds, allowing the operator to enter the connection.

3.3.3 Incoming End

Table 5

State of the circuit	Received signal			Dial pulses received
	short	long	continuous	
idle	seizing	Ignored	see Note 3	
seized	Ignored	clear forward	see Note 1	
seizure acknowledged	Ignored	clear forward	see Note 1	
sending address signals	Ignored	clear forward	see Note 1	digits
waiting for answer	Ignored	clear forward	see Note 1	
answered	Ignored [8]	clear forward	see Note 1	
cleared back	Ignored	clear forward	see Note 1	
forced released	Ignored	clear forward	see Note 1	
cleared-forward	Ignored	Ignored	see Note 1	
blocked	see Note 2	see Note 2	see Note 2	

In the case of the trunk offering procedure, line signalling taking place on the circuit between operator exchange and called subscriber's exchange, is described in the Table 6 below.

[8] In the case connection has been established by an operater, it is possible for the operater to enter the connection again Therefore the receipt of the short signal during the conversation could be recognized as the trunk offering

Table 6

State of the circuit	Received signal			
	short	long	continuous	
trunk offered	trunk disconnect	clear-forward	see Note 1	
trunk disconnected	trunk offering	clear forward	see Note 1	
cleared-back after offering	reringing	clear-forward	see Note 1	

Note 1.
The clear-back signal is sent and waiting for the unblocking signal is started. After unblocking signal has been recognised, the release guard signal is sent to release the connection.

Note 2.
In the *blocked state* of the circuit none of these signals can not be recognised, see 3.2.9.

Note 3.
The alarm is given to the technical staff. No other action is taken.

3.3.4 Safeguard Against Failures

The PCM equipment and the exchange line signalling equipment are designed in such a way that at least those faults which are most likely to occur in this equipment or in the interconnecting cables, result in blocking of the circuit at the outgoing end and in the ultimate clearing of the connection beyond the incoming switching equipment. This can be achieved, as far as possible, by ensuring that the blocking signal is sent on line upon:

- removal of PCM or switching equipment by maintenance personnel;
- occurrences of abnormal conditions (e.g. open wire, low voltage) in switching equipment.

3.4 Blind seizure

Blind seizure takes place when the calling exchange has not an ability of tone generation. In order to solve the problem, called exchange (with tone generation ability) sends appropriate tones through speech channel. The differences from normal call set-up could be noticed only at the incoming end of the circuit[9] and they are the following:

1. On receipt of the seizing signal, the incoming end of the circuit sends the dial tone through the speech channel instead of seizing acknowledgement. *Seizure acknowledged state* of the circuit is established.

[9]The outgoing end of the circuit, which blind seizure apply to, would never be at the exchange SRCE

2. As first digit is received, dial tone is not sent any more through the speech channel. Speech channel is through-connected to the called subscriber's exchange.
3. If the called subscriber is busy, busy tone is sent through the speech channel.
4. Subscriber line free signal is not sent to the outgoing end.
5. Answer signal is not sent to the outgoing end.
6. In the case of line congestion, congestion tone is sent through the speech channel.
7. Clear back signal is never sent to the outgoing end, since the circuit is considered to be prior to the charging point.
8. Other signals (congestion signal, metering signal, forced release signal, release guard signal, blocking signal, unblocking signal) are sent as usual.
9. Trunk offering signals (i.e. clear-back after offering signal [10]

3.5 Both-way working

System D1-D1 is specified for one-way working, but in principle the line signalling code detailed in 2.3is also suitable for use on both-way circuits. Where Administrations have undertaken, by bilateral agreement, to use both-way working, the clauses and additional specifications for exchange signalling equipment detailed in 3.5.1 and 3.5.2 below, must be observed.

The both-way equipment, depending on situation, acts as outgoing or incoming equipment. In the *idle state*, direction of a both-way circuit is not determined until receiving or sending the seizing signal. If the seizing signal is received, the both-way equipment goes to the incoming mode and remains until the release of the call. Otherwise, in the case of successful seizure, the outgoing mode is established.

3.5.1 Procedures Under Normal Conditions

a) *Double Seizure*

Double seizure is detected if one end of the both-way circuit sent the seizing signal and received the seizing signal within a period defined as a timer vkPZ1 after seizing signal sending. The timer is started with beginning of seizing signal sending.

In order to prevent recognition of the seizing acknowledgement as double seizure, at the incoming end of the both-way circuit, sending of the seizing acknowledgement must not occur within time period defined as vkPTS2, after seizure.

[10]This is the only backward signal out of all trunk offering signals are not applicable when blind seizure takes place.

In such a situation the connection is released at both ends. The both ends initiate the normal clear-forward procedure. Repeat attempt for call set-up may be made on another circuit.

In the sense of preventive action it is recommended that an opposite order of circuit selection be used by each exchange of a both-way circuit group to minimise possibility of double seizure.

b) *Blocking and Unblocking Procedure*

When a both-way circuit is blocked manually in its *idle state* at one end (e.g. end B) the blocking signal is sent to the other end (A). The circuit is then kept blocked locally (at end A) against all calls in the A to B traffic direction as long as the *blocked state* persists in the B to A direction.

In order to avoid permanent blocking, end A maintains the idle signalling code in the direction A to B.

3.5.2 Special Arrangement

The physical realisation of signalling equipment terminating a both-way circuit may allow that part of the equipment concerned with outgoing calls to be removed without preventing the remaining equipment from being used for incoming calls. In this case it is only necessary to block the circuit locally against outgoing calls and a blocking signal is not sent to the other end.

4 TIMER SPECIFICATION

Timers, defined in Switching system SRCE and mentioned in this document are the following:

- vkPTS a period of the outgoing end's waiting for seizure acknowledgement signal
- vkPZ1 a period, started from the moment of the seizing signal sending in the case of both-way working, within which the outgoing switching equipment must not receive a short signal.
- vkOSL a period, started from the moment of the clear-forward signal sending, within which the outgoing end should recognise the release-guard signal.
- vkANU a period of the outgoing end's waiting for the answer signal, after successful sending digits procedure.
- vkPJ a period of the outgoing end's waiting for the reanswering signal after the clear-back signal has been received.
- vkPTS2 a period of the incoming end's delay to send seizure acknowledgement signal

Minimum, maximum and default values for timers in ms are specified in the following table:

Table 7

timer	Values[ms]		
	Minimum	Maximum	Default
vkPZl	300	300	300
vkOSL	4000	15000	8000
vkANU	120000	120000	120000
vkPJ	60000	120000	120000
vkPTS	15000	30000	18000
vkPTS2	500	500	500

5 REFERENCES

1. **ITU-T Recommendation Q.400**, *Specifications of Signalling System R2, Definitions and functions of signals,* Fascicle VI.4, *Blue Book*

2. **ITU-T Recommendation Q.421**, *Specifications of Signalling System R2; Line Signalling, Digital version; Digital line signalling code,* Fascicle VI.4, *Blue Book*

3. **ITU-T Recommendation Q.422**, *Specifications of Signalling System R2; Line Signalling, Digital version; Clauses for Exchange Line Signalling equipment,* Fascicle VI.4, *Blue Book*

4. **ITU-T Recommendation Q.117**, *General Recommendations on Telephone Switching and Signalling; Clauses Applicable to ITU-T Standard Systems; Alarms for Technical Staff and Arrangements in Case of Faults,* Fascicle VI.1, *Blue Book*

5. **ITU-T Recommendation G.732**, *General Aspects of Digital Transmission Systems; Terminal Equipment; Characteristics of primary PCM multiplex equipment operating at 2048 kbit/s* **,** Fascicle III.4, *Blue Book*

6. **ITU-T Recommendation G.734**, *General Aspects of Digital Transmission Systems; Terminal Equipment; Characteristics of synchronous digital multiplex equipment operating at 1544 kbit/s,* Fascicle III.4, *Blue Book*

7. **ITU-T Supplement No. 6**, *Line Signalling (Digital Version) with Metering,* Fascicle VI.4, *Blue Book*