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DIGITAL EXCHANGES

**DIGITAL EXCHANGE INTERFACES
FOR SUBSCRIBER ACCESS**

ITU-T Recommendation Q.512

(Previously "CCITT Recommendation")

FOREWORD

The ITU-T (Telecommunication Standardization Sector) is a permanent organ of the International Telecommunication Union (ITU). The ITU-T is responsible for studying technical, operating and tariff questions and issuing Recommendations on them with a view to standardizing telecommunications on a worldwide basis.

The World Telecommunication Standardization Conference (WTSC), which meets every four years, establishes the topics for study by the ITU-T Study Groups which, in their turn, produce Recommendations on these topics.

The approval of Recommendations by the Members of the ITU-T is covered by the procedure laid down in WTSC Resolution No. 1 (Helsinki, March 1-12, 1993).

ITU-T Recommendation Q.512 was revised by ITU-T Study Group 11 (1993-1996) and was approved under the WTSC Resolution No. 1 procedure on the 7th of February 1995.

NOTE

In this Recommendation, the expression "Administration" is used for conciseness to indicate both a telecommunication administration and a recognized operating agency.

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SUMMARY

This Recommendation describes the subscriber side interface characteristics of digital exchanges. It applies to digital local and combined exchanges for telephony in Integrated Digital Networks (IDN) and to local and combined exchanges in an Integrated Services Digital Network (ISDN), and also to mixed (analogue/digital) networks.

This Recommendation is part of the Q.510-Series of Recommendations which defines the interface functions for digital exchanges in Integrated Digital Networks (IDN), mixed analogue/digital networks, 64 kbit/s-based Integrated Services Digital Network (ISDN).

BACKGROUND

Preamble to the Q.500-Series of Recommendations

In 1980, CCITT Study Group XI published the first series of Q.500 Recommendations related to “Digital transit exchanges for national and international applications”.

In 1984, CCITT Study Group XI approved two sets of Recommendations on digital exchanges:

- “Digital transit exchanges in integrated digital networks and mixed analogue/digital networks” – Q.500-Series of Recommendations; and
- “Digital local and combined exchanges” – Q.510-Series of Recommendations.

In 1988, CCITT Study Group XI combined the Series Q.500 and Q.510 Recommendations into a single set applicable to digital local, combined, transit and international exchanges in Integrated Digital Networks (IDN) and mixed analogue-digital networks, and also to local, combined, transit and international exchanges in an Integrated Services Digital Network (ISDN).

In 1994, ITU-T Study Group 11 revised the Q.500-Series of Recommendations in order to include a new exchange interface for subscriber access – the V₅ interface (i.e. the V_{5,1} interface). The V₃ interface is to the case of an ISDN primary rate access and the case that this interface is used not structured according to the ISDN principles is considered as not subject to ITU-T Recommendations. The V₄ interface is marked as not subject to ITU-T Recommendations; reference should be made to interface V_{5,1} which covers static multiplexed ISDN basic accesses. The V₄ interface was a digital interface used to connect a digital access link which includes a static multiplexer supporting several basic access digital sections. For this interface, the specification (i.e. CV₁ channel structure) was not completed.

ITU-T will continue to further develop and complete these Recommendations in areas where there are unresolved issues and develop additional Recommendations on digital exchanges in the Q.500-Series and other series in the future.

The structure for the Q.500-Series of digital switching Recommendations is provided in Recommendation Q.500.

DIGITAL EXCHANGE INTERFACES FOR SUBSCRIBER ACCESS

(Melbourne, 1988; revised in 1994)

1 Scope

It applies to digital local and combined exchanges for telephony in Integrated Digital Networks (IDN) and to local and combined exchanges in an Integrated Services Digital Network (ISDN), and also to mixed (analogue/digital) networks. The field of application of this Recommendation is more fully defined in Recommendation Q.500 [B6].

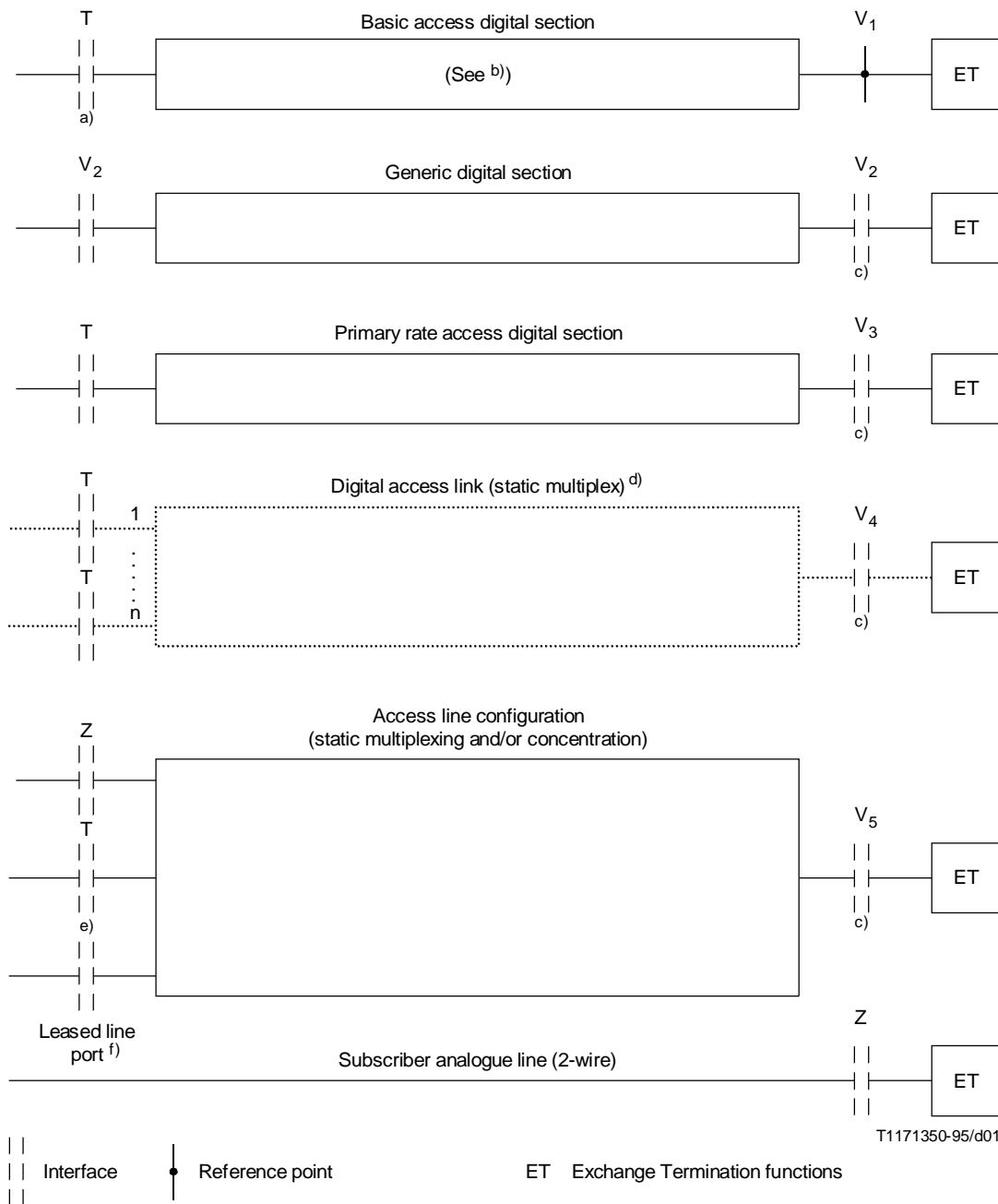
Exchange interfaces for subscriber access that have been considered are described, and illustrated in Figure 1 and Table 1, but they are not intended to specify every interface. Other interfaces are for further study.

This Recommendation is not intended to define any transmission system, network or subscriber equipment in or connected to, a digital exchange via these interfaces. Therefore only the characteristics of the interfaces are described.

2 References

The following Recommendations and other references contain provisions which, through reference in this text, constitute provisions of this Recommendation. At the time of publication, the editions indicated were valid. All Recommendations and other references are subject to revision: all users of this Recommendation are therefore encouraged to investigate the possibility of applying the most recent edition of the Recommendations and other references listed below. A list of the currently valid ITU-T Recommendations is regularly published.

- [1] CCITT Recommendation G.703 (1991), *Physical/electrical characteristics of hierarchical digital interfaces.*
- [2] CCITT Recommendation G.704 (1991), *Synchronous frame structures used at primary and secondary hierarchical levels.*
- [3] CCITT Recommendation G.706 (1991), *Frame alignment and Cyclic Redundancy Check (CRC) procedures relating to basic frame structures defined in Recommendation G.704.*
- [4] ITU-T Recommendation G.960 (1993), *Digital section for ISDN basic rate access.*
- [5] ITU-T Recommendation G.961 (1993), *Digital transmission system on metallic local lines for ISDN basic rate access.*
- [6] ITU-T Recommendation G.962 (1993), *Access digital section for ISDN primary rate at 2048 kbit/s.*
- [7] ITU-T Recommendation G.963 (1993), *Access digital section for ISDN primary rate at 1544 kbit/s.*
- [8] ITU-T Recommendation G.964 (1994), *V Interfaces at the digital Local Exchange (LE) – V_{5.1} interface (based on 2048 kbit/s) for the support of Access Network (AN).*
- [9] ITU-T Recommendation G.965 (1995), *V interfaces at the digital Local Exchange (LE) – V_{5.2} interface (based on 2048 kbit/s) for the support of Access Network (AN).*
- [10] CCITT Recommendation M.3603 (1992), *Application of maintenance principles to ISDN basic rate access.*
- [11] CCITT Recommendation M.3604 (1992), *Application of maintenance principles to ISDN primary rate access.*
- [12] CCITT Recommendation M.3605 (1992), *Application of maintenance principles to static multiplexed ISDN rate access.*



- a) Interface T is defined in Recommendation I.411.
- b) The characteristics of a digital transmission system on metallic local lines for ISDN basic rate access which may form part of the basic access digital section are defined in Recommendation G.961.
- c) The differences among V₂, V₃, V₄ and V₅ are essential multiplexing and signalling requirements. The transmission requirements are substantially identical (e.g. Recommendations G.703 and G.704).
- d) See information provided in "Background".
- e) May be basic rate or primary rate access. Primary rate access only supported by V_{5.2} interface.
- f) For reserved connections established under control of the local exchange without control plane signalling between user and local exchange.

NOTE – Not all interfaces will necessarily exist in every implementation.

FIGURE 1/Q.512
Illustration of possible access configurations

TABLE 1/Q.512

Interface references

Access type	Interface/ reference points	Paragraph	Related physical and functional Recs.	Related OAM Recs.	Application to connect
Basic access digital section	V ₁	5.2	G.960 ^{a)}	M.3603	ISDN basic access (2B + D)
Generic digital section	V ₂	5.3	G.703 G.704	None	Digital network equipment, supporting any combination of access types
Primary rate access digital section ^{b)}	V ₃	5.4	G.703 G.704 G.706 G.962 G.963	M.3604	ISDN primary rate access
Digital access link (Static multiplex)	V ₄	5.5	Not subject to ITU-T Recommendations ^{c)}		
Access network configurations	V ₅	5.6	G.703 G.704 G.706 G.964 G.965	M.3603 M.3604 ^{d)}	A multiple of analogue subscriber lines, ISDN basic accesses and ISDN primary rate accesses with multiplexing and/or concentration capability for bearer channels
Generic analogue subscriber access	Z	6.1	None ^{e)}	None	Analogue subscriber lines
<p>a) Recommendation G.961 specifies the characteristics of a digital transmission system on metallic local lines which may form part of the basic access digital section.</p> <p>b) In the case of ISDN access this is the primary rate access digital section.</p> <p>c) See information in "Background".</p> <p>d) For ISDN application through the V₅ interfaces.</p> <p>e) Characteristics other than those defined in Recommendations Q.551 and Q.552 are not subject to ITU-T Recommendations.</p>					

3 Terms and definitions

For the purposes of this Recommendation, the following definitions apply:

3.1 digital section: A digital section is defined as the whole of the means of digital transmission of a digital signal of specified rate between two consecutive reference points. A digital link comprises one or more digital sections and may include either a multiplexer or concentrator, but not switching.

3.2 access digital section: The functional requirements to transmit the information from/to the user-network interface and to transmit, multiplex, demultiplex and process information required for operation and maintenance from/to the associated V-reference point related to that particular user-network interface. This excludes the extraction, concentration and multiplexing/demultiplexing of channels with hierarchies other than the one being concerned (as these are considered by the V-reference point).

In addition, this Recommendation uses terms defined in Recommendations G.962 [6], G.963 [7], G.964 [8], G.965 [9] and Q.9 [B5].

In this Recommendation the term “exchange” or “local exchange” is used for conciseness to indicate both a (digital) local exchange and a (digital) combined exchange. A (digital) combined exchange is one which includes both local exchange and transit/toll exchange functions.

4 Abbreviations

For the purposes of this Recommendation, the following abbreviations are used:

AN	Access Network
CRC	Cyclic Redundancy Check
ET	Exchange Termination
IDN	Integrated Digital Network
ISDN	Integrated Services Digital Network
NT1	Network Termination Type 1
PABX	Private Automatic Branch Exchange
PCM	Pulse code modulation
PSTN	Public Switched Telephone Network

5 Characteristics of digital interfaces for subscriber access

5.1 General

Digital interfaces for subscriber access are defined at the V-reference point which is the boundary between the Exchange Termination (ET) and the digital access section or link. These interfaces are designated interface V and are defined to allow flexibility of implementation for different exchange and transmission equipment realizations. However, a physical interface will not be specified for all subscriber access types identified (see Figure 1).

As an objective, the characteristics of digital interfaces on the subscriber side of the exchange should be aligned with the characteristics of ISDN user/network access structures (see Recommendation I.411 [B1]).

However, in many countries, digital access arrangements not structured according to ISDN principles are used, e.g. to ensure compatibility with existing networks and services and it is expected that these arrangements will continue to be used for several years. These types of interfaces not structured according to the ISDN principles are not subject to ITU-T Recommendations.

5.2 Interface V₁

5.2.1 General

Interface V₁ may be used at the V₁ reference point to connect to an ISDN basic access digital section for the provision of a single basic access. The characteristics of the basic access digital section are defined in Recommendation G.960 [4] and the characteristics and parameters of a digital transmission system which may form part of the digital section for the ISDN basic rate access are given in Recommendation G.961 [5].

5.2.2 Functional characteristics

The functional description is illustrated in Figure 2 and the following functional requirements are defined:

- 1) *(2B + D) channels*
To provide the bidirectional transmission capability for two B-channels and one 16 kbit/s D-channel as described in Recommendation I.412 [B2].
- 2) *Bit timing*
To provide bit (signal element) timing to enable the digital section to recover information from the aggregate bit stream.

3) *Frame timing*

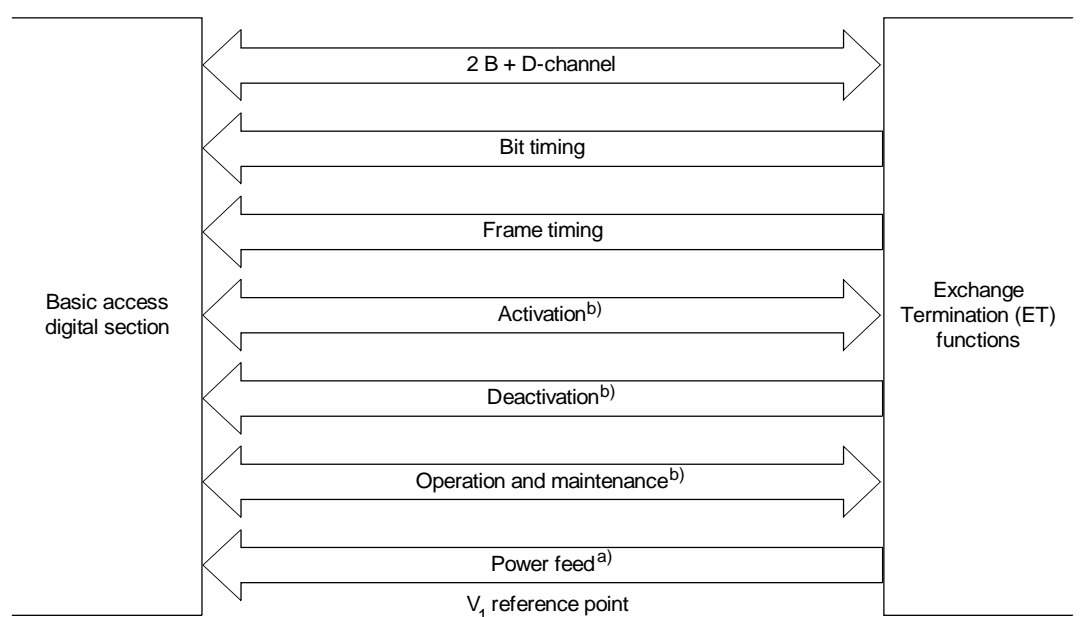
To provide frame timing to enable digital section and ET to recover the time division multiplexed channels.

4) *CV₁ channel*

The CV₁ channel provides, for each direction of transmission, the capability to transfer management functions required for the digital section as specified in Recommendations G.960 [4] and M.3603 [10]. The CV₁ channel may carry one or more functional links. These functions include activation from network side, activation request from a digital section, deactivation from ET side, operation and maintenance signals.

5) *Power feed*

This function provides for remote power feeding for the digital section and possibly terminal equipment. This function is optional.



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a) The provision of power feed function is optional.

b) These functions are conveyed by the CV₁ channel.

FIGURE 2/Q.512
Functions at interface V₁

5.2.3 Electrical characteristics

The electrical characteristics of interface V₁ are not subject to ITU-T Recommendations.

5.2.4 Channel types, channel allocation and signalling

The channel types associated with interface V₁ include two B-channels and one D-channel as defined at the user network interface in Recommendation I.412 [B2]. In addition, the CV₁ channel is required to support the operational and maintenance functions.

The channel allocation is not subject to ITU-T Recommendations.

The D-channel signalling procedures are defined in the Q.920 and Q.930-Series Recommendations.

5.3 Interface V₂

5.3.1 General

Interface V₂ is a generic digital interface used to connect remote or local digital network equipment via a first or second order digital section. This network equipment may support any combination of analogue, digital and ISDN subscriber access. The characteristics of this interface may not be structured according to the ISDN principles.

5.3.2 Functional characteristics

The functional characteristics depend on the specific application of the V₂ interface. These are not generally subject to ITU-T Recommendations.

5.3.3 Electrical characteristics

The electrical characteristics of interface V₂ are described in Recommendation G.703 [1]. The basic frame structure at interface V₂ should be identical to that of the first or second order rate multiplexes described in Recommendation G.704 [2].

5.3.4 Channel types, channel allocation and signalling

The channel types, channel allocation and signalling depend on the specific application of the V₂ interface. These are not generally subject to ITU-T Recommendations.

5.4 Interface V₃

5.4.1 General

Interface V₃ is a digital interface used to connect digital subscriber equipment (e.g. PABX) via a generic digital subscriber section for the provision of a single primary rate access. The use of this interface to connect subscriber equipment with characteristics not structured according to the ISDN principles is not subject to ITU-T Recommendations.

5.4.2 Functional characteristics

Recommendations G.962 [6] and G.963 [7] define the access digital section which covers the functional and procedural aspects. The maintenance procedures, defined in Recommendation M.3604 [11] are taken into account in Recommendations G.962 [6] and G.963 [7].

5.4.3 Electrical characteristics

The electrical characteristics of interface V₃ are described in Recommendation G.703 [1].

The frame structure at interface V₃ should be identical to that described in Recommendation G.704 [2].

5.4.4 Channel types, channel allocation and signalling

The channel types and allocation associated with interface V₃ are 30 B + 1 D at 2048 kbit/s or 23 B + 1 D at 1544 kbit/s as described in Recommendation I.431 [B4].

The channel allocation should also consider that:

- a) When the signalling for the B-channels in one primary rate structure is carried by the D-channel in another primary rate structure, the channel timeslot normally used for signalling may be used to provide an additional B-channel.
- b) At interface V₃ the designated number of B-channels is always present within the multiplexed channel structure, but one or more of the B-channels may not be used in any given application.

The D-channel signalling procedures are defined in the Q.920 and Q.930-Series Recommendations.

5.5 Interface V₄

This interface is not considered to be a matter for ITU-T Recommendations.

NOTE – See information provided in “Background”.

5.6 Interface V₅

5.6.1 General

Interface V₅ is a digital interface (based on 2048 kbit/s) between an Access Network (AN) and the Local Exchange for the support of the following access types:

- analogue telephone access;
- ISDN basic access with a line transmission system conforming to Recommendation G.960 [4] for the case with an NT1 separate from the AN;
- ISDN basic access with a user network interface according to Recommendation I.430 [B3] at the user side of the AN (i.e. the interface at the T reference point);
- ISDN primary rate access with a line transmission system conforming to Recommendation G.962 [6] for the case with an NT1 separate from the AN (V_{5,2} interface only);
- ISDN primary rate access with a user network interface according to Recommendation I.431 [B4] at the user side of the AN (i.e. the interface at the T reference point) (V_{5,2} interface only);
- other analogue or digital accesses for semi-permanent connections without associated outband signalling information.

These access types are supported by interface V₅ using flexible information channel (bearer channel) allocation with (for V_{5,2} interface as specified in Recommendation G.965 [9]) or without (for V_{5,1} interface as specified in Recommendation G.964 [8]) concentration capability within the AN.

The AN is defined as a system implemented between the Local Exchange and the user, replacing part or the whole of the local line distribution network. The functions associated with the V₅ interface of an AN can be configured and operated flexibly via a management Q interface. The detailed specification of the Q₃ interface specifications for the V₅ environment are contained in the Q.570-Series of Recommendations. The AN may consist of multiplexing, cross connect and transmission functions.

The V₅ interface may be implemented as a V_{5,1} or a V_{5,2} interface supporting different access types and providing different bearer channel handling capabilities as given above. The V_{5,1} interface consists of a single 2048 kbit/s interface while the V_{5,2} interface can be a multiple of 2048 kbit/s interface links with a maximum number of 16 interface links.

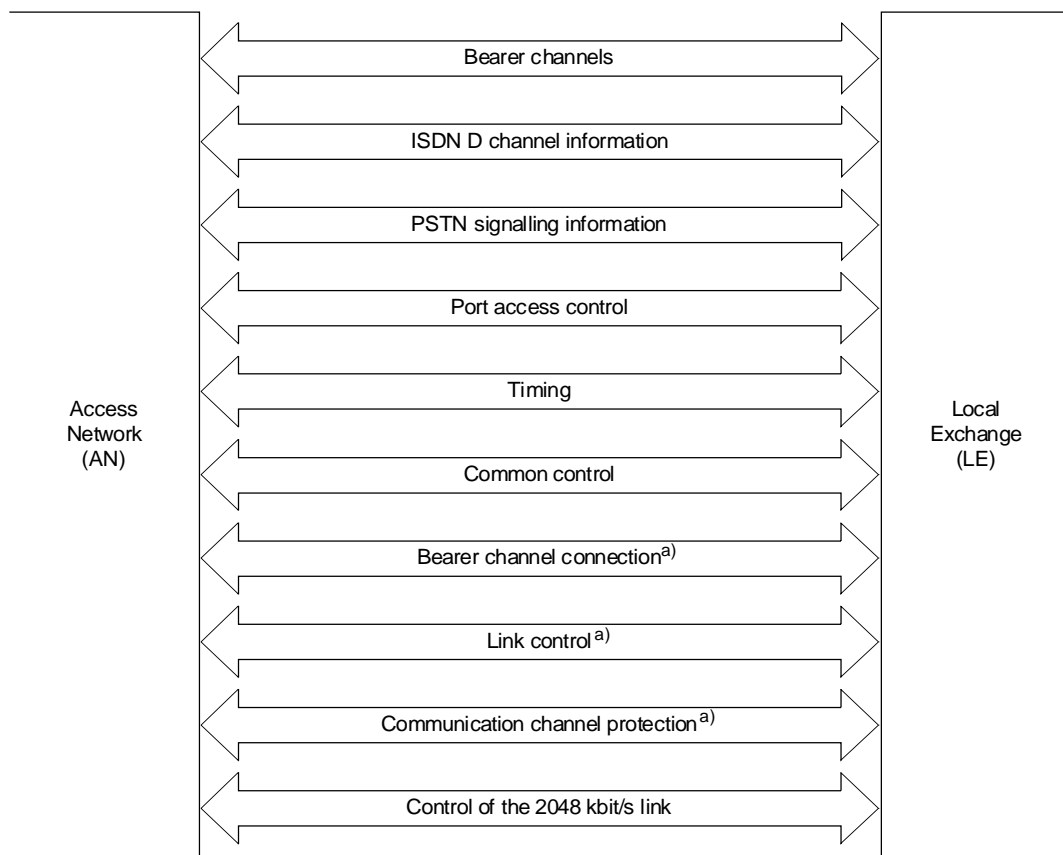
5.6.2 Functional characteristics

The functional and procedural requirements of the interface shall conform to Recommendation G.704 [2] and G.706 [3], 2048 kbit/s case. The CRC-4 (CRC) procedure specified in Recommendations G.704 [2] and G.706 [3] shall be applied including the CRC error reporting using bit E in the CRC-multiframe.

The functional description is illustrated in Figure 3. The following functional requirements are defined:

- *Bearer channels* – To provide the bidirectional transmission capability for allocated B-channels from basic access user ports or PCM encoded 64 kbit/s channels from PSTN user ports.
- *ISDN D-channel information* – To provide the bidirectional transmission capability for D-channel information from basic access user ports (including Ds-, p- and f-type data).
- *PSTN signalling information* – To provide the bidirectional transmission capability for signalling information of PSTN user ports.

- *Control of user ports* – To provide the bidirectional transmission capability to carry the status and control of each individual user port.
- *Control of the 2048 kbit/s link* – Frame alignment, multiframe alignment, alarm indication and CRC information of the 2048 kbit/s.
- *Control of layer 2 links* – To provide bidirectional communication capabilities to carry the various protocols.
- *Control for the support of common functions* – To provide synchronized application of provisioning data and restart capability.
- *Timing* – To provide the necessary timing information for bit transmission, octet identification and frame synchronization.
- *Control of 2048 kbit/s link related procedures* – To provide link identification and link blocking and unblocking capability (V_{5,2} only).
- *Control of bearer channel connections* – To provide on-demand bearer channel connection allocation and deallocation for the concentration function (V_{5,2} only).
- *Communication channel protection* – To control protection switching for communication channels affected by 2048 kbit/s link failure (V_{5,2} only).



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^{a)} For V_{5,2} interface only.

FIGURE 3/Q.512
Functional description of the V₅ interface

5.6.3 Electrical characteristics

The $V_{5,1}$ interface consists of a single 2048 kbit/s interface as defined in Recommendation G.703 [1].

The $V_{5,2}$ interface may consist of a maximum of 16 times 2 048 kbit/s interface links as defined in Recommendation G.703 [1].

The electrical and physical characteristics of the interface for each interface link shall conform to Recommendation G.703 [1], 2048 kbit/s case.

5.6.4 Channel types, channel allocation and signalling

The information provided below is an excerpt of the detailed V_5 interface specifications as contained in Recommendations G.964 [8] and G.965 [9].

5.6.4.1 Channel types

The $V_{5,1}$ interface or any link of the $V_{5,2}$ interface shall be structured according to Recommendations G.704 [2] and G.706 [3]. Timeslots 1 to 31 shall be used for channel types allocated by provisioning:

- timeslots which carry ISDN and PSTN bearer channels;
- communication channels which carry ISDN D-channel information, PSTN signalling information and control information;
- communication channels which carry information for the link control, the bearer connection control and the link protection ($V_{5,2}$ only).

5.6.4.2 Channel allocation

There may be 1, 2 or 3 communication channels provisioned in the $V_{5,1}$ interface. Only timeslots 16, 15 and 31 shall be assigned for communication channels. All timeslots not allocated for a communication channel may be allocated to bearer channels by provisioning.

There may be 0, 1, 2 or 3 communication channels provisioned for any link of a $V_{5,2}$ interface. Only timeslots 16, 15 and 31 shall be assigned for communication channels. All timeslots not allocated for a communication channel may be allocated to bearer channels under control of the bearer channel connection protocol.

5.6.4.3 Signalling

Signalling information for PSTN user ports are carried by a PSTN signalling protocol allocated to one of the provisioned communication channels.

Signalling information for ISDN user ports, as well as p-type and f-type data, are frame relayed into the provisioned communication channels.

Information for the control of user ports, links, bearer channel connections and protection of communication channels are carried by the relevant protocols in the assigned communication channels.

The related Recommendations for the protocols are given in Recommendations G.964 [8] and G.965 [9].

6 Characteristics of analogue interfaces for subscriber access

6.1 Interface Z

Interface Z is a generic analogue interface defined at the exchange side of an analogue subscriber line used to connect subscriber equipment (e.g., single telephone set or PABX).

It is recognized that the characteristics of analogue interfaces (generally designated Z-interface) vary considerably from country to country and therefore it is not intended that those interfaces be the subject of ITU-T Recommendations beyond those aspects covered in Recommendations Q.551 [B7] and Q.552 [B8].

Appendix I

Bibliography

(This appendix does not form an integral part of this Recommendation)

- [B1] ITU-T Recommendation I.411 (1993), *ISDN user-network interfaces – Reference configurations.*
- [B2] CCITT Recommendation I.412 (1988), *ISDN user-network interfaces – Interface structures and access capabilities.*
- [B3] ITU-T Recommendation I.430 (1993), *Basic user-network interface – Layer 1 specification.*
- [B4] ITU-T Recommendation I.431 (1993), *Primary rate user-network interface – Layer 1 specification.*
- [B5] CCITT Recommendation Q.9 (1988), *Vocabulary of switching and signalling terms.*
- [B6] CCITT Recommendation Q.500 (1988), *Digital local, combined, transit and international exchanges, introduction and field of application.*
- [B7] ITU-T Recommendation Q.551 (1994), *Transmission characteristics of digital exchanges.*
- [B8] ITU-T Recommendation Q.552 (1994), *Transmission characteristics at 2-wire analogue interfaces of digital exchange.*