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Abstract

This document is a Eurocontrol specification defining both the Multi Frequency Compelled ATS-R2 signalling protocol and the Signalling System Number 5 protocol to be used for communication between Air Traffic Control Voice Communication Systems of ECAC member states connected by International analogue leased lines. It also defines the interworking between these two signalling protocols.

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EXECUTIVE SUMMARY

This document is a Eurocontrol specification defining both the Multi Frequency Compelled (MFC) signalling protocol (Nominated ATS R2) and the Signalling System Number 5 protocol (nominated ATS No.5), to be used for communication between the Air Traffic Control Voice Communication Systems of the ECAC member states connected by International analogue leased lines. It also defines the interworking between these two signalling protocols.

RELATED DOCUMENTS FOR ATS VOICE NETWORKING

Network Planning

EUROCONTROL: ATS Voice Network Implementation and Planning Guidelines- Edition 1.0 January 2005 [4] (EATM Infocentre Ref 05/01/12-02)

ICAO: Manual on Air Traffic Services (ATS) Ground-Ground Voice Switching and Signalling Doc 9804 AN/762 – 2002 [9]

Voice Communication Systems

EUROCONTROL: Voice Communication System Procurement Guidelines – Edition 2.0 January 2005 [3] (EATM Infocentre Ref 05/01/12-03, replaces EATM Infocentre Ref 03052701, Edition 1.0)

Analogue Signalling Systems

EUROCONTROL: ATS R2 and ATS No5 signalling protocol specifications – Edition 2.0 June 2005 **(This document)** (EATM Infocentre Ref 05/01/12-04)

Digital Signalling Systems

Standard ECMA 312: Private Integrated Services Network (PISN) - Profile Standard for the Use of PSS1 (QSIG) in Air Traffic Services Networks (3rd Edn) "ATS-QSIG" [12]

Inter-working between Analogue and Digital Signalling Systems

EUROCONTROL: Inter-working between ATS-QSIG and ATS R2 signalling system - Edition 1.0 January 2005 [5] (EATM Infocentre Ref 05/01/12-05).

EUROCONTROL: Inter-working between ATS-QSIG and ATS Number 5 signalling systems – Edition 1.0 January 2005 [6] (EATM Infocentre Ref 05/01/12-06).

Reference Documents - are included in this document at ANNEX A – REFERENCES.

DEFINITIONS

Address: A string or combination of decimal digits, symbols and additional information that identifies the specific termination points of a connection in a network;

Air Navigation Service Provider (ANSP): An organization responsible for providing international air traffic management communication services.

Air Traffic Services (ATS): A generic term meaning variously, air traffic control unit, flight information centre or air traffic services reporting office;

Air Traffic Services Ground Voice Network (AGVN): Network of geographically dispersed VCS's connected by analogue and digital leased lines/circuits and used to handle voice calls between its users (i.e. controllers etc.) located in the various ATS units;

ATS R2: An adaptation for Air Traffic Services of the "ITU-T Recommendations Q.400 to Q.490 defining the ITU-T R2 signalling system";

ATS No.5: An Adaptation for Air Traffic Services of the "ITU-T Recommendations Q.140 to Q.164 defining the ITU-T No.5 signalling system";

ATS unit: Air Traffic Services Control Centre or Tower etc;

Backward direction: Is the direction from the terminating VCS towards the originating VCS;

Busy: ***Terminal busy-*** The condition that arises when an incoming call has reached the called user's terminal but there is no resource available to present the call to the user.

Network busy: The condition that arises when all speech paths between one VCS and another are either currently in use or (exceptionally) configured as out-of-service via the System Management Terminal. The term "congestion" is used synonymously with "network busy".

Circuit/Line: A combination of two transmission channels permitting bidirectional transmission of signals between two points to support a single communication;

Compelled signalling method over an inter-VCS link:

- A signal is generated and sent in a forward direction over the inter-VCS link.
- This signal is received and recognised and causes an acknowledgement signal to be sent in the backward direction.
- As soon as this acknowledgement signal is received and recognised, then the signal being sent in the forward direction is stopped.
- As soon as it is recognised that the signal being sent in the forward direction has stopped, the acknowledgement signal sent in the backward direction is also stopped.
- As soon as it has been recognised that the acknowledgement signal sent in the backward direction has stopped the appropriate following signal is sent in the forward direction and so the process goes on.
- The procedure is identical for compelled signals generated and sent in the backward direction.
- ATS R2 Register signalling is compelled. ITU-T No.5 Line signalling is compelled.

Controller Working Position (CWP): In the context of this specification, one particular type of terminal equipment used specifically for the purpose of performing operational duties of air traffic management;

Detour Route: An indirect physical path between the originating and terminating VCS through transit VCS(s). This is the path selected by a VCS when its "Direct Point-to-Point route" or "Direct Network Route" is not available.

Direct Network Route: A fixed and pre-established path through the network between the originating and terminating VCS. The path can comprise of successive physical circuits or inter-VCS links passing through Transit and/or gateway VCS's;

Direct Point-to-Point Route: A direct physical path between the originating and terminating VCS. The path is a single physical circuit or inter-VCS link that does not pass through transit/gateway VCS's and is not switched by the network;

End VCS: In the context of a particular call, an originating or terminating VCS;

Forward direction: Is the direction from the originating VCS towards the terminating VCS;

Gateway VCS: Within the context of a call, a VCS that performs interworking between one signalling system and another;

Inband signalling: Signalling employing frequencies within the voice band (300Hz to 3400Hz)

Incoming gateway VCS: A gateway VCS that routes an incoming call from a route employing one signalling system (i.e. ATS R2) on to an inter-VCS link employing a different signalling system (i.e. ATS QSIG);

Inter-VCS link (transmission link): A link between two VCS's comprising the totality of the signalling transfer means (i.e. a signalling channel) and the user information transfer (i.e. speech channels) means. An inter-VCS link can comprise of one or more circuits/lines;

Interworking: The process by which two signalling systems can interact;

Key: The term 'key' is used to refer to a single activation device such as a key, switch, button or an icon;

Link to Link signalling: Signalling is passed from one VCS to the next with the call being established/cleared on a link by link basis. ATS R2 and ATS No.5 use the link-to-link signalling method.

Network: A set of equipment (terminal equipment, switching equipment, call-processing equipment, etc.) located at geographically dispersed locations and interconnected via transmission links to provide telecommunication services to a defined group of users;

Non-Compelled signalling method over an inter-VCS link:

- A signal is generated and sent in a forward or backward direction shall not be acknowledged by a signal sent in the corresponding direction.
- ATS R2 Line signalling is Non-compelled. ITU-T No.5 Register Signalling is NON-compelled.

Number: An address restricted to containing numerical values, as defined by a numbering plan;

Originating VCS: Within the context of a call, the VCS to which the calling user's terminal equipment is attached;

Outgoing gateway VCS: A gateway VCS that routes an incoming call from an inter-VCS link employing one signalling system (i.e. ATS QSIG) on to a route employing a different signalling system (i.e. ATS R2);

Preferred Route: The route selected by a VCS when there are two or more options available. In this case a VCS will have its routing tables configured for a series of "Routes" listed in a hierarchical order. The order is usually associated with the fastest call performance criteria. (i .e. "Direct Point-to-Point Routes" followed by "Direct Network Routes" or "Detour Routes" etc.); The preferred route is selected at the instant the call is being established and can vary according to dynamic network factors (i.e. congestion, out-of-service conditions) occurring in the network at the time;

Priority Call: A call made by a user in case of emergency, with the capability to interrupt another non-priority call during network congestion and to intrude into the call of a busy Wanted user;

Routing Tables: Configuration within a VCS defining which route should be used in order to reach the terminating VCS:

Side, Incoming Side and Outgoing Side: The term "Side" is used to describe a VCS located at the end of an inter-VCS link. In the context of a call, the Outgoing Side is the Side that routes the call over the inter-VCS link and the Incoming Side is the Side that receives the call.

Terminal equipment: An item of equipment attached to a telecommunications network to provide access for a user to one or more services of that network. A telephone is a typical example of terminal equipment;

Terminating VCS: Within the context of a call, the VCS to which the called user's terminal equipment is attached;

Transit VCS: Within the context of a call, any VCS through which the call passes, excluding the Originating VCS and the Terminating VCS;

Unwanted User: The user other than the wanted user in the established call

Unwanted User VCS: The VCS of the unwanted user in a call intrusion

User: An Air Traffic Controller or other operational person using, via terminal equipment, the services provided by ATS ground voice networks to undertake the operational duties of air traffic management;

Voice Communication System: A nodal entity that provides automatic connection handling functions used for the provision of telecommunication services.

Wanted User: The user called in the established call

Wanted User VCS: The VCS of the wanted user of a call intrusion

1. ATS R2 SIGNALLING SPECIFICATION

1.1 Introduction

This section contains the detailed specification for the Multi Frequency Compelled signalling system protocol (from here on nominated ATS R2) to be used between the Voice Communication Systems (VCS's) of Air Traffic Service units in ECAC member states. This specification is derived from ITU-T Signalling System R2 [1].

1.2 ATS R2 Signalling Principle

ATS R2 line signalling shall be used in order to Seize a line, Clear a line and Block a line. Line signals always use a 2280 Hz tone and the duration of the tone identifies the type of line signal. Line signals can be sent from either side of an inter-VCS link. ATS R2 Line signals are non-compelled implying that a signal is sent in one direction only without a corresponding acknowledgement signal in the opposite direction.

ATS R2 register signalling shall be used in order to transfer the calling/called user addresses and the call priority level information over the inter-VCS link. ATS R2 register signalling shall also be used to transfer status signal information back from a terminating/transit VCS to the originating VCS.

ATS R2 register signals employ tone pairs to represent individual digits and status numbers. They can be sent from either side of an inter-VCS link. ATS R2 register signals are compelled implying that each signal sent in one direction must be acknowledged in the opposite direction.

ATS R2 User signals relate to providing information about the progress of the call to the user, through audible tones (e.g. dial tone, ringing tone, busy tone, congestion tone etc). They are also used to warn a user of an impending line interrupt of their call or an intrusion into their call.

ATS R2 signalling employs a "link to link" signalling method to establish a call. This implies that with a call involving two inter-VCS links, the signalling is exchanged between Originating and Transit VCS's to establish a voice circuit on the first link before the Transit VCS and Terminating VCS's exchange signalling in order to establish a voice circuit on the second link.

1.3 ATS R2 Line Signals, Register Signals and User Signals

ATS R2 signalling employs Line signals, Register Signals and User signals (audible user tones);

1.3.1 ATS R2 Line Signalling

ATS R2 line signalling is a non-compelled inband signalling system, which implies that the signals are sent in a forward direction only and are not acknowledged. The Line signals are 2280 Hz tones of fixed duration. ATS R2 line signalling uses idle-tone off, which implies that when the line is in the idle condition (i.e. not being seized or involved in an active call), no signalling frequency is sent on the line.

1.3.1.1 Line Signals

Line signals use the non-compelled signalling method and can be sent from either side of an inter-VCS link. The following 3 line signals exist:

- **Seizing**: sent from an originating VCS in order to seize a line for an outgoing call; sent from a transit VCS in order to seize a line for a transit call towards a terminating VCS;
- **Clear-Forward** (Release): sent from an originating or terminating VCS in order to clear an active call over an inter-VCS link.

  Sent from a transit VCS over the successive inter-VCS link after receiving a clear forward signal from the previous inter-VCS link in order to clear an active call switched at the transit VCS.

  Sent by an originating VCS if there is a failure in the ATS R2 signalling procedure.

  Appropriate action by one user only, shall be sufficient to terminate a communication, to transmit the Clear-Forward signal and to release the equipment within both VCSs that has been seized for the communication.
- **Blocking**: sent by the VCS performing line interrupt or maintenance procedures over an inter-VCS link.

1.3.1.2 Line Signals duration

For any inter-VCS link employing ATS R2 signalling it is necessary that one side of the inter-VCS link is configured as an “A” side (short line signal duration) and the other side of the inter-VCS link is configured as a “B” side (long line signal duration).

The duration of line signals for the different sides shall be as defined in Table 1.

Table 1: Line Signals Duration

Time in ms

Line Signal	Side A	Side B
Seizure	150 ± 25	350 ± 50
Clear-Forward (Release)	400 ± 70	1300 ± 200
Blocking	2600 ± 550	4800 ± 970
Recommendation Q.412, Section 2.2.2.7 provides guidance on the theoretical calculation of the Clear-Forward signal.		

The line signals shall be recognised by the line signal receiver. Recognition times shall be considerably smaller than the line signal duration times.

The values defined in Table 1: Line Signals Duration above permit automatic compensation of short-term and long-term fluctuations of the nominal signal duration.

1.3.1.3 ATS R2 Line Signalling Performance characteristics

Table 2: Line Signalling performance characteristics

Line signal frequency	2280 Hz
Frequency Tolerance	+/-4Hz
Transmit level	-8 dBmO ± 1 dB.
Receiver sensitivity range	-35dBm to –5dBm
Line signal recognition	Only if all other signals have a level 25dB less than the level of the 2280Hz signal
Immunity to signal interruption	10ms max

Note: "Implementers should be aware of the voice frequency property of the signalling tones. To avoid unwanted reaction, all three criteria (tone frequency, duration and level difference) must be within the specified limits for proper functionality".

1.3.1.4 Call Collision (Double Seizing)

Call collision occurs when two calls originating from VCSs at opposite ends of an inter-VCS link simultaneously attempt to send the seizing line signal over the same analogue leased line.

Note: a VCS should check that there is not a Seizing or Blocking Line signal already on the line (i.e. being sent from the opposite side of the inter-VCS link) before sending its Seizing line signal. If these are detected a different line should be selected if available.

In order to reduce the probability of call collisions occurring over an inter-VCS link it is necessary that one side of the inter-VCS link is configured as an "A" side and the other side of the inter-VCS link is configured as a "B" side. An "A" side should seize the lines in an ascending order and the "B" side should seize the lines in descending order.

Call collision shall be solved by application of the following principle; the duration of the seizure line signal transmitted from an "A" side of the inter-VCS link is shorter that the seizure line signal transmitted from the "B" side. A short seizure line signal from the "A" side shall not be recognised when during the same time period a long seizure line signal has been sent from the "B" side. The call originating from the "B" side shall proceed and the "A" side VCS if configured for automatic call repetition shall attempt to establish its call on an alternative line or on a Detour route. In the event that this is not possible then a calling user on the "A" side shall receive an audible user tone "Terminal Congestion".

Note: in order to shorten the call setup time, the "A" side should immediately stop sending its seizure line signal as soon as it has recognised that the seizure line signal is also be sent from the "B" side. The "A" side should then start the process of seizing an alternative line or detour route (should one be available).

1.3.1.5 Call Clearing

Calls can be cleared either in the forward direction if the calling user clears or in the backward direction if the called user clears. Calls can be cleared at any time by both "A" and "B" sides during the call establishment and conversation phases.

An established transit call should be cleared on a link to link basis.

Note: Due to the duration of the Clear-Forward (Release) line signal being different for "A" and "B" sides of an inter-VCS link, it is necessary that an established transit call is cleared on a link-to-link basis. Clearing a transit call on an end-to-end basis can result in an end VCS receiving a Clear Forward line signal with an incorrect duration. This can result in the call not be cleared correctly.

1.3.1.6 Inband Line signal suppression

The 2280 Hz tone of the Clear-Forward and the Blocking line signal shall be cut off from the headset of both user's in the established call some milliseconds after the start of the signal.

1.3.2 ATS R2 Register Signalling

All ATS R2 register signals shall be exchanged according to a compelled signalling procedure.

1.3.2.1 Register Signals

The following register signals exist:

- **Digits 0,1,2,3,4,5,6,7,8,9:** A 13-digit sequence of numbers comprising of a 6-digit destination address, a 1-digit priority level and a 6-digit source address. An originating or transit VCS sends the dual tone equivalent of the digit in the forward direction and expects to receive the corresponding dual tone acknowledgement of the same digit in the backward direction, prior to sending the successive digit.
- **Status signals**: A terminating or transit VCS sends the dual tone equivalent of the status number in the backward direction and expects to receive the corresponding dual tone acknowledgement of the same status number in the forwards direction.

The status number can represent one the following 4 status conditions:

- Terminal free,
- Terminal busy,
- Trunk congestion,
- Terminal Out of Service (or Called number not allocated).

1.3.2.2 ATS R2 Register signalling composition

All ATS R2 register signals shall be exchanged according to a compelled signalling procedure. This uses two groups of five frequencies, one group in an upper frequency band and the other group in a lower frequency band, within the available bandwidth of the voice channel. Signalling shall be performed by simultaneously sending two out of the five frequencies available, according to the coding defined in Table 3, Table 4 and Table 5 below.

Composition of the ATS R2 register signalling tone pairs for each individual digit shall be as defined as in Table 3.

Table 3: Composition of the ATS R2 Register signalling

Frequency in Hz

Upper Frequency Band	**Forward Direction**	**1 380**	**1 500**	**1 620**	**1 740**	**1 860**
Lower Frequency Band	**Backward Direction**	**1 140**	**1 020**	**900**	**780**	**660**
	Weight	**0**	**1**	**2**	**4**	**7**
No.	**Numerical Value**					
1	0+1	x	x			
2	0+2	x		x		
3	1+2		x	x		
4	0+4	x			x	
5	1+4		x		x	
6	2+4			x	x	
7	0+7	x				x
8	1+7		x			x
9	2+7			x		x
0	4+7				x	x
Reference:- Recommendation Q.441 Section 4.2.1 Table 5						

Each digit that is sent in the forward direction using the upper frequency band shall be acknowledged by re-transmissions of the same digit in the lower frequency band in the backward direction. Similarly a status signal sent in the backward direction using the lower frequency band indicating status information (i.e. user or network status info) shall be acknowledged by sending the corresponding signal in the forwards direction using the upper frequency band.

This compelled signalling procedure used when sending register signals provides an extra confirmation that they have been sent correctly in addition to the fact that dual tones are used to send a register signal.

The correspondence between register digits in the 13-digit address sequence and frequencies shall be as defined in Table 4 below.

Table 4: Correspondence between Register digits and Frequencies

Frequency in Hz

Register Digits	Calling Frequencies (Forward Direction)		Acknowledging Frequencies (Backward Direction)	
1	1 380	1 500	1 140	1 020
2	1 380	1 620	1 140	900
3	1 500	1 620	1 020	900
4	1 380	1 740	1 140	780
5	1 500	1 740	1 020	780
6	1 620	1 740	900	780
7	1 380	1 860	1 140	660
8	1 500	1 860	1 020	660
9	1 620	1 860	900	660
0	1 740	1 860	780	660
Reference:- Recommendation Q.441 Section 4.2.1 Table 5				

The correspondence between register Status information, status number and frequencies shall be as defined in Table 5.

Table 5: Correspondence between Register status number and Frequencies

Frequency in Hz

Register Status information	Status Number	Signalling Frequencies (Backward Direction)		Acknowledging Frequencies (Forward Direction)	
Terminal free	6	900	780	1 620	1 740
Terminal busy	3	1 020	900	1 500	1 620
Trunk congestion	8	1 020	660	1 500	1 860
Terminal out of service or called number not allocated	5	1 020	780	1 500	1 740
Note: The origin of this table is related to ITU-T Recommendation Q441, Tables 5 and 9.					

In the case of a fault or no acknowledgement signal received in the backward direction, the signalling procedure shall be stopped and the originating VCS shall send the 'Clear-Forward' line signal in the forward direction.

1.3.2.3 ATS R2 Register status signal generation conditions

Table 6 below defines the conditions when Register Status Signals are generated by either a transit or a terminating VCS.

Table 6: Register Status signal generation conditions

Register Status information	Status Number	Generated by Terminating VCS when:	Generated by Transit VCS when:
Terminal free	6	• Called terminal is being alerted to the incoming call (i.e ringing). Inband ringing tone is then sent on line.	
Terminal busy	3	• Called terminal is busy. (Normally only generated if Indirect Access Call Queue is full).	
Trunk congestion	8		• No direct or detour route to destination due to congestion of available lines with calls having an equal or higher priority level.
Terminal out of service or called number not allocated	5	• Called party address is unallocated (unassigned) • Address format invalid • Called terminal out-of-order • No compatible destination exists.	• Called party address is unallocated (unassigned) • Address format invalid • No compatible destination exists. • Timeout when waiting for register signal acknowledgement

On receipt of an ATS R2 Register Status signal with status numbers 3, 5 or 8, the Originating VCS shall send a “Clear Forward” line signal in the forwards direction in order to clear the circuit for another call.

1.3.2.4 ATS R2 Receiver performance characteristics

The performance of the ATS R2 register-signalling receiver shall be as defined in Table 7.

Table 7: ATS R2 Register Signalling Receiver Performance Characteristics

1	Frequency tolerance.	± 10 Hz	Recommendation Q. 455 par. 4.4.5.2 b)
2	Sensitivity range; absolute power level of each of the two frequencies	- 35 to - 5 dBm	Recommendation Q. 455 par. 4.4.5.2 b)
3	Impedance	600 Ohm	
4	Difference in level between:- a) adjacent frequencies b) non-adjacent frequencies	a) Less than 5 dB b) Less than 7 dB	Recommendation Q. 455 par. 4.4.5.2 b)
5	Sum of operation and release time (T_O + T_R) *(See Table 6 Legend below)*	Less than 70 ms	Recommendation Q. 455 par. 4.4.5.2
6	Maximum difference in time due to distortion *(See Table 6 Legend below)*	$(T'_O + T'_R) \leq (T_O + T_R) + 5$ ms	Recommendation Q. 455 par. 4.4.5.2
7	Difference in power level between signal in the forward direction P_S and the actual level at the receiver input P_N; $(P_S - P_N)$	≤13 dB	
8	Immunity to signal interruption.	10 ms maximum.	
9	'No operation' requirement: the receiver shall not operate when receiving any combination of two pure sine waves with the characteristics defined as.	a) each with a power level of -42 dBm within the 300 Hz - 3 400 Hz band; b) each with a power level of -5 dBm within the 1 300 Hz - 3 400 Hz band for the set of receivers used in the backward direction, and within the 330 Hz - 1 150 Hz and 2 130 Hz - 3 400 Hz bands for the set of receivers used in the forward direction.	Recommendation Q. 455 par. 4.4.5.3
10	'Non recognition' requirement: the receiver shall not recognise a signal consisting of two signalling frequencies out of the set of frequencies normally used in the transmission direction with the characteristics defined as:	Level of -5 dBm and duration of less than 5 ms.	Recommendation Q. 455 par. 4.4.5.3 with duration modified from 7ms to 5ms
11	Input return loss within the 300 Hz - 3400 Hz band	Less than 10.5 dB	
12	Input return loss within the 500 Hz - 2000 Hz band	Less than 16.5 dB	

Legend to Parameters Used in Table 7

Operation time T_0: Defined as the time interval between the application of both frequencies and recognition of the multifrequency combination if the two frequencies making up a multifrequency combination are applied simultaneously to the input of the receiving part of the multifrequency signalling equipment.

Operation time T'_0: Defined as the time interval between the application of the second frequency and recognition of the multifrequency combination if one of the two frequencies making up a multifrequency combination is applied to the input of the receiving part of the multifrequency signalling equipment somewhat after the other frequency.

Release time T_R: Defined as the time interval between the cut-off and recognition of the end of the multifrequency combination if the two frequencies making up a multifrequency combination are simultaneously cut off from the input of the receiving part of the multifrequency signalling equipment.

Release time T'_R: Defined as the time interval between the cut-off of the second frequency and recognition of the end of the multifrequency combination if one of the two frequencies making up a multifrequency combination is cut off from the input of the receiving part of the multifrequency signalling equipment somewhat after the other frequency.

1.3.2.5 ATS R2 Transmitter performance characteristics

The performance of the ATS R2 signal transmitter shall be as defined in Table 8.

Table 8: ATS R2 Register Signalling Transmitter Performance Characteristics

1	Frequency variation	Less than 4 Hz	Recommendation Q.454 par. 4.4.4.1
2	Absolute power level of each non-modulated signalling frequency transmitted by the sending part	- 8 dBm0 ± 1 dBm0	Recommendation Q.454 par. 4.4.4.2 a) i)
3	Standard power level of each of the two frequencies	- 9 dBm +/- 1dBm	
4	Total power level due to harmonic distortion and intermodulation of all frequencies within the 300 Hz – 3400 Hz band shall be below the level of one signalling frequency by	37 dB or more	Recommendation Q.454 par. 4.4.4.4
5	Impedance	600 Ohm	
6	When no signalling frequency is being sent the total power load of the transmitted leak current shall be below the level of either of the signalling frequencies by:	50 dB or more	Recommendation Q.454 par. 4.4.4.3
7	As defined in 6. above when a signalling frequency is being sent	35 dB	Recommendation Q.454 par. 4.4.4.3 modified from 30 db to 35 db.
8	Signal time tolerance: the time interval between starting or terminating the transmission on each of the two frequencies shall not exceed:	1 ms	Recommendation Q.454 par. 4.4.4.5

1.3.2.6 ATS R2 Numbering Plan

The 13-digit register signal address sequence is comprised of a 6-digit destination (called user) address, a 1-digit priority level and a 6-digit source (calling user) address. The 6-digit format used for the destination and source addresses should be compliant with the recommendation contained within the ICAO Document 9804 [9] Chapter 2 Section 2.3.

For further information refer to the Numbering Schemes section in the Eurocontrol document entitled “ATS Ground Voice Network Implementation and Planning Guidelines” [4].

1.3.2.7 ATS R2 Call Priority level implementation

The 7th digit in the 13-digit address sequence shall be used to define the call priority level of the ATS R2 call. This can have the value 1, 2, 3 or 4 on a Direct Point-to-Point route.

An originating or transit VCS should increase the value of the 7th digit in the 13-digit sequence by 5 when it routes the call over a Detour route with respect to the Direct Point-to-Point route.

Table 9: Call Priority level ranges for Direct/Detour routes

ATS R2 Call Priority Level	Call Routing
1-4	Via a Direct Point-to-Point route
6-9	Via a Detour route

The priority level of an ATS R2 call is a means of attaching an indicator to the call to show its level of importance. It is intended for use when it is necessary to make an urgent call concerning the safety of aircraft (i.e. an emergency situation) and to enable the interruption of less urgent calls in progress at the time if the inter-VCS link is congested.

Note: The calling user is not able to change the priority level of a call after the call attempt has been initiated. Hence a call having the highest priority level must be initiated from the beginning.

For further information about "Priority Calls" and "Priority Call Management and Routing Strategy" within the "ATS Ground Voice Network", refer to Eurocontrol documents entitled "Voice Communication System Procurement Guidelines" [3] and "ATS Ground Voice Network Implementation and Planning Guidelines" [4].

1.3.3 ATS R2 User Signals

These are the audible tones directed to the earpiece in order that the user can determine the progress of the call. These tones can be divided into two groups (i.e. tones generated locally to local user and audible tones sent on line).

1.3.3.1 Audible tones locally generated towards local user

The received status signal number returned by the terminating or transit VCS will be converted into distinguishable audible tones for the calling user to hear.

A VCS should be capable of locally generating the following audible tones, as recommended in Table 10 below, in order to indicate call progress to the local user.

Table 10: Locally generated audible user tones

Tone	Status number received	Purpose	Frequency (Hz)	Period
Terminal busy	3	Returned to the calling user by originating VCS if all available voice paths to a called user are occupied.	425	(0.5 s on, 0.5 s off), repeated
Congestion	8	Returned to the calling user by originating VCS if a call cannot be completed to required called user due to all appropriate inter-VCS links being occupied or otherwise unavailable.	425 /1000 Hz	(0.5 s each), repeated
Number Unobtainable (Note 1)	5	Returned to the calling user by the originating VCS if a terminal is "Out of Service" or the called user address is unassigned.	1000	(0.5 s on, 0.5 s off), repeated
Note 1: Not specified in ITU-T Recommendation E.180 [11]				

1.3.3.2 Audible tones transmitted on the line

A VCS should be capable of generating the following audible tones as recommended in Table 11 below and sending them over the analogue leased line.

Table 11: Audible tones transmitted on analogue leased line

Tone	Purpose	Frequency (Hz)	Period
Ringing	Sent by terminating VCS to the calling user (inband) after successful call establishment and prior to call acceptance by the called user.	425	(1 s on, 4 s off), repeated
Interrupt warning (Note 1)	Injected into the voice path to warn a user of the imminent priority interruption of an established call. This signal is sent by the VCS that is handling the call interruption over the inter-VCS link.	1000	(40ms, 0.5s off) repeated for up to 15s prior to forced disconnection (ATS Ground Voice Network guidelines [4] recommends 5 seconds)
Intrusion warning (Note 1)	Injected into the voice path to warn the unwanted user of the imminent priority conferencing of an established call. This signal is sent by the Wanted User VCS.	1000	1 s on
Note 1: Not specified in ITU-T Recommendation E.180 [11]			

When a terminating VCS returns a status number 6 “Terminal free” status number (indicating that the called user is being alerted) it shall connect the voice path and send an audible "ringing tone".

1.3.3.3 VCS Output voice level

A VCS should be capable of configuring the voice level output on the line to a value in the range from -20dBm0 to OdBm0. The recommended nominal voice level output over the line should be configured to be -10dBm.

Note: Many VCS's use Automatic Level Control (ALC) circuits to regulate the voice level received from the line to that of its internal nominal level. An ALC circuit should be capable of receiving voice levels from the line in the range from -30dBm to 0dBm.

For further information about the Output Voice Level of a VCS refer to Eurocontrol document entitled "ATS Ground Voice Network Implementation and Planning Guidelines" [4].

1.3.4 Line Interrupt

During times of congestion on an inter-VCS link, an active ATS R2 call could be interrupted in order that its line can be allocated to another ATS R2 call with higher priority.

An Interrupt Warning tone (as defined in Table 11) shall be Injected into the voice path by the VCS performing the call interrupt, in order to warn the remote user of the imminent line interruption of their established call. On expiry of the Interrupt Warning Period, the Blocking line signal shall be sent on the line by the VCS performing the line interrupt. Both users shall be disconnected and the line disconnected with the start of the Blocking signal. (See Figure 5).

After termination of the Blocking signal the VCS performing the line interrupt shall transmit the complete signalling sequence, starting with the Seizing signal, in order to establish the ATS R2 call with higher priority.

***Note:** If another line becomes available and has been seized for the higher priority call during the Interrupt warning period, the Interrupt warning tone being injected into the voice path should be stopped. The users shall remain connected.*

***Note:** If another line becomes available and has been seized for the higher priority call while the Blocking signal is being sent, the VCS should continue to send the blocking signal for its full duration and then release the line by sending the Clear-Forward line signal. (see Figure 6).*

***Note:** Line interrupt can only occur during the conversation phase and not during call establishment or call clearing phases.*

1.3.5 Line Blocking and unblocking procedure

The "Blocking" line signal is also used to prevent seizure of a line from either end of an inter-VCS link prior to either maintenance activity being performed, back-up system operation or a VCS working in degraded mode etc. A line blocking procedure is considered an essential feature in the management of the trunk lines over an inter-VCS link.

The "Blocking" line signal should be sent over the line in order to block its use at both ends. On sending the "Blocking" line signal, a VCS should remove this line from service in order that it can't be seized. Similarly on receiving a "Blocking" line signal, a VCS should also remove the line from service. Failure to follow these procedures could result in a call attempt being performed on an inactive line which would be released only on expiry of the pre-defined time-out parameters.

A line can only be unblocked from the side that initially sent the "Blocking" line signal. In order to unblock a line, the VCS should replace the line in service and either send a "Clear Forward" line signal (in the case that there is no call attempt being implemented), or a "Seizure" line signal (in the case that a call attempt is being implemented). On receiving a "Clear Forward" or "Seizure" line signal, a VCS should also replace the line in service.

In the case that a line unblock attempt is made from the side that didn't initiate the blocking, this should have no effect on the blocked line's condition and it should remain blocked. The local user should be connected to a locally generated "trunk congestion" tone.

When a blocked line has been brought back into service with the "Clear Forward" line signal, there should be a line check implemented through a test call over the line in order to ensure it is

fully operational. For further information about recommended Line Checking and Test Call Procedure refer to Eurocontrol document entitled “ATS Ground Voice Network Implementation and Planning Guidelines” [4].

1.3.6 Call Intrusion

An active ATS R2 call could be subject to intrusion from another ATS R2 call with higher priority. Whether call intrusion is permitted at a VCS is ANSP dependent.

An Intrusion Warning tone (as defined in Table 11) shall be Injected into the voice path towards the unwanted user in the active call, by the VCS of the wanted user in the call intrusion. This warns the unwanted user of an imminent intrusion on their established call.

Note: *Usually the VCS of the wanted user should also connect a locally generated Intrusion Warning tone to the voice path of the wanted user. This decision is however ANSP dependent and not related to the signalling system being used.*

The Intrusion Warning tone should be removed from the voice path of the unwanted user (and the wanted user, if locally generated) when a call intrusion is effective.

Note: *Some ANSP’s prefer to inject an intrusion effective tone into the voice path when the intrusion is effective. This decision is however ANSP dependent and not related to the signalling system being used.*

For further information about “Call Intrusion” within the “ATS Ground Voice Network”, refer to Eurocontrol documents entitled “Voice Communication System Procurement Guidelines” [3] and “ATS Ground Voice Network Implementation and Planning Guidelines” [4].

1.4 Complete ATS R2 Signalling Sequence

When making an ATS R2 call over an inter-VCS link, the complete signalling sequence is defined as follows:

1. The originating VCS sends the Seizing line signal.
2. The originating VCS then sends the 13-digit register address sequence. Each digit acknowledged in a compelled manner.
3. The terminating VCS responds with the register “Status” number ("terminal free (6)", "terminal busy (3)" or “terminal out of service (5)" or “trunk congestion (8)”). This digit must also be acknowledged in a compelled manner.
4. Register “Status” numbers 3, 5 and 8 will cause an appropriate tone to be generated locally by the originating VCS to the calling user. This will also cause the originating VCS to send the Clear-Forward line signal in order to release the line.
5. Register “Status” number 6 will cause the terminating VCS to connect the voice path to the calling user and send an audible "ringing tone" on the line.
6. The audible “ringing tone” will be stopped by the terminating VCS when the call has been answered.
7. An audible “Interrupt Warning tone” placed on the line by the VCS performing the call priority interrupt, informs the users of the impending disconnection of their call. On expiry of the “Interrupt Warning Period”, the blocking line signal is sent on the line.
8. An audible “Intrusion tone” placed on the line by the VCS of the wanted user in the call intrusion, informs the unwanted user of impending intrusion into their call. This tone is removed when the intrusion is effective.

For Transit calls over two inter-VCS links, ATS R2 performs signalling on a link-to-link basis in order to establish a voice circuit between the end VCS’s.

Figure 1 to Figure 6 shows the complete ATS R2 signalling sequence with ATS R2 timing parameter explanatory notes for a single inter-VCS link being defined in Table 12.

1.5 Time Outs

1.5.1 Time Out for Digit Transmission

The Time Out setting for:

a) Digit Transmission

b) P3, P4, P5, P7

c) P2, P8

shall be 200 ms.

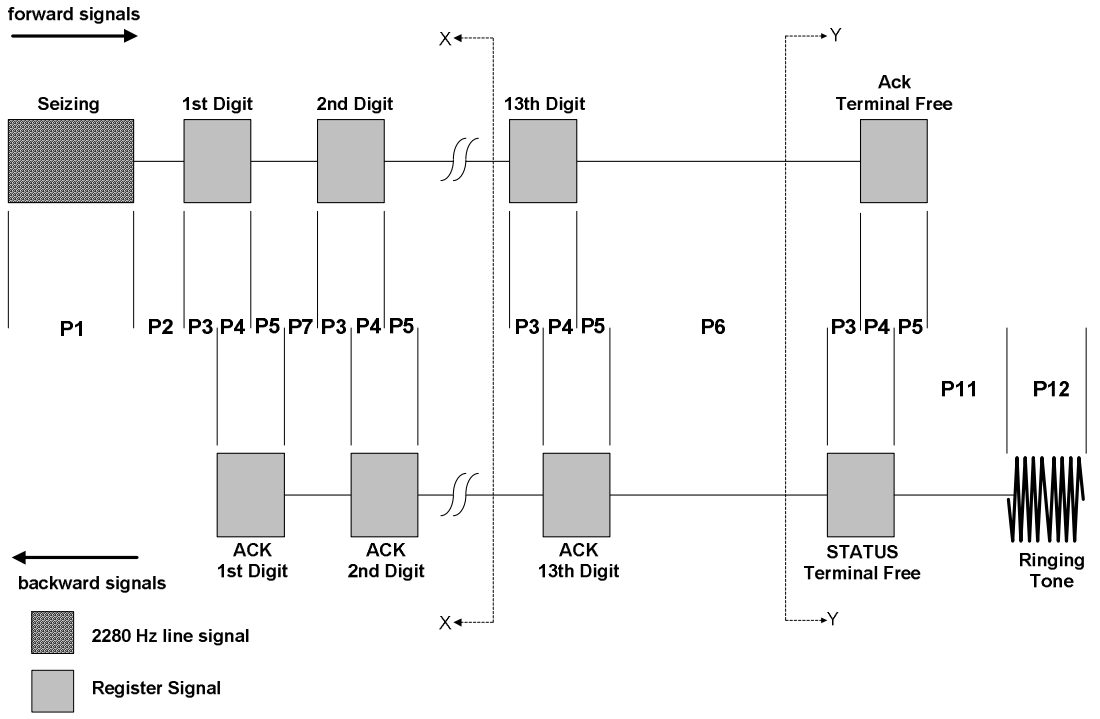

Figure 1: ATS R2 Signalling – Terminal Free

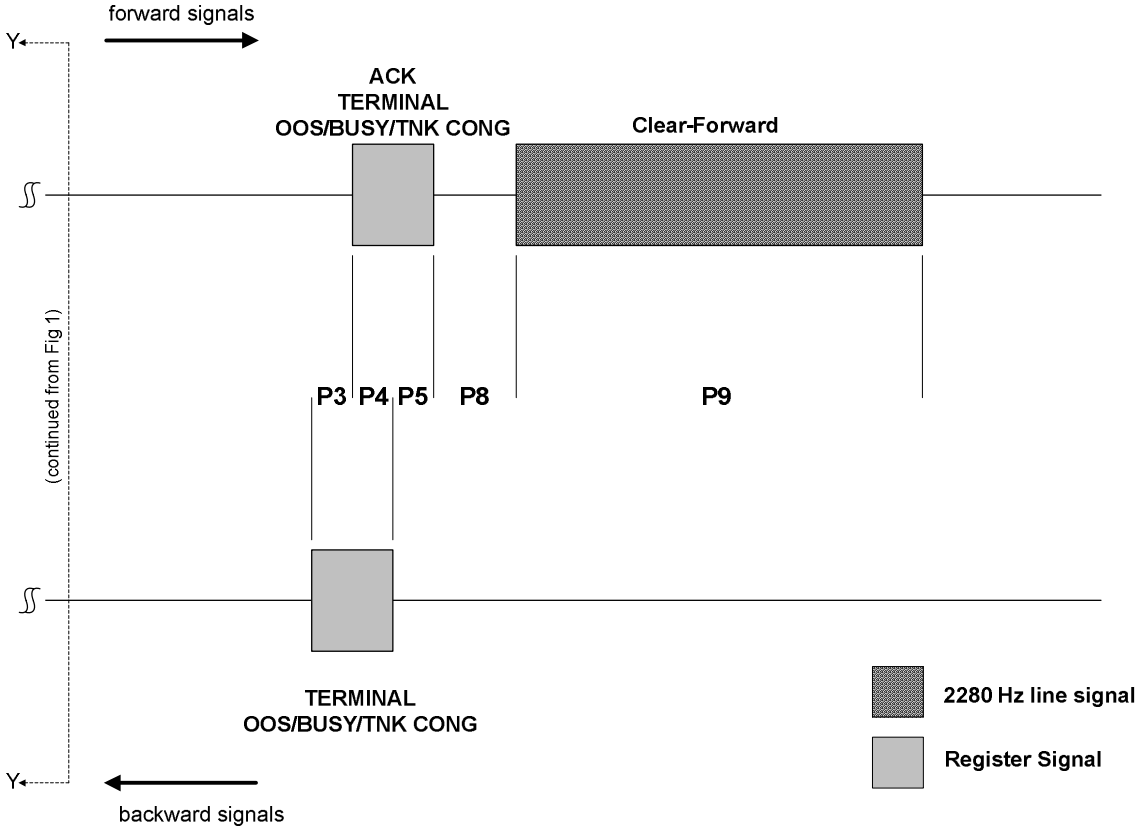

Figure 2: ATS R2 Signalling – Out-of-Service/Busy/Congested- Clear Forward

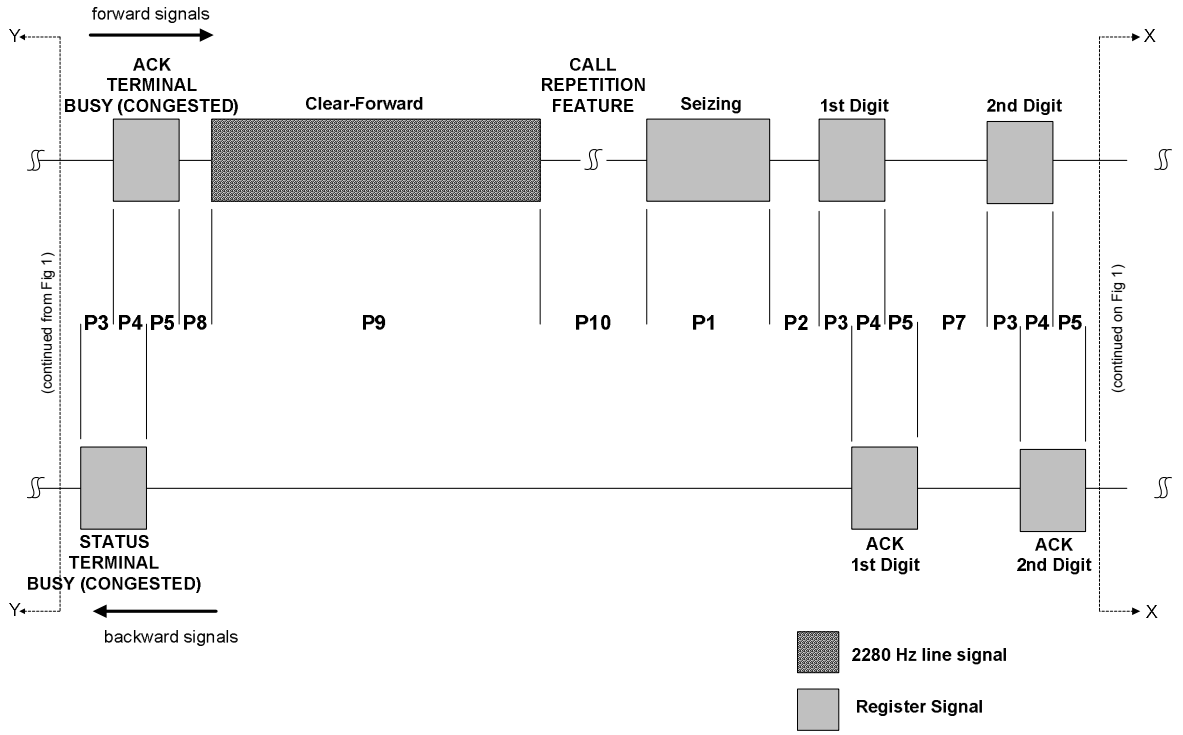

Figure 3: ATS R2 Signalling – Terminal Busy/Congested –Call Repetition enabled

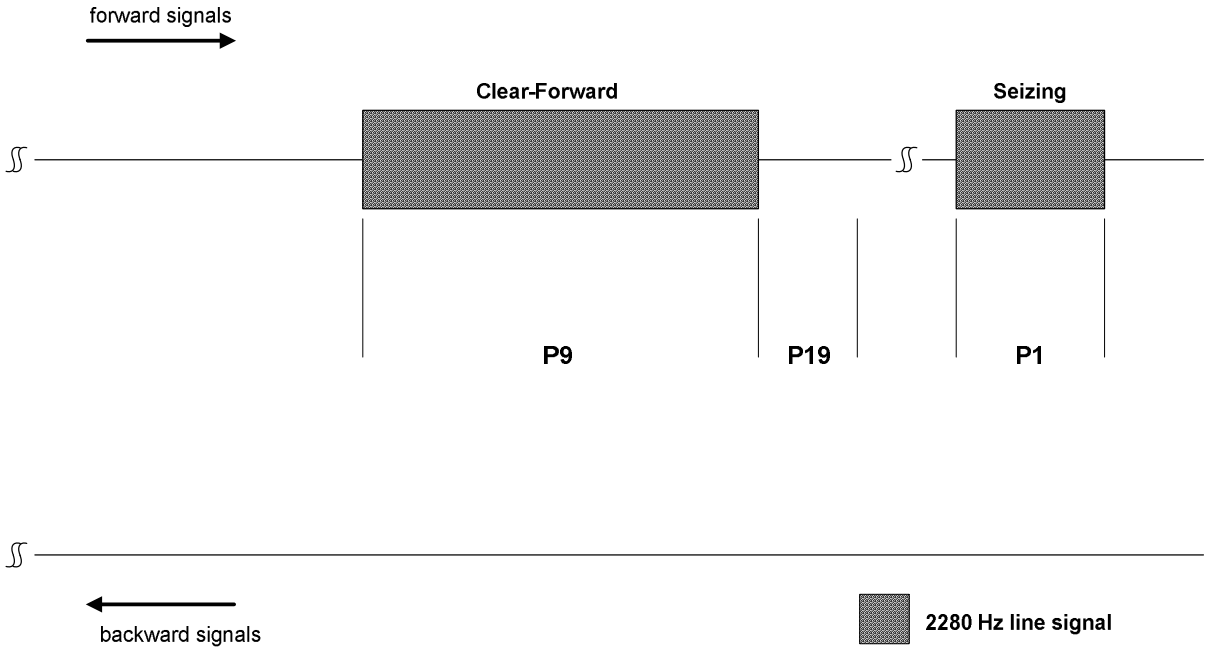

Figure 4: ATS R2 Signalling – Normal Release

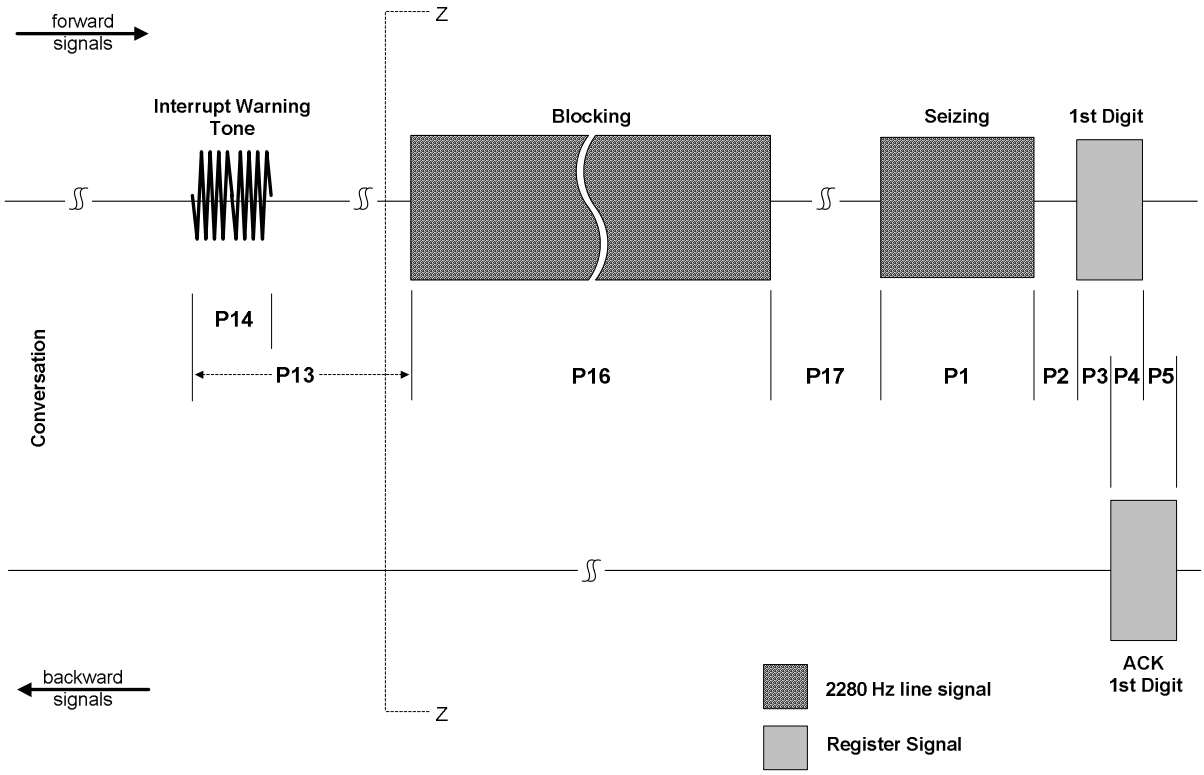

Figure 5: ATS R2 Signalling – Priority Interrupt (using single line)

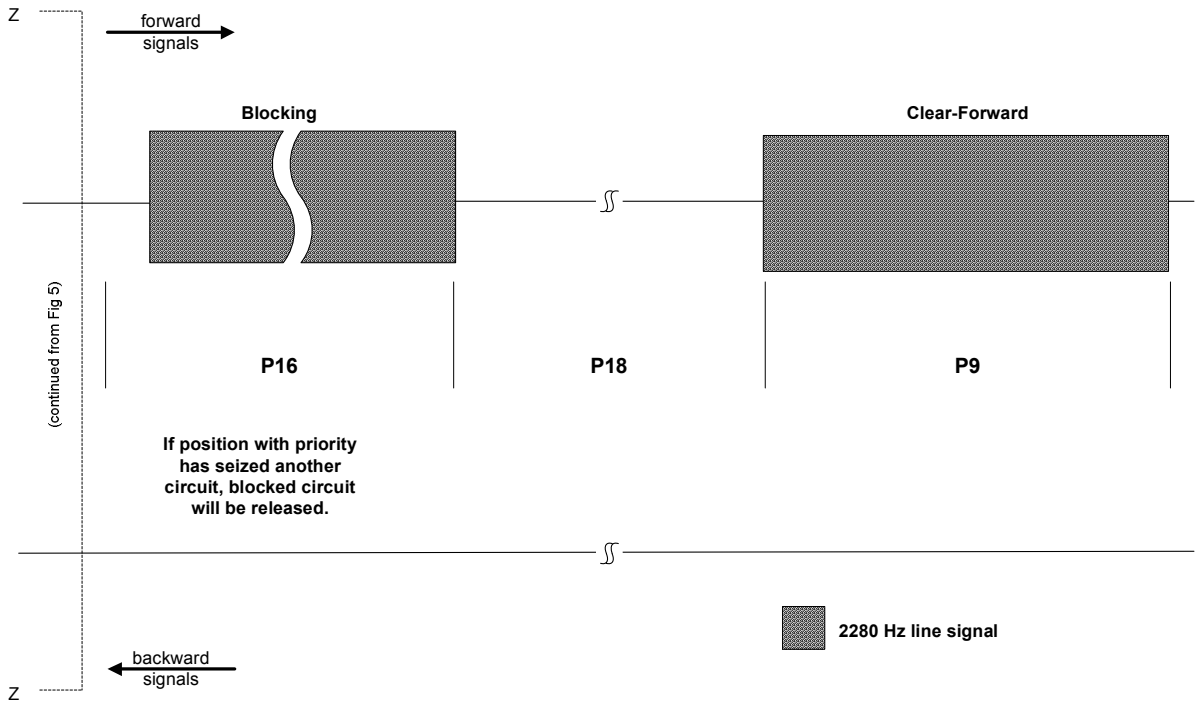

Figure 6: ATS R2 Signalling – Priority Interrupt (different line seized)

Table 12 provides some explanatory notes relating to the timing parameters Px defined in Figures 1 to 6.

Table 12: ATS R2 Timing parameters for a single inter-VCS link

Item	Description	Side A	Side B	Time-out	Remarks	Reference
P1	Seizing Total duration of the Seizing signal.	150 ms ± 25 ms	350 ms ± 50 ms			ATS R2 specified
P2	Interval between the end of the Seizing signal and the start of the 1st digit signal.	40 ± 10 ms	40 ± 10 ms	200 ms	(Note 1)	Recommendation Q.412 Section 2.2.1
P3	$T_O+T_{int}+T_{s.}$ Interval between the start of a register signal (either digit or status) and the start of the corresponding acknowledgement. (Excludes line propagation delay T_{PF})	40 ± 10 ms	40 ± 10 ms	200 ms (Includes propagation delay T_{PF} $+T_{PB}$)	(Existing equipment need not necessarily be changed if P3 is greater than 200 ms). (Note 1)	Recommendation Q.457 Section 4.5.2
P4	$T_O+T_{S.}$ Interval between the start of an acknowledgement signal and the end of the corresponding preceding register signal. (Excludes line propagation delay T_{PB})	40 ± 10 ms	40 ± 10 ms	200 ms (Includes propagation delay T_{PF} $+T_{PB}$)	(Note 1)	Recommendation Q.457 Section 4.5.2
P5	$T_R+T_{S.}$ Interval between the end of a register signal (either digit or status) and the end of the corresponding acknowledgement. (Excludes line propagation delay T_{PF})	40 ± 10 ms	40 ± 10 ms	200 ms (Includes propagation delay T_{PF} $+T_{PB}$)	(Note 1)	Recommendation Q.457 Section 4.5.2
P6	Interval between the end of the 13th acknowledge signal and the start of a register type status signal.	30ms to 300 ms	30ms to 300 ms	1 s	Refer to P22 for transit call timeout. (Existing equipment need not necessarily be changed if P6 already has same timeout value as P22).	ATS R2 specified

Item	Description	Side A	Side B	Time-out	Remarks	Reference
P7	T_R+T_s Interval between the end of an acknowledge signal and the start of the succeeding register type digit signal. (Excludes line propagation delay T_{PB})	40 ± 10 ms	40 ± 10 ms	200 ms (Includes propagation delay T_{PF} $+T_{PB}$)	(Note 1)	Recommendation Q.457 Section 4.5.2
P8	Interval between the end of either: a) the Terminal Out of Service acknowledge signal; or b) the Trunk Congestion acknowledge signal; or c) the Terminal Busy acknowledgement signal and the start of the Clear-Forward signal.	40 ± 10 ms	40 ± 10 ms	200 ms	(Note 1)	Recommendation Q. 412
P9	Total duration of the Clear-Forward signal.	400 ms ± 70 ms	1300ms ±200ms			ATS R2 specified
P10	CALL REPETITION interval. The duration between the end of the Clear-Forward signal and the start of the Seizing signal.	1s to 10s	1s to 10s	ANSP dependent	Originally this value was 2 s to 5 s, existing equipment need not necessarily be changed.	
P11	Duration of the interval between the end of the status signal and the start of the "Ringing tone".	0.5 s to 1 s	0.5 s to 1 s		Originally this value was 0.5 s to 4 s, existing equipment need not necessarily be changed	
P12	RINGING TONE 425 Hz	1s ON/4s OFF (Repeated)	1s ON/4s OFF (Repeated)	ANSP dependent		As defined in section 2.3.3.2.
P13	Duration of INTERRUPT WARNING tone period from the start of the first interrupt signal to the start of the Blocking signal. INTERRUPT WARNING tone shall be repeated throughout this period.	< 15s (ATS Ground Voice network guidelines recommends 5s [4].)	<15s (ATS Ground Voice network guidelines recommends 5s [4].)		Compliant with VCS procurement guideline document [3].	ATS R2 specified

Item	Description	Side A	Side B	Time-out	Remarks	Reference
P14	INTERRUPT WARNING tone	40 ms ON 0.5 s OFF	40 ms ON 0.5 s OFF			ATS R2 specified
P15	*NOT USED*					
P16	The total duration of the Blocking signal.	2600ms±550ms	4800ms±970ms			ATS R2 specified Note: Blocking signal is sent from either side of an inter-VCS link.
P17	Interval between the end of the Blocking signal to when the line is available for seizure in a new call.	100 ms to 5 s	100 ms to 5 s		This parameter is subject to switching system characteristics	
P18	LINE RELEASE after priority interrupt. Interval between the end of the Blocking signal to the start of the Clear-Forward signal.	100ms to 5 s	100ms to 5 s		If the earmarked line is not seized by the priority call within this time the line must be released.	
P19	Interval between the end of the Clear-Forward signal to when the line is available for seizure in a new call.	100 ms	100 ms			
P20	*NOT USED*					
P∑	MFC Cycle (T) for terrestrial conditions. (P∑=T=P3+P4+P5+P7)	120ms≤T≤200ms	120ms≤T≤200ms	300 ms		Recommendation Q.457 Section 4.5.2 Figure 18 Note Q.457 evaluates extremes of duration between 120ms and 200ms for terrestrial connections. A typical value is therefore 160ms.
Note 1: A receive recognition time of 40ms +/- 20ms is acceptable to ensure backwards compatibility with existing systems.						

Recommendation *The software should provide easy access to, and modification of, the time parameters shown in Table 12.*

Call Repetition Feature

The Call Repetition feature is not part of the ATS R2 protocol. This is a VCS dependent feature. For further information about Call Repetition Feature and its employment within the ATS Ground Voice Network, refer to document entitled "ATS Ground Voice Network Implementation and Planning Guidelines" [4].

Legend to Parameters Used in Table 12

T_O:	**Operation Time** If the two frequencies making up a Multi-frequency combination are applied simultaneously to the input of the receiver, the time interval between the application of both frequencies and recognition of the Multi-frequency combination is called the operation time.	**Typical values** $T_O + T_R \leq 70$ ms	**Reference** Recommendation Q.451 4.4.2.2 a)
T_R:	**Release Time** If the two frequencies making up a Multi-frequency combination are simultaneously cut-off from the input of the receiver, the time interval between the cut-off and the recognition of the end of the Multi-frequency combination is called the release time.	$T_O + T_R \leq 70$ ms	Recommendation Q.451 4.4.2.2 b)
T_s:	**Starting and Stopping Time** The time required for starting or stopping the sending of a Multi-frequency combination is denoted as T_s.	$2.5\text{ms} \leq T_s \leq 5\text{ms}$	Recommendation Q.457 Section 4.5.2
T_{PF}:	**Propagation Forward** The transmission delay of the slower of the two frequencies of the forward signal is denoted T_{PF}.	10 ms	Recommendation Q.457 Section 4.5.2
T_{PB}:	**Propagation Backward** The transmission delay of the slower of the two frequencies of the backward signal is denoted T_{PB}.	10 ms	Recommendation Q.457 Section 4.5.2
T_{int}:	**Internal Operating Time** The time required for the Multi-frequency receiver to determine which backward signal to send in reply to a forward signal is denoted as T_{int}. The time must be kept as small as possible.		Recommendation Q.451 4.4.2.3 a)

2. ATS NO.5 SIGNALLING SPECIFICATION

2.1 Introduction

This section contains the detailed specification for the ATS Signalling System No.5 protocol (from here on nominated ATS No.5) to be used between the Voice Communication Systems of Air Traffic Service units in ECAC member states. This specification is derived from ITU-T Signalling System No.5 [2].

2.2 ATS No.5 Signalling Principle

ATS No.5 line signalling shall be used in order to Seize a line, Clear a line from either calling or called user side, Block a line and answer a call. Line signals use one or two tones. VCS's are able to distinguish between different line signals by keeping track of the call state during the call setup or clearing procedure. Line signals can be sent from either side of an inter-VCS link. ATS No.5 line signals are compelled implying that each line signal sent in one direction has a corresponding acknowledgement line signal in the opposite direction.

ATS No.5 register signalling shall be used in order to transfer the calling/called user addresses and the call priority level information over the inter-VCS link. ATS No.5 register signalling shall also be used to transfer status signal information back from a terminating/transit VCS to the originating VCS.

ATS No.5 register signalling employs different tone pairs to represent individual digits and status signals. ATS No.5 register signalling can be sent from either side of an inter-VCS link. ATS No.5 register signalling is non-compelled implying that each signal sent in one direction is not acknowledged in the opposite direction.

ATS No.5 User signals relate to providing information about the progress of the call to the user, through audible tones (e.g. dial tone, ringing tone, busy tone, congestion tone etc). They are also used to warn a user of an impending line interrupt of their call or an intrusion into their call.

ATS No.5 signalling employs a "link to link" signalling method to establish a call. This implies that with a call involving two inter-VCS links, the signalling is exchanged between Originating and Transit VCS's to establish a voice circuit on the first link before the Transit VCS and Terminating VCS's exchange signalling in order to establish a voice circuit on the second link.

2.3 ATS No.5 Line Signals, Register Signals and User Signals

ATS No.5 signalling employs Line signals, Register Signals and User signals (audible user tones);

2.3.1 ATS No.5 Line Signalling

ATS No.5 line signalling is a compelled inband signalling system, which implies that the signals are sent in a forward direction and are acknowledged in the backward direction and vice versa. The Line signals are based on the use of two frequencies 2400Hz and 2600Hz transmitted individually or in a combination.

ATS No.5 line signalling uses idle-tone off, which implies that when the line is in the idle condition (i.e. not being seized or involved in an active call), no signalling frequency is sent on the line.

By taking advantage of the call scenario sequence in which specific signals occur, signals of the same frequency content are able to characterise different functions. Consequently, the signalling equipment shall operate in a sequential manner retaining a memory of the preceding call states and the direction of signalling in order to differentiate between signals having the same frequency.

Each line signal that is sent in one direction has a defined acknowledgement line signal as a response. These line signal pairs are defined as in the Table 13 below.

Table 13: ATS No.5 Line Signal pairs

Line Signal in forward direction	Corresponding Line Signal in backward direction
Seizing Signal	Proceed to send signal
Answer Acknowledge	Answer signal
Clear Forward signal	Release Guard signal
Clear Backward Acknowledge	Clear Backward signal
Blocking	Release Guard signal

2.3.1.1 Line Signals

Line signals use the compelled signalling method and can be sent from either side of an inter-VCS link. The following line signals exist:

- **Seizing Signal** ***(sent in forward direction)***: sent from an originating VCS in order to seize a line for an outgoing call; sent from a transit VCS in order to seize a line for a transit call towards a terminating VCS; It has a frequency of 2400Hz.
- **Proceed-to-send signal** ***(sent in backward direction):*** sent by a transit or terminating VCS as response to receiving seizing signal. Indicates that the equipment is ready to receive the address information (i.e. dialled digits). It has a frequency of 2600Hz.
- **Answer Signal** ***(sent in backward direction):*** sent by a Terminating VCS to an Originating or Transit VCS to indicate that the called user has answered the call. It has a frequency of 2400Hz.

  For detour calls (though a gateway VCS), the answer signal is overlap-compelled, which implies that it is automatically sent at a gateway VCS to the originating VCS as soon as the register status number 6 (terminal free) signal is received from the terminating VCS, in order to obtain a faster call setup time.
- **Answer Acknowledgement signal** ***(sent in forward direction):*** sent from the Originating or transit VCS to acknowledge the answer signal. It has a frequency of 2400Hz.
- **Clear Forward signal** ***(sent in forward direction):*** sent when the calling user clears call. It has two frequencies of 2400Hz and 2600Hz.

  The clear-forward signal, is acknowledged by a release guard signal under all conditions of the equipment including the idle condition and may be sent from an outgoing end at any time to initiate the release of the line. The clear-forward signal shall completely override any other signal and may break into any other signal sequence.

- **Release Guard signal** ***(sent in backward direction):*** sent as response to the clear forward signal. It also has two frequencies of 2400Hz and 2600Hz.

  The Release Guard is used to protect a line against seizure as long as the disconnection operations controlled by reception of the clear-forward signal have not been completed at its incoming end.

- **Clear Back signal** ***(sent in backward direction):*** sent to the Originating or Transit VCS when the called user clears the call. It has a frequency of 2600Hz.

- **Clear Back Acknowledge signal** ***(sent in forward direction):*** sent from the Originating or Transit VCS to acknowledge the clear back signal. It will cause the triggering of a Clear Forward signal in the forward direction in order to clear both ends of the call. It has a frequency of 2400Hz.

- **Blocking:** sent by the VCS performing line interrupt or maintenance procedures over an inter-VCS link. It has two frequencies of 2400Hz and 2600Hz. A blocking signal sent from either side of an inter-VCS link shall trigger a Release Guard signal in the opposite direction.

2.3.1.2 Line Signal frequencies

The frequencies of line signals shall be as defined in Table 14.

Table 14: Line Signal Frequencies

Signal	Frequency in Hz	Reference
Seizing	2400 Hz	Recommendation Q.1.4.1, 2.1.5
Proceed-to-send	2600 Hz	Recommendation Q.1.4.1, 2.1.5
Answer	2400 Hz	Recommendation Q.1.4.1, 2.1.5
Answer acknowledgement	2400 Hz	Recommendation Q.1.4.1, 2.1.5
Clear-Forward	2400 Hz + 2600 Hz (compound)	Recommendation Q.1.4.1, 2.1.5
Release guard	2400 Hz + 2600 Hz (compound)	Recommendation Q.1.4.1, 2.1.5
Clear back	2600 Hz	Recommendation Q.1.4.1, 2.1.5
Clear back acknowledgement	2400 Hz	Recommendation Q.1.4.1, 2.1.5
Blocking	2400 Hz + 2600 Hz (compound)	

2.3.1.3 Call collision (Double Seizing)

Call collision occurs when two calls originating from VCS's at opposite ends of an inter-VCS link simultaneously attempt to send the seizing line signal over the same analogue leased line.

Note: a VCS should check that there is not a Seizing or Blocking Line signal already on the line (i.e. being sent from the opposite side of the inter-VCS link) before sending its Seizing line signal. If these are detected a different line should be selected if available.

In order to reduce the probability of call collisions occurring over an inter-VCS link it is necessary that one side of the link is configured as an "A" side and the other side of the link is configured as a "B" side. An "A" side should seize the lines in an ascending order and the "B" side should seize the lines in descending order.

Call collisions shall be solved by application of the following principle. The detection of a call collision shall be achieved when one VCS on an inter-VCS link transmits the outgoing Seizing signal (2400 Hz) and at the same time receives the Seizing signal (2400 Hz) from the other end of the inter-VCS link and not the Proceed-to-send signal (2600Hz) as expected. In this event the seizing signal transmitted from the VCS having detected the call collision shall persist for at least 850 ms ± 200 ms to permit the other end to detect the call collision.

In the event of a call collision being detected, it is recommended that a "B" side VCS shall re-attempt the same call on the same line while the "A" side VCS if configured for automatic call repetition shall attempt to establish its call on an alternative line or Detour route. In the event that this is not possible then a calling user on the "A" side shall receive a locally generated audible user tone "Terminal Congestion".

2.3.1.4 Call Clearing

Calls can be cleared either in the forward direction if the calling user clears or in the backward direction if the called user clears. Calls cleared in the backward direction will cause a trigger for the call to also be cleared in the forward direction. Calls can be cleared at any time by both "A" and "B" sides during the call establishment and conversation phases.

2.3.1.5 Inband line signal suppression

The 2400 Hz/2600 Hz tone of the Clear-Forward and Blocking line signals and the 2600 Hz Clear Back tone shall be cut off from the headset of both users' in the established call some milliseconds after the start of the signal.

2.3.2 ATS No.5 Register Signalling

All ATS No.5 register signals shall be exchanged according to a non-compelled signalling procedure.

2.3.2.1 Register signals

The following register signals exist:

- **Digits KP, 0,1,2,3,4,5,6,7,8,9, ST:** A "start of pulsing" (KP) pulse, a 13-digit sequence of numbers comprising of a 6-digit destination address, a 1-digit priority level and a 6-digit source address, an "end-of-pulsing" (ST) pulse.

  An originating or transit VCS sends the dual tone equivalent of each digit in succession in the forward direction only.

- **Status signals**: As soon as the "ST" pulse is received, a terminating or transit VCS sends the dual tone equivalent of the status number in the backward direction. The status register signal is however not acknowledged.

The status number can represent one the following 4 status conditions:

- Terminal free,
- Terminal busy,
- Trunk congestion,
- Terminal Out of Service (or Called number not allocated).

2.3.2.2 ATS No.5 Register signalling composition

The register signalling shall employ a two-out-of-six multi-frequency code, with signalling in the forward direction only, as shown in the Table 15 below.

The correspondence between Register digits, the “start of pulsing” pulse KP, the “end of pulsing pulse” ST and the Frequencies is defined in Table 15 below.

On receipt of a proceed-to-send line signal, the seizing line signal is terminated and a 'start of pulsing' (KP) pulse, followed by the 13-digit address sequence is transmitted by the register. After the 13th digit an 'end-of-pulsing' (ST) pulse shall be transmitted. The 13-digit numerical signal is comprised of 6 digits for the destination address, 1 digit for call priority and 6 digits for the source address.

Table 15: Correspondence between Register digits and frequencies

Signal	Frequencies in Hz	Reference
KP	1 100 + 1 700	Recommendation Q.151, 3.1.1, Table 2
1	700 + 900	Recommendation Q.151, 3.1.1, Table 2
2	700 + 1 100	Recommendation Q.151, 3.1.1, Table 2
3	900 + 1 100	Recommendation Q.151, 3.1.1, Table 2
4	700 + 1 300	Recommendation Q.151, 3.1.1, Table 2
5	900 + 1 300	Recommendation Q.151, 3.1.1, Table 2
6	1 100 + 1 300	Recommendation Q.151, 3.1.1, Table 2
7	700 + 1 500	Recommendation Q.151, 3.1.1, Table 2
8	900 + 1 500	Recommendation Q.151, 3.1.1, Table 2
9	1 100 + 1 500	Recommendation Q.151, 3.1.1, Table 2
0	1 300 + 1 500	Recommendation Q.151, 3.1.1, Table 2
ST	1 500 + 1 700	Recommendation Q.151, 3.1.1, Table 2

Note that the KP signal used is the same as the KP1 signal defined in the ITU-T No. 5 specification. The KP2 signal described in the ITU-T No.5 specification is not used.

The Signalling system No.5 Status signals are register signals and are used to indicate if the terminal is free, busy, out-of-service or if there is trunk congestion. As soon as the ST pulse is received a status signal, as defined in the Table 16 below shall be sent in the backward direction.

The correspondence between register status information, status number and frequencies are defined in the Table 16 below.

Table 16: Correspondence between Register status number and Frequencies

Frequency in Hz

Register Status information	Status Number	Signalling Frequencies (Backward Direction)		Reference
Terminal free	6	1100	1300	Recommendation Q.151, 3.1.1., Table 2
Terminal busy	3	900	1100	Recommendation Q.151, 3.1.1, Table 2
Trunk congestion	8	900	1500	Recommendation Q.151, 3.1.1, Table 2
Terminal out of service or called number not allocated	5	900	1300	Recommendation Q.151, 3.1.1, Table 2

2.3.2.3 ATS No.5 Register status signal generation conditions

Table 17 below defines the conditions when Register Status Signals are generated by either a transit or terminating VCS.

Table 17: Register Status signal generation conditions

Register Status information	Status Number	Generated by Terminating VCS when:	Generated by Transit VCS when:
Terminal free	6	• Called terminal is being alerted to the incoming call (i.e ringing). Inband ringing tone is then sent on line.	
Terminal busy	3	• Called terminal is busy. (Normally only generated if Indirect Access Call Queue is full).	
Trunk congestion	8		• No direct or detour route to destination due to congestion of available lines with calls having an equal or higher priority level.
Terminal out of service or called number not allocated	5	• Called party address is unallocated (unassigned) • Address format invalid • Called terminal out-of-order • No compatible destination exists.	• Called party address is unallocated (unassigned) • Address format invalid • No compatible destination exists.

On receipt of an ATS No.5 Register Status signal with status numbers 3, 5 or 8, the Originating VCS shall send a “Clear Forward” line signal in the forwards direction in order to clear the

circuit for another call. This shall be acknowledged by a “Release Guard” signal in the backwards direction.

2.3.2.4 ATS No.5 Receiver performance characteristics

The performance of the signal receiver equipment shall be as defined in Table 18.

Table 18: Signal Receiver Performance Characteristics

1	Frequency range	± 15 Hz	Recommendation Q.154 3.4.1 a)
2	Sensitivity range: absolute power level of each of the two frequencies	- 35 dBm to - 5 dBm	
3	Impedance	600 Ohm	
4	Difference in level between: a) adjacent frequencies; and b) non-adjacent frequencies	a) Less than 5 dB b) Less than 7 dB	
5	Sum of operation and release time	125 ms ± 25 ms	
6	Immunity to signal interruptions	<15 ms	Recommendation Q.141 Section 2.1.4
7	End of signal recognition for line interruptions	>40ms	
8	'No operation' requirement: the receiver shall not operate when receiving any combination of two pure sine waves with the characteristics given.	Each with a power level of less than 42 dBm within the 300 Hz - 3 400 Hz band.	
9	'Non-recognition' requirement: the receiver shall not recognise a signal consisting of two signalling frequencies out of the set of signalling frequencies normally used in the transmission direction with the characteristics given.	Level of - 5 dBm and a duration of less than 10 ms	
10	Input return loss within the 300 Hz - 3 400 Hz band	Less than 20 dB	Recommendation Q.154 3.4.4.

2.3.2.5 ATS No.5 Transmitter performance characteristics

The performance of the signal transmitter equipment shall be as defined in Table 19.

Table 19: Signal Transmitter Performance Characteristics

1	Frequency variation	Less than 6 Hz	Recommendation Q.153 3.3.1
2	Absolute power level of each non-modulated signalling frequency transmitted by the sending part	- 7 dBm0 ± 1 dBm0	Recommendation Q.153 3.3.2
3	Level tolerance between the two signalling frequencies	Less than 1 dB	Recommendation Q.153 3.3.2
4	Total power level due to harmonic distortion and intermodulation of all frequencies within the band 300 Hz-3400 Hz shall be below the level of one signalling frequency by:	30 dB or more	
5	Impedance	600 Ohm	
6	When no signalling frequency is being sent the total power load of the transmitted leak current shall be below the level of either of the signalling frequencies by:	50 dB or more	Recommendation Q.153 3.3.2 a)
7	As for 6 above when a signalling frequency is being sent	35 dB	
8	Compound signal time tolerance: the time interval between starting/ stopping the sending of each of the two frequencies shall not exceed	1 ms	Recommendation Q.153 3.3.4

2.3.2.6 ATS No.5 Numbering Plan

The 13-digit register signal address sequence is comprised of a 6-digit destination (called user) address, a 1-digit priority level and a 6-digit source (calling user) address. The 6-digit format used for the destination and source addresses should be compliant with the recommendation contained within the ICAO Document 9804 [9] Chapter 2 Section 2.3.

For further information refer to the Numbering Schemes section in the Eurocontrol document entitled “ATS Ground Voice Network Implementation and Planning Guidelines” [4].

2.3.2.7 ATS No.5 Priority level implementation

The 7th digit in the 13-digit address sequence shall be used to define the priority level of the ATS No.5 call. This can have the value 1, 2, 3 or 4 on a Direct Point-to-Point route.

An originating or transit VCS should increase the value of the 7th digit in the 13-digit sequence by 5 when it routes the call over a Detour route with respect to the Direct Point-to-Point route.

Table 20: Call Priority level ranges for Direct/Detour routes

ATS No.5 Call Priority Level	Call Routing
1-4	Via a Direct Point-to-Point route
6-9	Via a Detour route

The priority level of an ATS No.5 call is a means of attaching an indicator to the call to show its level of importance. It is intended for use when it is necessary to make an urgent call concerning the safety of aircraft (i.e., an emergency situation) and to enable the interruption of less urgent calls in progress at the time if the inter-VCS link is congested.

Note: The calling user is not able to change the priority level of a call after the call attempt has been initiated. Hence a call having the highest priority level must be initiated from the beginning.

For further information about "Priority Calls" and "Priority Call Management and Routing Strategy" within the "ATS Ground Voice Network", refer to Eurocontrol documents entitled "Voice Communication System Procurement Guidelines" [3] and "ATS Ground Voice Network Implementation and Planning Guidelines" [4].

2.3.3 ATS No.5 User Signals

These are the audible tones directed to the earpiece in order that the user can determine the progress of the call. These tones can be divided into two groups (i.e. tones generated locally to local user and audible tones sent on line).

2.3.3.1 Audible tones locally generated towards local user

The received status signal number returned by the terminating or transit VCS will be converted into distinguishable audible tones for the calling user to hear.

A VCS should be capable of locally generating the following audible tones, as recommended in Table 21 below, in order to indicate call progress to the local user.

Table 21: Locally generated audible user tones

Tone	Status number received	Purpose	Frequency (Hz)	Period
Terminal busy	3	Returned to the calling user by originating VCS if all available voice paths to a called user are occupied.	425	(0.5 s on, 0.5 s off), repeated
Congestion	8	Returned to the calling user by originating VCS if a call cannot be completed to required called user due to all appropriate inter-VCS links being occupied or otherwise unavailable.	425/1000 Hz	(0.5 s each), repeated
Number Unobtainable (Note 1)	5	Returned to the calling user by the originating VCS if a terminal is "Out of Service" or the called user address is unassigned.	1000	(0.5 s on, 0.5 s off), repeated
Note 1: Not specified in ITU-T Recommendation E.180 [11]				

2.3.3.2 Audible tones transmitted on the line

A VCS should be capable of generating the following audible tones as recommended in Table 22 below and sending them over the analogue leased line.

Table 22: Audible tones transmitted on analogue leased line

Tone	Purpose	Frequency (Hz)	Period
Ringing	Sent by terminating VCS to the calling user (inband) after successful call establishment and prior to call acceptance by the called user.	425	(1 s on, 4 s off), repeated
Interrupt warning (Note 1)	Injected into the voice path to warn a user of the imminent priority interruption of an established call. This signal is sent by the VCS that is handling the call interruption over the inter-VCS link.	1000	(40ms, 0.5s off) repeated for up to 15s prior to forced disconnection (ATS Ground Voice Network guidelines [4] recommends 5 seconds)
Intrusion warning (Note 1)	Injected into the voice path to warn the unwanted user of the imminent priority conferencing of an established call. This signal is sent by the Wanted User VCS.	1000	1 s on
Note 1: Not specified in ITU-T Recommendation E.180 [11]			

When a terminating VCS returns a status number 6 “Terminal free” status number (indicating that the called user is being alerted) it shall connect the voice path and send an audible "ringing tone" on the analogue leased line to the calling user.

2.3.3.3 VCS Output voice level

A VCS should be capable of configuring the voice level output on the line to a value in the range from -20dBm to OdBm. The recommended nominal voice level output over the line should be configured to be -10dBm.

Note: Many VCS's use Automatic Level Control (ALC) circuits to regulate the voice level received from the line to that of its internal nominal level. An ALC circuit should be capable of receiving voice levels from the line in the range from -30dBm to 0dBm.

For further information about the Output Voice Level of a VCS refer to Eurocontrol document entitled "ATS Ground Voice Network Implementation and Planning Guidelines" [4].

2.3.4 Line Interrupt

During times of congestion on an inter-VCS link, an active ATS No.5 call could be interrupted in order that its line can be allocated to another ATS No.5 call with higher priority.

An Interrupt Warning tone (as defined in Table 22) shall be Injected into the voice path by the VCS performing the call interrupt, in order to warn the remote user of the imminent line interruption of their established call. On expiry of the Interrupt Warning Period, the Blocking line signal shall be sent on the line by the VCS performing the line interrupt. Both users shall be disconnected and the line disconnected with the start of the Blocking signal (See Figure 12). A blocking signal sent in the forward direction will cause a Release Guard line signal to be sent in the backward direction and vice-versa.

After termination of the Blocking signal the VCS performing the line interrupt shall transmit the complete signalling sequence, starting with the Seizing signal, in order to establish the ATS No.5 call with higher priority.

***Note:** If another line becomes available and has been seized for the higher priority call during the Interrupt warning period, the Interrupt warning tone being injected into the voice path should be stopped. The users shall remain connected.*

***Note:** If another line becomes available and has been seized for the higher priority call while the Blocking signal is being sent, the VCS should continue to send the blocking signal for its full duration and then release the line by sending either the Clear-Forward or the Clear Back line signal, depending on which side of the inter-VCS link is sending the blocking tone.*

***Note:** Line interrupt can only occur during the conversation phase and not during call establishment or call clearing phases.*

2.3.5 Line Blocking and unblocking procedure

The "Blocking" line signal is also used to prevent seizure of a line from either end of an inter-VCS link prior to either maintenance activity being performed, back-up system operation or a VCS working in degraded mode etc. A line blocking procedure is considered an essential feature in the management of the trunk lines over an inter-VCS link.

The "Blocking" line signal should be sent over the line in order to block its use at both ends. On sending the "Blocking" line signal, a VCS should remove this line from service in order that it can't be seized. Similarly on receiving a "Blocking" line signal, a VCS should also remove the line from service. Failure to follow these procedures could result in a call attempt being performed on an inactive line which would be released only on expiry of the pre-defined time-out parameters.

A line can only be unblocked from the side that initially sent the "Blocking" line signal. In order to unblock a line, the VCS should replace the line in service and either send a "Clear Forward" line signal (in the case that there is no call attempt being implemented), or a "Seizure" line signal (in the case that a call attempt is being implemented). On receiving a "Clear Forward" or "Seizure" line signal, a VCS should also replace the line in service.

In the case that a line unblock attempt is made from the side that didn't initiate the blocking, this should have no effect on the blocked line's condition and it should remain blocked. The local user should be connected to a locally generated "trunk congestion" tone.

When a blocked line has been brought back into service with the “Clear Forward” line signal, there should be a line check implemented through a test call over the line in order to ensure it is fully operational. For further information about recommended Line Checking and Test Call Procedure refer to Eurocontrol document entitled “ATS Ground Voice Network Implementation and Planning Guidelines” [4].

2.3.6 Call Intrusion

An active ATS No.5 call could be subject to intrusion from another ATS No.5 call with higher priority. Whether call intrusion is permitted at a VCS is ANSP dependent.

An Intrusion Warning tone (as defined in Table 22) shall be Injected into the voice path towards the unwanted user in the active call, by the VCS of the wanted user of the call intrusion. This warns the unwanted user of an imminent intrusion on their established call.

Note: *Usually the VCS of the wanted user should also connect a locally generated Intrusion Warning tone to the voice path of the wanted user. This decision is however ANSP dependent and not related to the signalling system being used.*

The Intrusion Warning tone should be removed from the voice path of the unwanted user (and the wanted user, if locally generated) when a call intrusion is effective.

Note: *Some ANSP’s prefer to inject an intrusion effective tone into the voice path when the intrusion is effective. This decision is however ANSP dependent and not related to the signalling system being used.*

For further information about “Call Intrusion” within the “ATS Ground Voice Network”, refer to Eurocontrol documents entitled “Voice Communication System Procurement Guidelines” [3] and “ATS Ground Voice Network Implementation and Planning Guidelines” [4].

2.4 Complete ATS No.5 Signalling Sequence

When making an ATS No.5 call over an inter-VCS link, the complete signalling sequence is defined as follows:

1. The originating VCS sends the Seizing line signal.
2. The seizing signal is acknowledged in a compelled manner by the proceed-to-send line signal.
3. The originating VCS then sends the 13-digit register address sequence. These 13 digits are preceded by a “Start Pulse” and terminated by an “End Pulse”. These are not acknowledged.
4. The terminating VCS responds with the register “Status” number ("terminal free (6)", "terminal busy (3)" or “terminal out of service (5)" or “trunk congestion (8)”). This digit is also not acknowledged.
5. Register “Status” numbers 3, 5 and 8 will cause an appropriate tone to be generated locally by the originating VCS to the calling user. This will also cause the originating VCS to send the Clear-Forward line signal and this shall be acknowledged in a compelled manner by a Release Guard line signal in order to release the line.
6. Register “Status” number 6 will cause the terminating VCS to connect the voice path to the calling user and send an audible "ringing tone" on the line.
7. The audible “ringing tone” will be stopped by the terminating VCS when the call has been answered. The terminating VCS shall respond with an Answer line signal when the call has been answered and this shall be acknowledged in a compelled manner by the Answer Acknowledge line signal.
8. If the call is sent via a gateway VCS, this shall automatically send the Answer line signal to the originating VCS as soon as the register “Status” number 6 is received from the terminating VCS and prior to the call being answered in order to reduce the time required for call establishment.

9. An audible “Interrupt Warning tone” placed on the line by the VCS performing the call priority interrupt, informs the users of impending disconnection of their call. On expiry of the “Interrupt Warning Period”, the blocking line signal is sent on the line. This shall be acknowledged by the Release Guard signal that shall be returned for at least 200ms.
10. An audible “Intrusion tone” placed on the line by the VCS of the wanted user in the call intrusion, informs the unwanted user of impending intrusion into their call. This tone is removed when the intrusion is effective.

For Transit calls over two inter-VCS links, ATS No.5 performs signalling on a link-to-link basis in order to establish a voice circuit between the end VCS’s.

Figures 7 to Figure 13 shows the complete ATS No.5 signalling sequence

Table 23 provides some explanatory notes relating to the timing parameter Tx defined in Figures 7 to 13.

Table 23: ATS No.5 Timing parameters for a single inter-VCS link

Timing Parameter	Description	Duration	Pulse Duration Reference
T1	Interval between recognising the start of the Seizing signal and sending the Proceed-to-Send signal in the backward direction.	40 ms ± 10 ms	Recommendation Q.141, 2.1.5
T2	Interval between recognising the start of the Proceed-to-Send signal (sent in backward direction) and stopping the Seizing signal).	40 ms ± 10 ms	Recommendation Q.141, 2.1.5.
T3	Interval between recognising the end of the Seizing signal and stopping the Proceed-to-Send signal.	40 ms ± 10 ms (Note 1)	Recommendation Q.141, 2.1.5.
T4	Interval between stopping the Seizing signal and transmission of the register signal KP (Start-of-Pulsing) signal.	80 ms ± 20 ms	Recommendation Q.153, 3.3.3
T5	Total duration of the KP (Start-of-Pulsing) signal.	100 ms ± 10 ms	Recommendation Q.153, 3.3.3
T6	Duration of the intervals between numerical signals and between numerical signals and the KP or ST signals.	55 ms ± 5 ms	Recommendation Q.153, 3.3.3
T7	Total duration of: 1) Individual address digits signal 2) Individual status number signal.	55 ms ± 5 ms	Recommendation Q.153, 3.3.3
T8	Total duration of the ST (End-of-Pulsing) signal.	55 ms ± 5 ms	Recommendation Q.153, 3.3.3
T9	Interval between the end of the ST (End-of-Pulsing) signal and receiving the Register Status signal in the backward direction	30 ms to 300 ms Timeout = 2s (Refer to P22 for transit call timeout).	ATS No.5 specified
T10	Ringing tone. 425Hz	1s ON/ 4 s OFF (Repeated)	As defined in section 2.3.3.2

Timing Parameter	Description	Duration	Pulse Duration Reference
T11	Interval between the ending Status signal and the start of the Clear-Forward signal. In a practical situation T11 would include the following sequential events: a) Recognition Time Information processing of STATUS	40 ms ± 10 ms	
T12	Interval between recognising: 1) The start of the Answer signal prior to sending Answer Ack. signal 2) The start of the Clear-Forward signal prior to sending the Release Guard 3) The start of the Clear-Back signal prior to sending the Clear-Back Ack. 4) The start of the Blocking signal prior to sending the Release Guard	125 ms ± 25 ms	Recommendation Q.141, 2.1.5.
T13	Interval between recognising: 1) The start of the Release-Guard signal prior to stopping the Clear-Forward signal 2) The start of the Answer acknowledge signal prior to stopping the answer signal . 3) The start of the Clear-Back acknowledge signal prior to stopping the Clear-Back signal.	125 ms ± 25 ms	Recommendation Q.141, 2.1.5.
T14	Interval between recognising: 1) The end of the Clear-Forward signal prior to stopping the Release-Guard signal. 2) The end of the Clear-Back signal prior to stopping the Clear-Back acknowledge signal. 3) The end of the Answer signal prior to stopping the Answer acknowledge signal.	40 ms ± 10 ms (Note 1)	
T15	Interval between the end of the Clear-Back acknowledge signal and the start of the Clear-Forward signal.	at least 100ms (Note 2)	Recommendation Q.141 2.1.3.1 c)
T16	Call repetition interval	1 to 10 s	ANSP dependent
T17	Interval between the end of the Release Guard signal to when the line is available for seizure in a new call.	100 ms (Note 3)	
T18	After call priority interruption, the duration of the interval between the end of the Blocking signal and the start of the Seizing or the Clear-Forward signal.	100ms to 5 s	
T19	Duration of Interrupt Warning tone from the start of the first interrupt signal to the start of the Blocking signal. The period shall comprise a number of Interrupt Warning signals.	< 15s (ATS Ground Voice network guidelines recommends 5s [4].)	As defined in section 2.3.3.2

Timing Parameter	Description	Duration	Pulse Duration Reference
T20	The total duration of the Blocking signal.	1s ± 100 ms	ATS No.5 specified Note: Blocking signal is sent from either side of an inter-VCS link.
T21	INTERRUPT WARNING tone	40 ms ON 0.5 s OFF	ATS No.5 specified
T22	Total duration of Release Guard signal	> 200ms	Q.141 2.1.6. para. h
Note 1: A receive recognition time of 45ms +/- 15ms is acceptable to ensure backwards compatibility with existing systems. *Note 2: A receive recognition time of 100ms +/- 20ms is acceptable to ensure backwards compatibility with existing systems.* *Note 3: A receive recognition time of 50ms -100ms is acceptable to ensure backwards compatibility with existing systems.*			

Recommendation *The software should provide easy access to, and modification of, the time parameters shown in Table 23.*

Note: Transmission delays are not included in the duration values specified in this table.

Time-outs

Seizing, Answer, Clear-Back or Clear-Forward line signals have time-outs of 2 seconds.

Proceed-to-send, Release-Guard and Answer Acknowledgement signals have time-outs of 2 seconds.

Call Collision

The Seizing signal is transmitted for 850 ± 200ms when a call collision has been detected.

Call Repetition Feature

The Call Repetition feature is not part of the ATS No.5 protocol. This is a VCS dependent feature. For further information about Call Repetition Feature and its employment within the ATS Ground Voice Network, refer to document entitled “ATS Ground Voice Network Implementation and Planning Guidelines” [4].

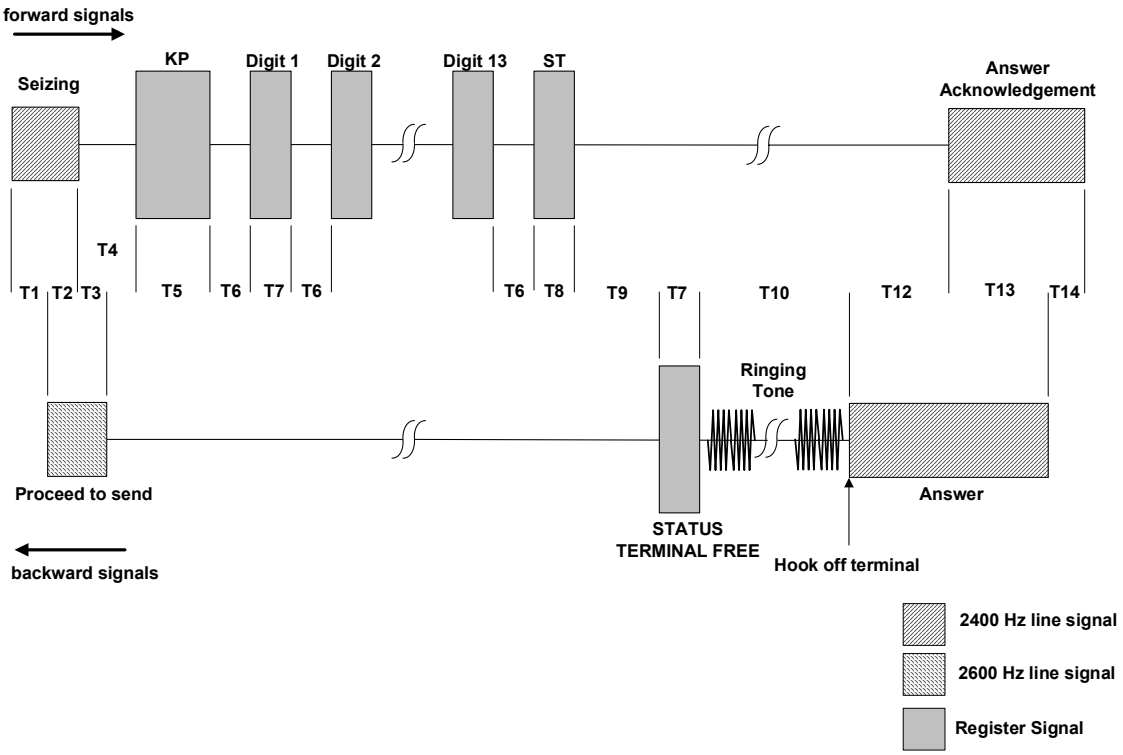

Figure 7: ATS No.5 Signalling – Terminal Free

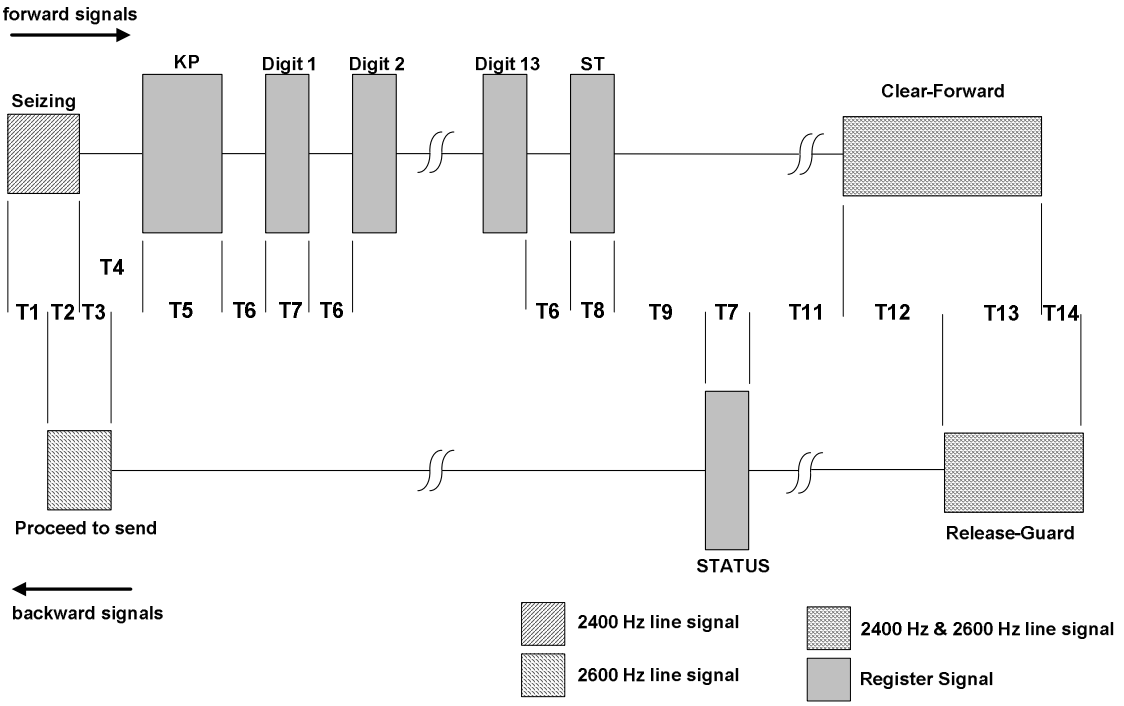

Figure 8: ATS No.5 Signalling – Terminal Out-of-Service/Congestion/Busy – Clear Forward

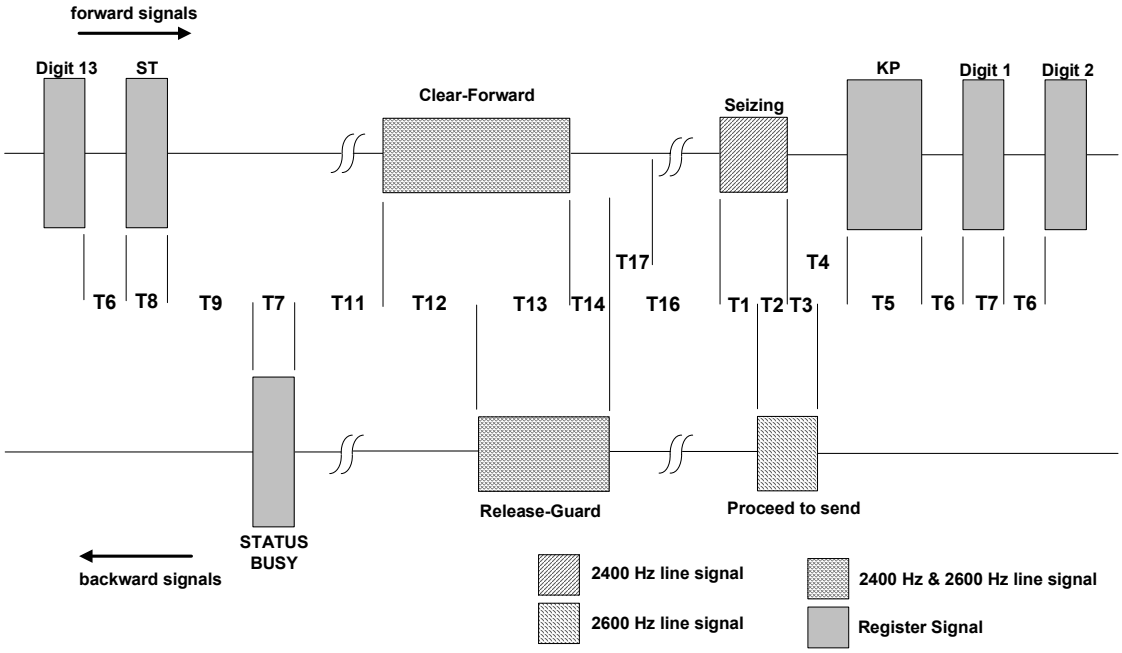

Figure 9: ATS No.5 Signalling – Terminal Busy/Congestion – Call Repetition enabled

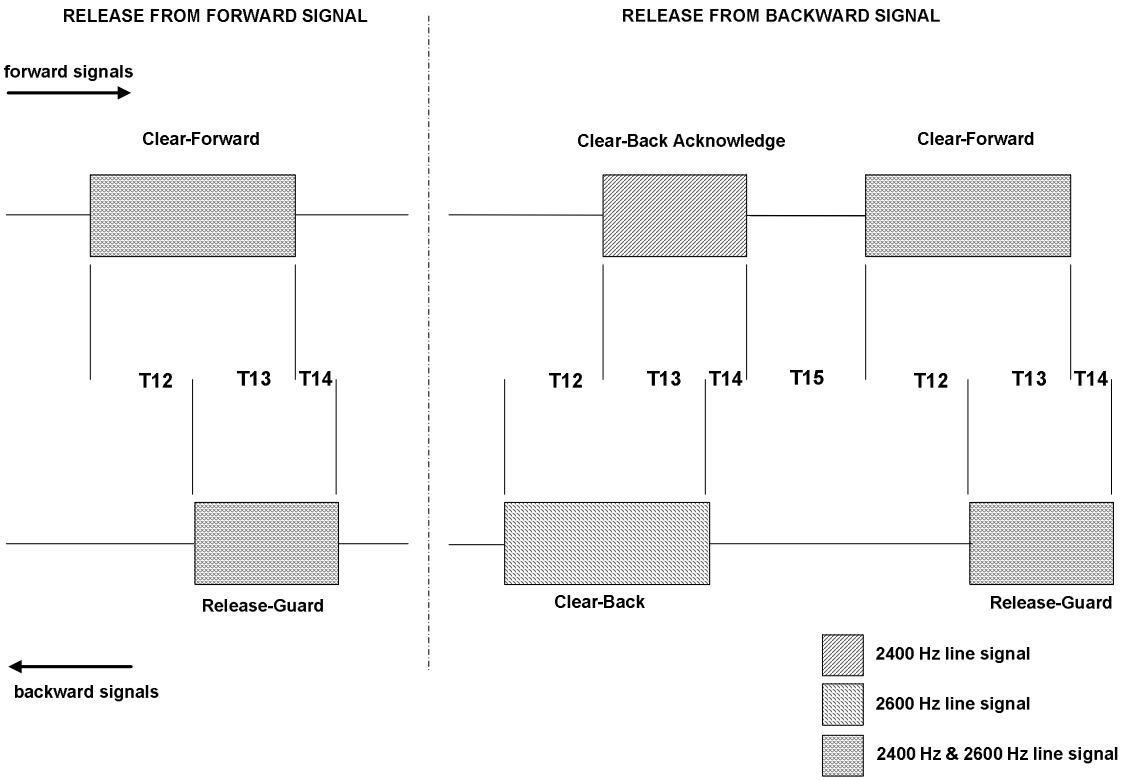

Figure 10: ATS No.5 Signalling – Line Release

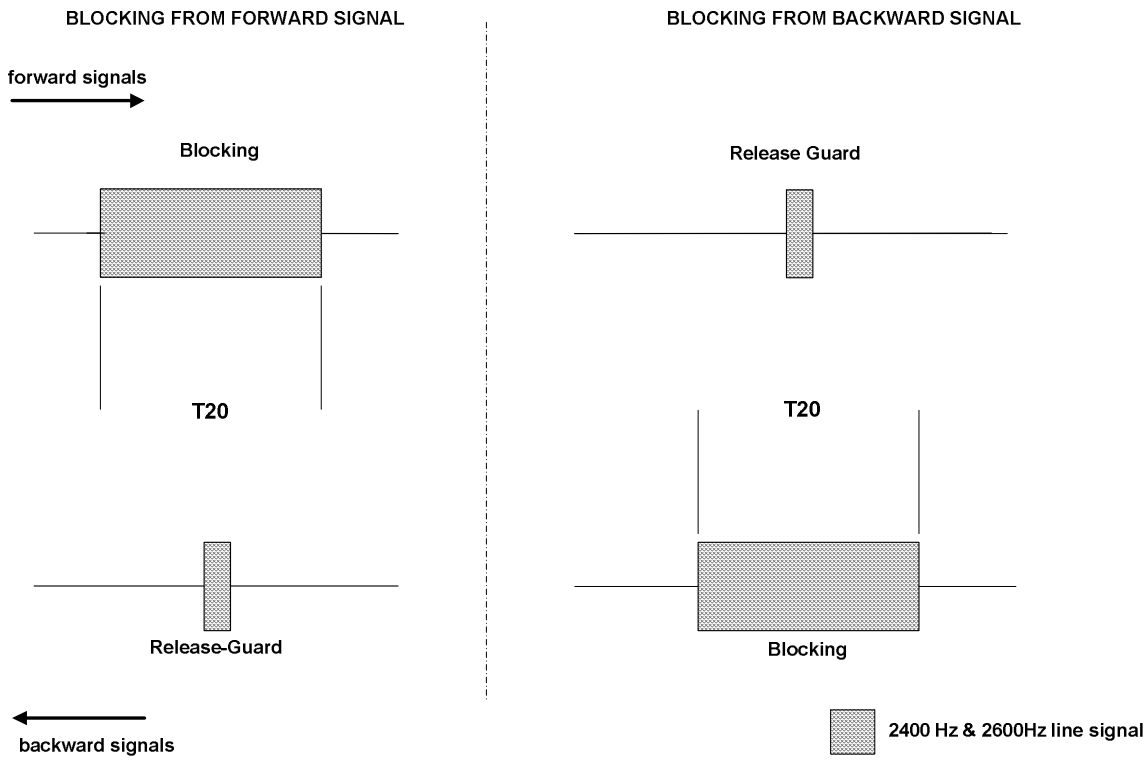

Figure 11: ATS No.5 Signalling – Blocking

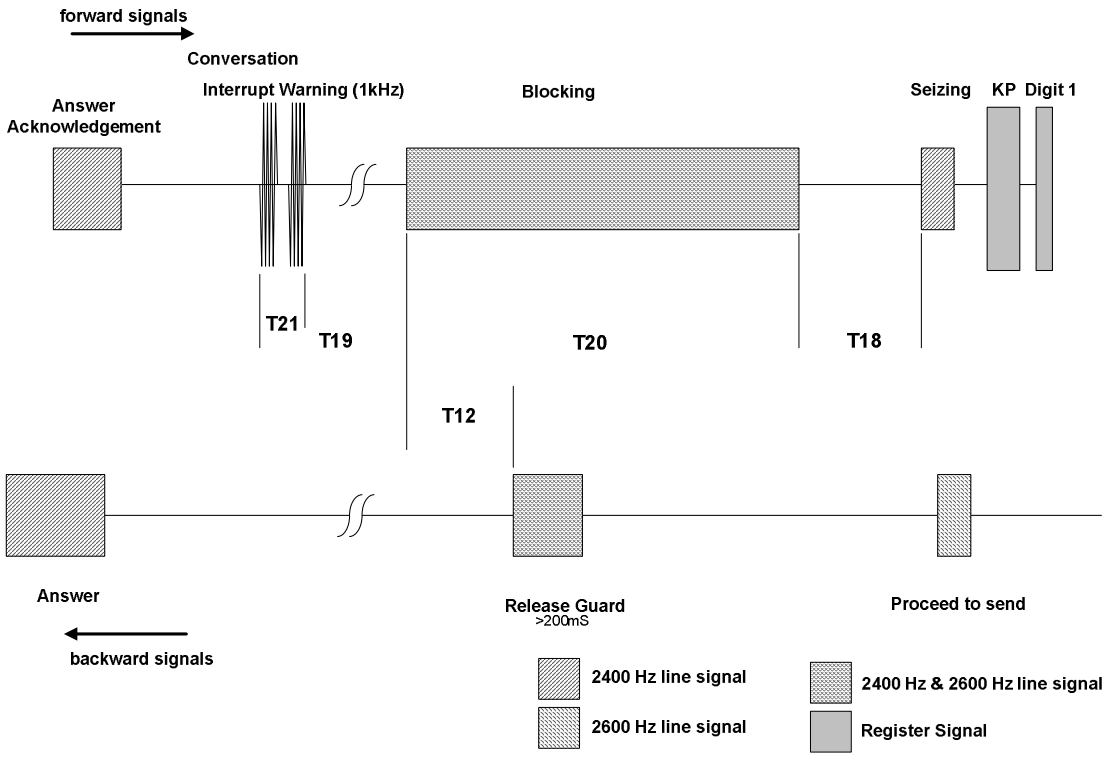

Figure 12: ATS No.5 Signalling – Priority Interruption (using single line)

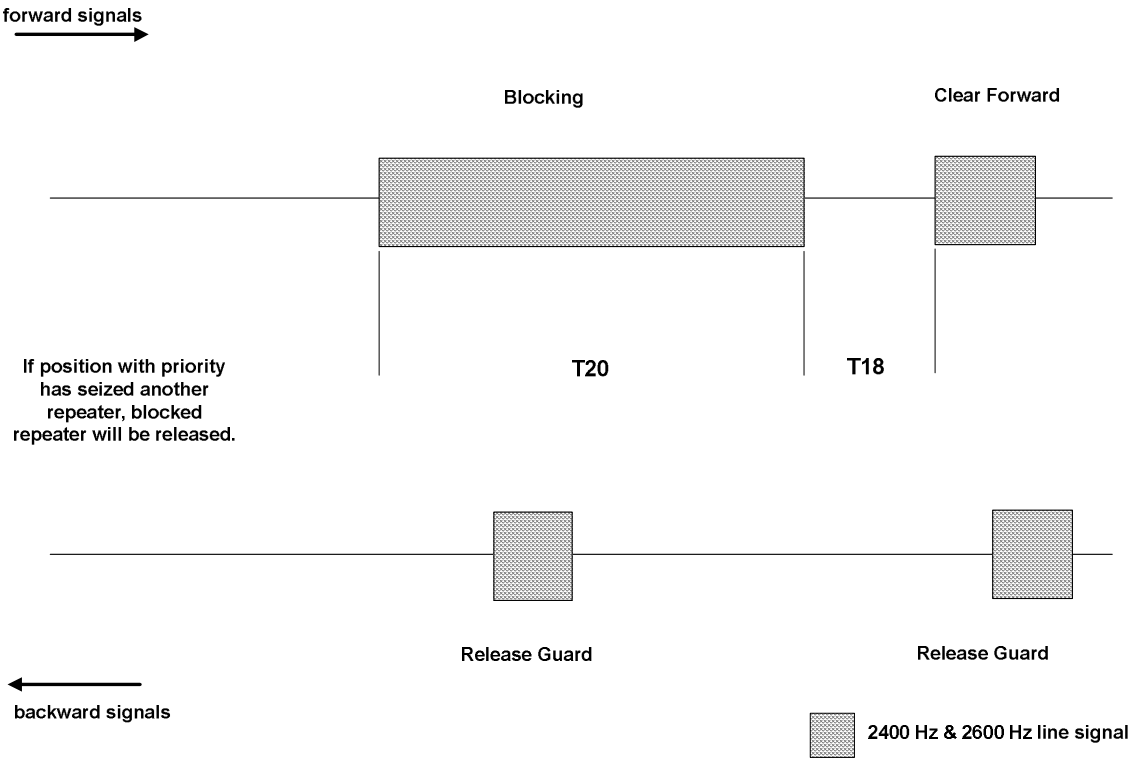

Figure 13: ATS No.5 Signalling – Priority Interruption (different line seized)

3. INTERWORKING OF ATS R2 AND ATS No.5 SIGNALLING SYSTEMS

3.1 General

The correct inter-working of different signalling procedures concerns transit and gateway VCS's only. Emphasis shall be placed on the fast transit of address information. However the signalling information exchange shall take place consecutively and not simultaneously on each inter-VCS link. This means that the signalling procedure on the first inter-VCS link should be terminated, i.e. all 13-digits received with calling user address and priority level checked, before the start of the signalling procedure on the second inter-VCS link. For the subsequent signalling the following configurations shall be taken into account.

The call processing time of a transit VCS (interval P21 indicated in Figure 14 / Figure 18 and specified in Table 24) is the time between returning an acknowledgement of the 13th address digit (ATS R2) or the ST pulse (ATS No.5) to the originating VCS on the first inter-VCS link and sending the Seizing line signal to the terminating VCS on the second inter-VCS link. This shall not exceed 300 ms.

The time to process a status signal at a transit VCS when it is returned by the terminating VCS towards the originating VCS shall be less than 300ms.

Table 24: Explanatory Notes for Figures 14 to 21

Item	Description	Side A	Side B	Time-out	Remarks
P21	System Processing Time/ Call Processing Time	≤ 300 ms	≤ 300 ms		
P22	Timeout value between the 13th Acknowledge signal (ATS R2) or the ST pulse (ATS No.5) and the start of a register type status signal for general transit interworking.			12 s	ANSP dependent
P23	Time between the ATS No.5 Terminal status Free signal and the (automatic) Answer signal in an ATS No.5 – ATS R2 Gateway	50 ms –100 ms	50 ms – 100 ms		VCS Gateway dependant

3.2 Transit ATS R2/ATS R2

After accepting an incoming call from the first inter-VCS link, a line shall be seized for the outgoing call on the second inter-VCS link and the signalling procedure shall be started while the originating VCS is still waiting for the status signal from the terminating VCS.

After receiving the status register signal from the terminating VCS, the transit VCS shall send it on to the originating VCS. If this Status register signal is "Terminal Free", the line shall be switched through (connected) by the transit VCS. Ringing tone generated by the Terminating VCS shall be present on the line. If however the Status register signal is "Terminal Busy" or "Out-of-Service" the originating VCS shall release the line on the first inter-VCS link and the transit VCS shall release the line on the second inter-VCS link.

When a call is answered at the terminating VCS it shall stop sending Ringing tone on the line

There shall be a timeout at the transit VCS between acknowledging the 13th digit from the originating VCS and receiving the status register signal from the terminating VCS. If the time out of the signalling procedure exceeds twelve seconds the call shall be considered as unsuccessful and the line shall be released.

It should be noted that the signalling over an inter-VCS link between VCS's can be terminated at any time by one side sending the Clear Forward line signal. The Transit ATS R2/ATS R2 signalling sequence shall be as shown in Figure 14.

3.3 Transit ATS No.5/ATS No.5

After accepting an incoming call from the first inter-VCS link, a line shall be seized for the outgoing call on the second inter-VCS link and the signalling procedure shall be started while the originating VCS is still waiting for the status signal from the terminating VCS.

After receiving the status register signal from the terminating VCS, the transit VCS shall send it on to the originating VCS. If this Status register signal is "Terminal Free", the line shall be switched through (connected) by the transit VCS. Ringing tone generated by the Terminating VCS shall be present on the line. If however the Status register signal is "Terminal Busy" or "Out-of-Service" the originating VCS shall release the line on the first inter-VCS link while the transit VCS shall release the line on the second inter-VCS link.

When the call is answered at the terminating VCS it shall stop sending Ringing tone on the line and send an Answer signal to the transit VCS. The transit VCS shall send the "Answer signal" on to the originating VCS as soon as it has been received from the terminating VCS.

There shall be a timeout at the transit VCS between receiving the ST pulse from the originating VCS and receiving the status register signal from the terminating VCS. If the time out of the signalling procedure exceeds twelve seconds the call shall be considered as unsuccessful and the line shall be released.

It should be noted that the signalling over an inter-VCS link between VCS's can be terminated at any time by sending a Clear Forward line signal in the forward direction or the Clear back signal in the backwards direction. The Transit ATS No.5/ATS No.5 signalling sequence shall be as shown in Figure 18.

3.4 Gateway ATS R2/ATS No.5

After accepting an incoming call from the first inter-VCS link using ATS R2 signalling, a line shall be seized for the outgoing call on the second inter-VCS link using ATS No.5 signalling and the signalling procedure shall be started while the originating VCS is still waiting for the status signal from the terminating VCS.

After receiving the status register signal from the terminating VCS, the gateway VCS shall send it on to the originating VCS. If this Status register signal is "Terminal Free", the line shall be switched through (connected) by the gateway VCS. Ringing tone generated by the Terminating VCS shall be present on the line. If however the Status register signal is "Terminal Busy" or "Out-of-Service" the originating VCS shall release the line on the first inter-VCS link and the gateway VCS shall release the line on the second inter-VCS link.

When a call is answered at the terminating VCS it shall stop sending Ringing tone on the line and send an Answer signal to the gateway VCS.

There shall be a timeout at the gateway VCS between acknowledging the 13^{th} digit from the originating VCS and receiving the status register signal from the terminating VCS. If the time out of the signalling procedure exceeds twelve seconds the call shall be considered as unsuccessful and the line shall be released.

It should be noted that the signalling over an inter-VCS link between VCS's can be terminated at any time by sending the Clear Forward line signal over the inter-VCS link using ATS R2 signalling or the Clear Forward/ Clear Back line signal over the inter-VCS link using ATS No.5 signalling.

The signalling sequence shall be as shown in Figure 15, Figure 16 and Figure 17.

3.5 Gateway ATS No.5/ATS R2

After accepting an incoming call from the first inter-VCS link using ATS No.5 signalling, a line shall be seized for the outgoing call on the second inter-VCS link using ATS R2 signalling and the signalling procedure shall be started while the originating VCS is still waiting for the status signal from the terminating VCS.

After receiving the status register signal from the terminating VCS, the gateway VCS shall send it on to the originating VCS. If this Status register signal is “Terminal Free”, the gateway VCS shall also automatically send an Answer signal to the originating VCS (even though the call has not been answered at the terminating VCS) and switch through the line in order to obtain a faster call establishment time. Ringing tone generated by the Terminating VCS shall be present on the line. If however the Status register signal from the terminating VCS is “Terminal Busy” or “Out-of-Service” the originating VCS shall release the line on the first inter-VCS link while the gateway VCS shall release the line on the second inter-VCS link.

When a call is answered at the terminating VCS it shall stop sending Ringing tone on the line.

There shall be a timeout at the transit VCS between receiving the ST pulse from the originating VCS and receiving the status register signal from the terminating VCS. If the time out of the signalling procedure exceeds twelve seconds the call shall be considered as unsuccessful and the line shall be released.

It should be noted that the signalling over an inter-VCS link between VCS’s can be terminated at any time by sending the Clear Forward line signal over the inter-VCS link using ATS R2 signalling or the Clear Forward/ Clear Back line signal over the inter-VCS link using ATS No.5 signalling.

The signalling sequence shall be as shown in Figure 19, Figure 20 and Figure 21.

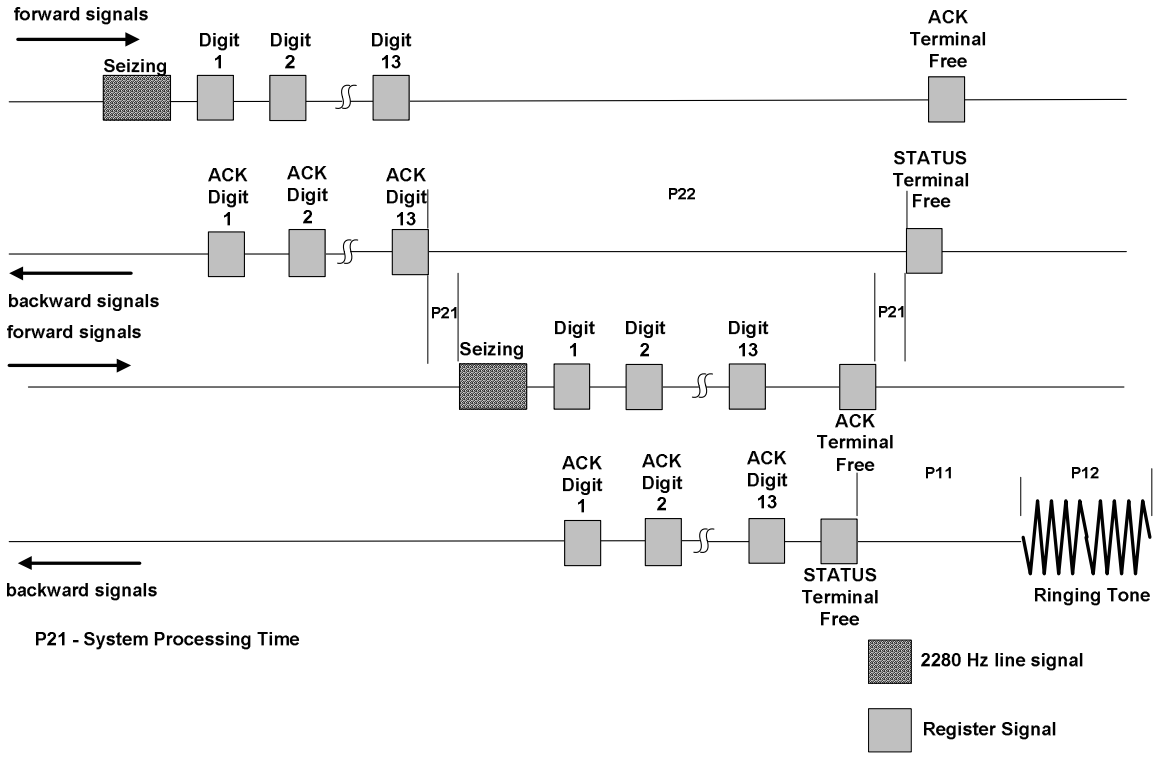

Figure 14: ATS R2 to ATS R2 signalling sequence at Transit – Terminal Free

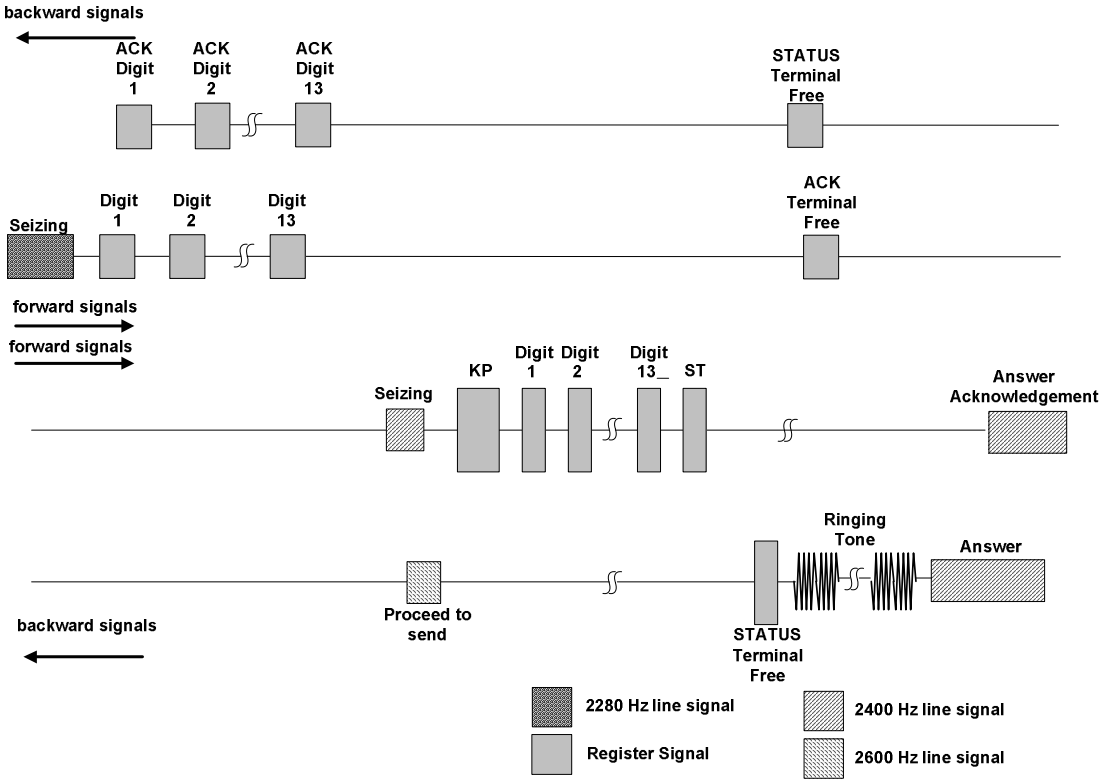

Figure 15: ATS R2 to ATS No.5 signalling sequence at Transit/Gateway – Terminal Free

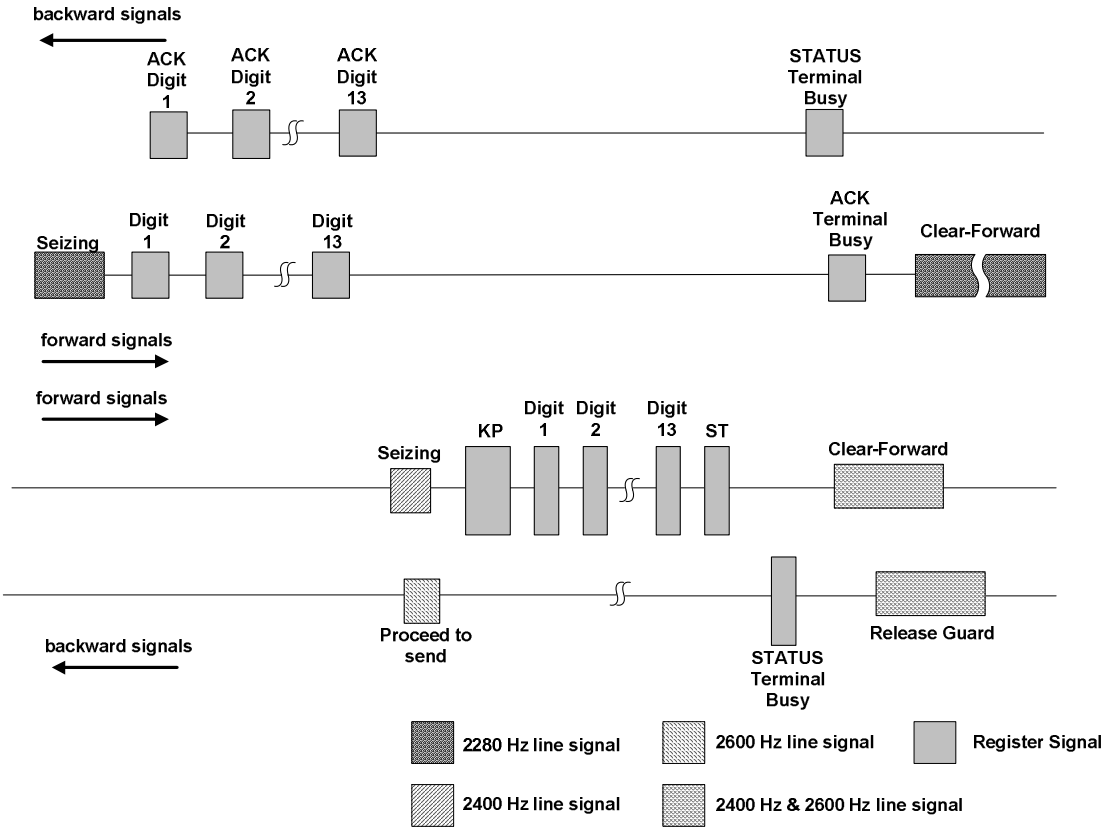

Figure 16: ATS R2 to ATS No.5 signalling sequence at Transit/Gateway – Terminal Busy

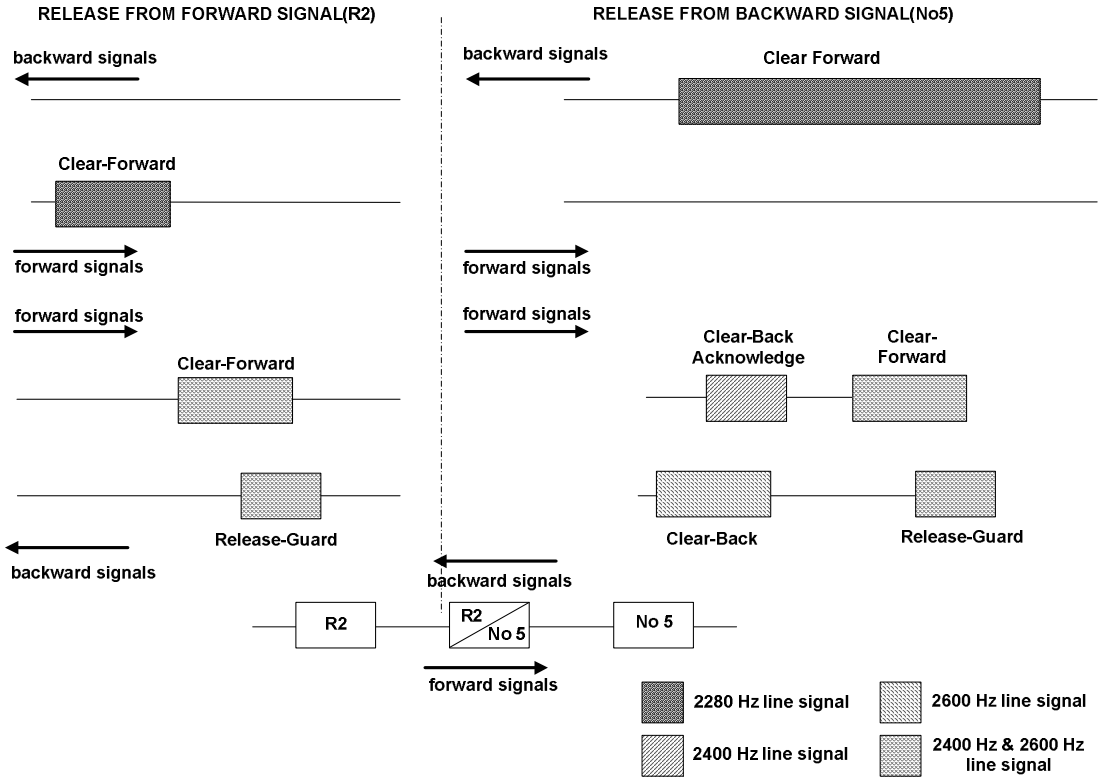

Figure 17: ATS R2 to ATS No.5 signalling sequence at Transit/Gateway – Release

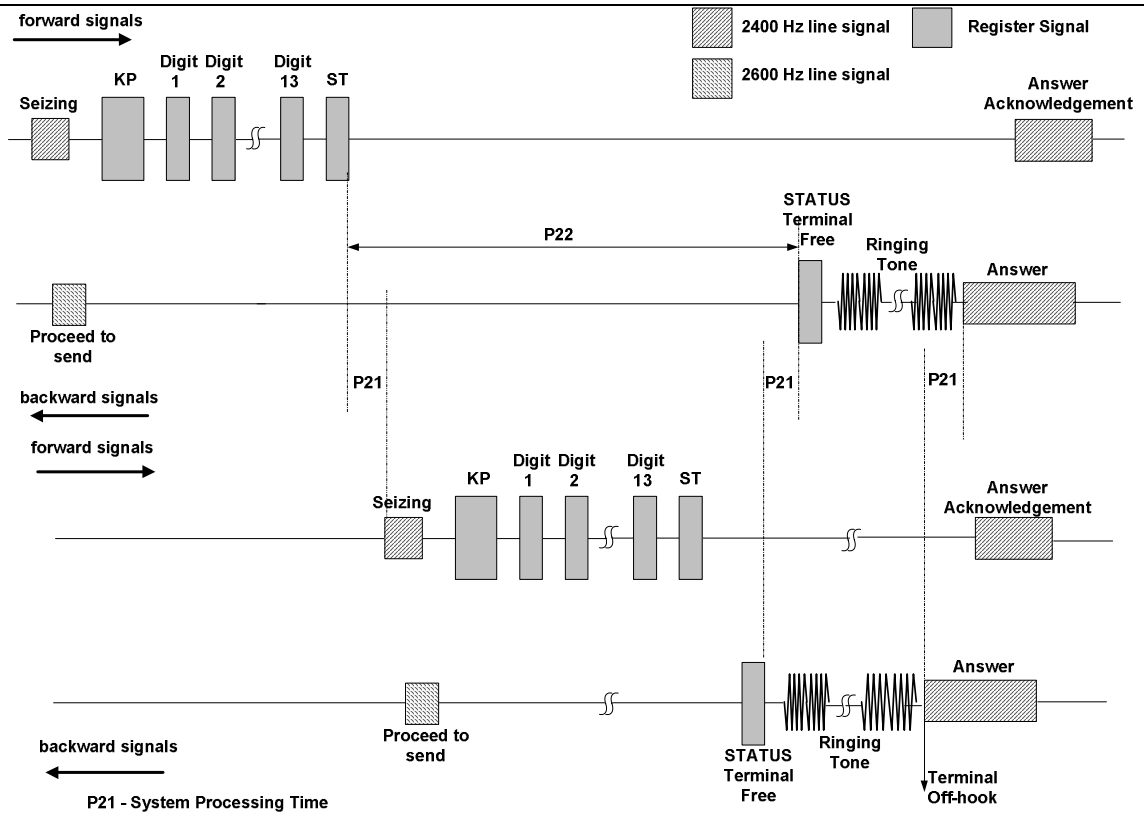

Figure 18: ATS No.5 to ATS No.5 signalling sequence at Transit – Terminal Free

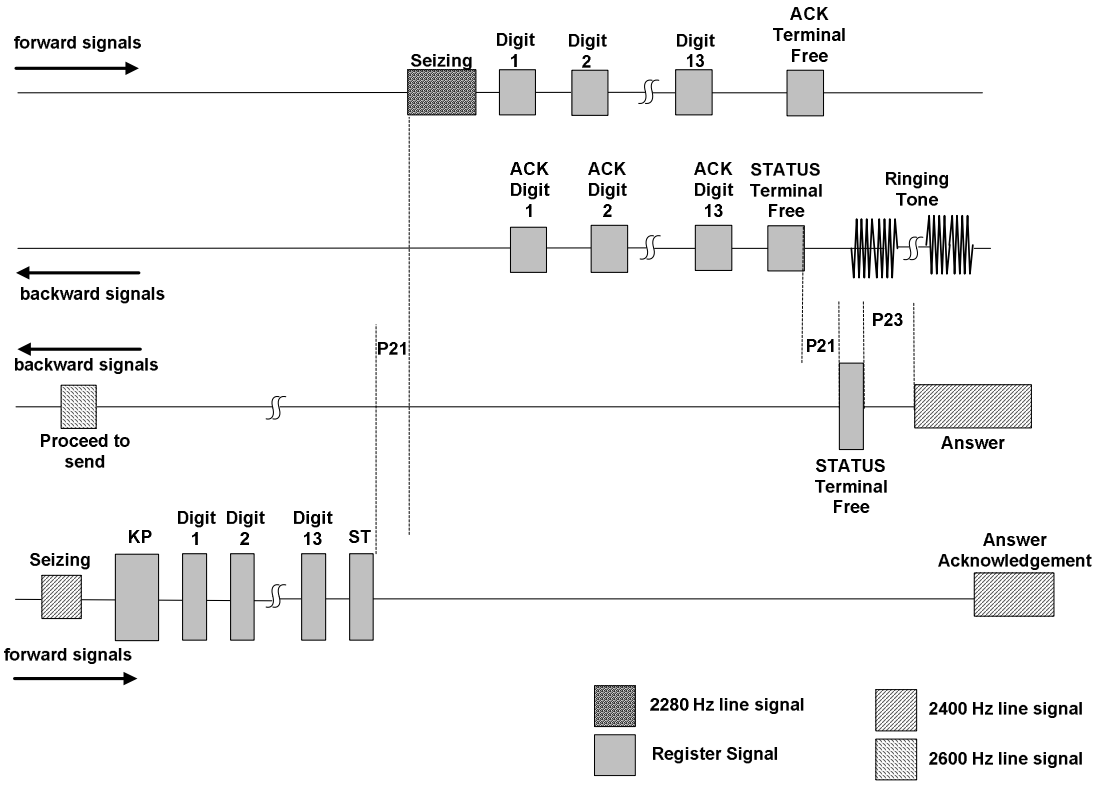

Figure 19: ATS No.5 to ATS R2 signalling sequence at Transit/Gateway – Terminal Free

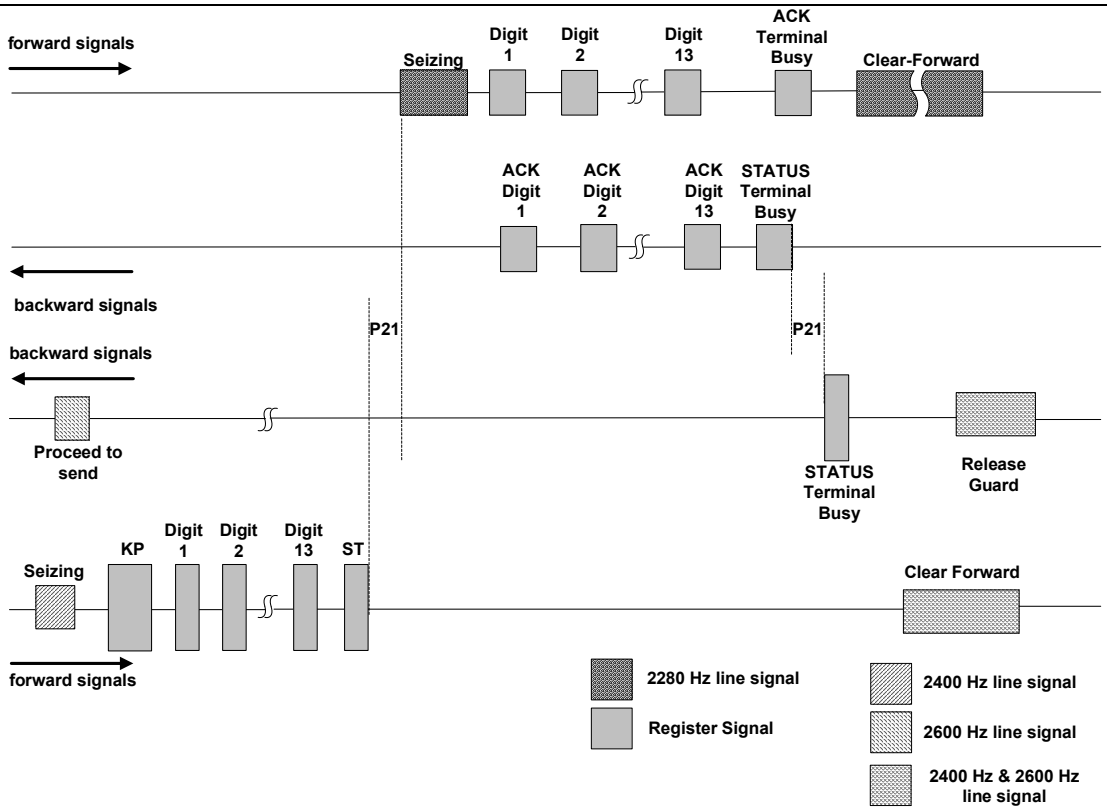

Figure 20: ATS No.5 to ATS R2 signalling sequence at Transit/Gateway – Terminal Busy

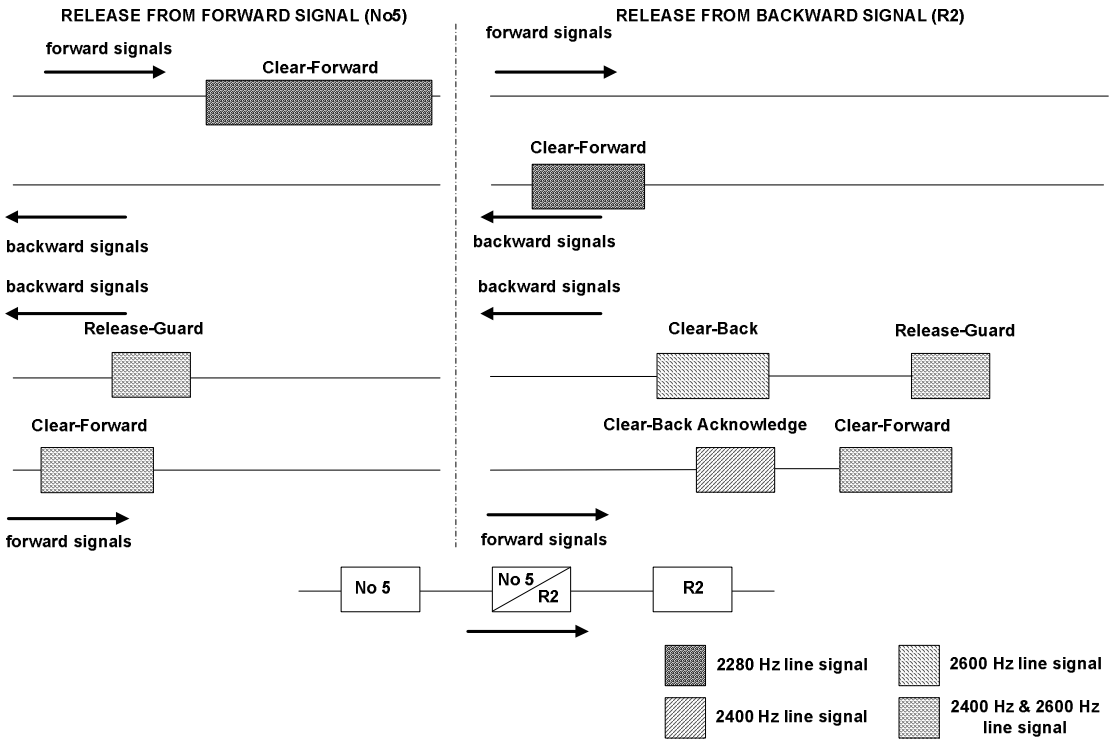

Figure 21: ATS No.5 to ATS R2 signalling sequence at Transit/Gateway – Release

ANNEX A – REFERENCES

For the purposes of this document, the following references apply:

1	ITU-T Recommendations Q.400 to Q.490 defining R2 signalling system
2	ITU-T Recommendations Q.140 to Q.164 defining No.5 signalling system
3	Eurocontrol “Voice Communication System Procurement Guidelines” Edition 2.0; EATM Infocentre reference: 05/01/12-03.
4	Eurocontrol: “ATS Ground Voice Network Implementation and Planning Guidelines” Edition 1.0; EATM Infocentre Reference: 05/01/12-02
5	Eurocontrol “Interworking between ATS QSIG and ATS R2 signalling systems” Edition 1.0; EATM Infocentre Reference: 05/01/12-05
6	Eurocontrol “Interworking between ATS QSIG and ATS No.5 signalling systems Edition 1.0; EATM Infocentre Reference: 05/01/12-06
7	ICAO Convention on International Civil Aviation, Annex 10, Volume III, Part II, Chapter 4: "Aeronautical Speech Circuits"
8	ICAO Convention on International Civil Aviation, Annex 11, Chapter 6: "Air Traffic Services Requirements for Communications"
9	ICAO: "Manual on Air Traffic Services (ATS) Ground-To-Ground Voice Switching and Signalling" (Doc 9804)
10	ITU-T Recommendation M1030 "Characteristics of Ordinary Quality International Leased Circuits Forming Part of Private Switched Telephone Networks'
11	ITU-T Recommendation Q.35/E.180: "Technical characteristics of tones for the telephone service"
12	ECMA-312 ed.3/EN 301-846: Private Integrated Services Network (PISN) – Profile Standard for use of PSS1 (QSIG) in Air Traffic Services Networks.

Further recommended reading includes pages 65, 66 and 67 of ITU-T Recommendation M1030 'Characteristics of Ordinary Quality International Leased Circuits Forming Part of Private Switched Telephone Networks (PSTN)' which provides useful additional information.

ANNEX B – ABBREVIATIONS

For the purposes of this document, the following abbreviations apply:

ANSP	Air Navigation Service Provider
AGVN	ATS Ground Voice Network
ATC	Air Traffic Control
ATS	Air Traffic Services
ATS No.5	ITU-R No.5 signalling system adapted for ATS
ATS R2	ITU-T R2 signalling system adapted for ATS
CWP	Controller Working Position
DA	Direct Access
ECAC	European Civil Aviation Conference
ECMA	An international industry association dedicated to the standardisation of information and communication systems
EN	European Norme
ETSI	European Telecommunications Standards Institute
GW	Gateway
IDA	Indirect Access
ISO	International Standards Organization
ITU-T	International Telecommunication Union Telecommunication Standardization Sector
MFC	Multi Frequency Compelled
ms	Millisecond
MSC	Message Sequence Chart
PSTN	Public Switched Telephone Network
s	seconds
VCS	Voice Communication System