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Information processing — Basic mode control procedures for data communication systems

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FOREWORD

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Draft International Standards adopted by the Technical Committees are circulated to the Member Bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 1745 was drawn up by Technical Committee ISO/TC 97, *Computers and information processing*, and circulated to the Member Bodies in May 1973.

It has been approved by the Member Bodies of the following countries :

Australia	Japan	Switzerland
Brazil	Netherlands	Thailand
Canada	New Zealand	Turkey
Czechoslovakia	Poland	United Kingdom
Egypt, Arab Rep. of	Romania	U.S.A.
France	South Africa, Rep. of	U.S.S.R.
Hungary	Spain	Yugoslavia
Italy	Sweden	

The Member Bodies of the following countries expressed disapproval of the document on technical grounds :

Bulgaria
Germany

This International Standard cancels and replaces ISO Recommendation R 1745-1971, of which it constitutes a technical revision.

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Information processing — Basic mode control procedures for data communication systems

0 INTRODUCTION

0.1 General

A data communication system may be considered as the ensemble of the terminal installations and the interconnecting network that permits information to be exchanged.

A data link concept is identifiable when considering terminal installations connected to the same network, operating at the same speed, in the same code. Whenever actions on the respective transmission control characters take place, a separation of data links is constituted. Typical examples where this applies are : store and forward switching centres, concentrators, intermediate reformatting and speed-change devices.

The information transfer in a data link is monitored by data link control procedures where some characters, selected within a code set, are given particular meanings according to the transmission phase and are used for various purposes such as to delineate information, to reverse the direction of transmission, to ask questions, to answer, etc.

The data link control procedures are categorized in classes which are referred to as modes of operation. The present considerations relate to one class called "basic mode", which is defined as follows :

> In the basic mode all the necessary transmission control information (for example, message framing and supervisory instructions) passing from one station to another is carried over the link by discrete control characters selected from the ten transmission control characters which are defined in the ISO/CCITT 7-bit code (ISO 646). The information exchanges are carried out in the alternate mode on standard communication facilities. The control of the data link is not affected by any characters other than the ten transmission control characters. Other codes than the ISO/CCITT code may therefore be transmitted provided that they do not contain any of the ten transmission control characters in either heading or text. Sequences of transmission control character combinations such as DLE.XXX are not permitted, with the one exception DLE.EOT which is defined as "Disconnect".

Extensions to the basic mode are contained in the following International Standards :

> ISO 2111, *Basic mode control procedures — Code independent information transfer;*
>
> ISO 2628, *Basic mode control procedures — Complements;*
>
> ISO 2629, *Basic mode control procedures — Conversational information message transfer;*

and also in annexes B and C of this International Standard.

The following considerations have been taken into account in developing the rules for the basic mode :

The rules are based on the assumption that one of the stations in each connection would be either a computer or a device capable of handling automatically an exchange of information. The rules are designed to allow the complexity of operation to be increased from a basic level by adding options. These options are designed so that any number of stations can still communicate even though they normally operate at different levels of complexity.

It is desirable to reduce optional features in this International Standard to a minimum, but still retain a balance between an economic solution for the "low cost systems" and extendability for encompassing more complex systems. The rules may be difficult to implement in very simple systems involving low cost devices and human control. On the other hand, in complex high speed computer links, the rules may seriously restrict the throughput of information. These two cases are regarded as the upper and lower fringes of the present International Standard and may be the subject of future International Standards.

With the above considerations, typical limitations of basic mode control procedures are :

- restriction of efficiency by the time delay which is due to the alternate mode of operation;
- single link operation only.

0.2 Communication phases

The table below shows the various possible phases and sub-phases of a data communication.

Phases 1 and 5, which relate to the establishment and clearing of connections over the general switched network, are under the responsibility of the CCITT and are therefore not covered by this International Standard.

In each phase, one of the stations directs the operation and is responsible for the continuity of the communication. The other station or stations only react to the actions of the responsible station.

The transmission control characters which are shown alongside the various sub-phases are those which are involved in the basic mode of operation.

EOT is shown in parentheses in Phases 2 and 3 because its use within the phases initiates a changeover to Phase 4.

1 SCOPE AND FIELD OF APPLICATION

1.1 General

This International Standard specifies the method of implementation of the ISO/CCITT 7-bit coded character set[1] for information interchange on data transmission channels. It also defines the formats of the transmitted messages and the supervisory sequences which are part of the transmission control procedures. It covers the majority of existing data transmission systems and data link configurations used in conjunction with data processing systems.

These control procedures deal with transmission over one link at a time and do not describe the operation of data links in "tandem". They relate to the class of control procedures which is known as the basic mode and apply at the interface between data communication equipment and data terminal equipment.

Table of phases

Phase		Function: Action / Reaction	Station's name: Responsible / Responsive	Transmission control characters used in basic mode: Forward / Backward	Notes
1 Establishment of connection over general network	*a*) Switching *b*) Identification				CCITT Responsibility
2 Establishment of data link	*a*) Switching	Call / Answer	Calling / Called		Not covered at present
	b) Polling	Poll / Reply	Control / Tributary	(EOT), ENQ / (EOT)	
	c) Selecting	Select / Reply	Master / Slave	(EOT), ENQ / ACK, NAK	
3 Information transfer		Transfer / Supervision	Master / Slave	SOH, STX ETB, ETX, (EOT) / ACK, NAK, (EOT)	
4 Termination	*a*) Return to neutral state	Terminate Interrupt	Master / Slave	EOT / EOT	
	b) Return to control station	Terminate Interrupt	Master / Slave	EOT / EOT	
	c) Disconnect	Disconnect Disconnect	Master / Slave	DLE, EOT / DLE, EOT	
5 Clearing of connection					CCITT Responsibility

1) See ISO 646. CCITT : Alphabet No. 5.

It is accepted that, in their present form, the control procedures are a framework upon which a system can be built and that, before the successful interconnection of equipment from different supplies can be ensured, it will be necessary to define additional details, such as :

— structure of prefixes or addresses when used;

— "time-out" procedures and the recovery procedures which follow the various time-out conditions (see ISO 2628).

This International Standard must be considered in conjunction with the following ISO publications :

1) ISO 1177, *Information processing — Character structure for start/stop and synchronous transmission;*

2) ISO 1155, *Information processing — Use of longitudinal parity to detect errors in information messages.*

1.2 Assumptions

1) The information to be transmitted will normally be coded in accordance with the 7-bit ISO/CCITT code.

2) All transmission control functions will be performed by the use of ten specific transmission control characters which are defined in this code as TC 1 to TC 10.

3) No recommendation is made regarding

— the technique used (hardware or software);

— the part of the terminal installation where the information messages and supervisory sequences are generated and recognized.

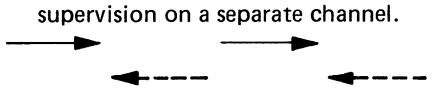
4) Transmission may be at any data transfer rate, either serial or parallel and either start/stop or synchronous.

5) Responses to an information message or a supervisory sequence may be either by turn around of the channel or by using another channel.

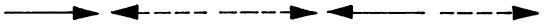
6) The basic mode control procedures are applicable to systems of varied complexity based on either-way transmission using :

a) One-way transfer of information with alternate supervision on the same channel.

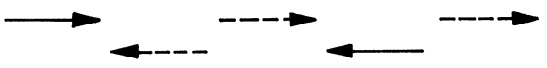
b) One-way transfer of information with alternate supervision on a separate channel.



c) Alternate two-way transfer of information with alternate supervision on the same channel.



d) Alternate two-way transfer of information with alternate supervision on separate channels.



7) The following cases will be the subject of further study :

a) One-way transfer of information with simultaneous supervision.

b) Alternate two-way transfer of information with simultaneous supervision.

c) Two-way simultaneous transfer of information with alternate supervision.

d) Two-way simultaneous transfer of information with simultaneous supervision.

2 DEFINITIONS OF THE TRANSMISSION CONTROL CHARACTERS

The basic definitions of the ten transmission control characters, as taken from ISO 646, are listed below (see clause 5 for description of use).

(TC1) **SOH Start of heading**

A transmission control character used as the first character of a heading of an information message.

(TC2) **STX Start of text**

A transmission control character which precedes a text and which is used to terminate a heading.

(TC3) **ETX End of text**

A transmission control character which terminates a text.

(TC4) **EOT End of transmission**

A transmission control character used to indicate the conclusion of the transmission of one or more texts.

(TC5) **ENQ Inquiry**

A transmission control character used as a request for a response from a remote station — the response may include station identification and/or station status. When a "Who are you" function is required on the general switched transmission network, the first use of ENQ after the connection is established shall have the meaning "Who are you" (station identification). Subsequent use of ENQ may, or may not, include the function "Who are you", as determined by agreement.

(TC6) **ACK Acknowledge**

A transmission control character transmitted by a receiver as an affirmative response to the sender.

(TC7) **DLE Data link escape**

A transmission control character which will change the meaning of a limited number of contiguously following characters. It is used exclusively to provide supplementary data transmission control functions. Only graphic characters and transmission control characters can be used in DLE sequences.

(TC8) **NAK Negative acknowledge**

A transmission control character transmitted by a receiver as a negative response to the sender.

(TC9) **SYN Synchronous idle**

A transmission control character used by a synchronous transmission system in the absence of any other character (idle condition) to provide a signal from which synchronism may be achieved or retained between data terminal equipment.

(TC10) **ETB End of transmission block**

A transmission control character used to indicate the end of a transmission block of data where data is divided into such blocks for transmission purposes.

3 MESSAGE FORMATS

The various possible messages are categorized as follows :

- information messages;
- forward supervisory sequences;
- backward supervisory sequences.

3.1 General rules

Every transferred sequence of characters contains at least one transmission control character. These are used either to define the nature of the information contained in a sequence of data or to convey supervisory functions.

- They must not be considered information. Therefore, they must not be transmitted as part of the text or heading of an information message with the exception of SYN which may be inserted as required but which must not be regarded as information.

- When used singly or at the end of a message or sequence, they invite the station receiving them to take action.

a) *Information messages*

Information messages consist of a text which can be preceded by a heading; the heading is delivered with the text. Routing indication, for intermediate points in particular, must be in the heading. Other auxiliary information may be either in the heading or in the text.

SOH, STX, ETB and ETX are used as information framing characters. They cannot be sent singly.

Information messages, or information blocks, may be accompanied by a block checking character in accordance with ISO 1155. The use of this block checking character, shown in parentheses, is optional and therefore subject to prior agreement.

b) *Supervisory sequences*

All supervisory sequences except DLE.EOT are composed of either a single transmission control character or a single transmission control character preceded by one or several graphics.

In some of the following supervisory sequences the meaning of the character or characters which precede the transmission control character is defined (for example Polling address). In others, it is simply shown as a prefix which may include one or more of the following :

- identity information;
- address information;
- status information;
- any other qualifier as necessary (for example response number).

The use of these prefixes and their description is subject to prior agreement. They may be standardized at a later date.

EOT, ENQ, ACK and NAK are used for supervision. They can never appear contiguously.

The prefix must not contain more than 15 characters.

3.2 Information messages

a) S T X — — TEXT — — E T X (B C C)

b) S T X — — TEXT — — E T B (B C C)

(See note 2, below)

c) S O H — — HEADING — — S T X — — TEXT — — E T X (B C C)

d) S O H — — HEADING — — S T X — — TEXT — — E T B (B C C)

(See note 2, below)

e) S O H — — HEADING — — E T B (B C C)

(See note 2, below)

NOTES

1 Fillers may be inserted in the heading and the text (for example SYN).

2 In formats b), d) and e) above which end with ETB, some continuation is required.

3 All the above messages can be aborted by terminating them at any point with EOT. Future study may lead to the specifying of another method for aborting which allows the continuation of the communication.

3.3 Forward supervisory sequences

a) Polling

Polling address ENQ

(See note below)

b) Selecting

1) Station selection

Selecting address ENQ

(See note below)

If a reply is not required, ENQ is not used and the selecting sequence is immediately followed by the information message.

2) Identification and status

(Prefix) ENQ

3) Out of neutral

(Prefix) ENQ

c) Return to control station — Return to neutral state

(Prefix) EOT

(See note below)

d) Disconnect

(Prefix) DLE EOT

NOTE — Polling sequences are always preceded by EOT except in systems involving Phase 1 where the omission of EOT is optional. Selecting sequences may also be preceded by EOT.

Some systems may not be able to tolerate a polling or selecting sequence immediately following EOT. In such cases it may be necessary to ensure a short delay between the EOT and the address by using, for example, a number of "filler" characters.

3.4 Backward supervisory sequences

a) Positive reply to :

— an information message

— selecting

(Prefix) ACK

b) Negative reply to :

— an information message

(Prefix) NAK

c) Negative reply to :

— a polling supervisory sequence

(Prefix) EOT

d) Negative reply to :

— a selecting supervisory sequence

(Prefix) NAK

e) Request for :

— an interruption

(Prefix) EOT

— a return of responsibility to the control station

(Prefix) EOT

— return to neutral state

(Prefix) EOT

(See note 2, below)

f) Disconnect

(Prefix) DLE EOT

NOTES

1 The procedures for the cases of "no reply" are covered in 4.3.

2 Future study may lead to replacing the interruption by EOT with another method.

4 DESCRIPTION OF PHASES

The operational procedures of a complete system can be constructed from the following separate phases and sub-phases :

Phase 1[1] Establishment of connection over the general network

a) Switching

b) Identification

1) This phase is under the responsibility of the CCITT.

Phase 2 Establishment of data link

a) Switching

b) Polling

c) Selecting

Phase 3 Information transfer

Phase 4 Termination

a) Return to neutral state

b) Return to control station

c) Disconnect

Phase 5[1] Clearing of connection

4.1 Phase linkage

Figure 1 represents the various phases of a communication which are linked (thick lines) to achieve one transmission, or information transfer, in the most general case encompassed by the basic mode control procedures.

The sequence of events for such a communication would be as follows :

Phase 1 a), b) Establishment of connection over the general switched network

Here the connection is established by the telecommunications administration and this is likely to be divided into two sub-phases : "Switching" and "Identification". They will both be under the responsibility of the administration.

Unless otherwise stipulated by the administration, once this phase is achieved, the calling station takes on the responsibility for the communication and acts as master station or control station.

Means for signalling the completion of Phase 1 will be defined with reference to Recommendations on interfaces (for example, CCITT-V24, Circuit 107).

Phase 2 a), b), c) Establishment of data link

After establishing the Connection on the general network it is required to establish the data link. This procedure may involve some private line Switching performed by a private Switching exchange or a line concentrator before polling and selecting.

The "Polling" procedure, carried out by the control station, invites a tributary station to transmit any message it may have.

This procedure transfers the responsibility of the communication to the polled station, which takes the status of master station.

The "Selecting" procedure, carried out by the so-designated master station, invites in turn another station to get ready to receive an information message.

This procedure gives to the selected station the status of slave station.

1) This phase is under the responsibility of the CCITT.

Phase 3 Information transfer

Assuming the slave station(s) has accepted to receive the information message, the master station commences its transmission.

During this phase there are no changes of station status or responsibility.

Phase 4 a), b), c) Termination

When the information message has been transmitted and satisfactorily received by the slave station(s), the master station sends EOT to announce to the control station that its transmission requirement has temporarily ceased. By doing so, the master station relinquishes its master status and returns the responsibility of the communication to the control station.

If there are no further transmission requirements, the control station, by sending DLE.EOT, releases the possibly involved private switching equipment.

Phase 5 Clearing of connection (General network)

The Disconnect function (DLE.EOT) of the termination phase will initiate the clearing of the connection over the general switched network. The procedure for so doing is under the responsibility of the administration.

As a matter of fact, in most systems, several data link establishments and several information transfers take place in sequence within a communication.

This is illustrated by the phase linkage arrows marked PL 1, 2,...6. An example of such a multiple communication could be :

Phase 1 a), b) — We reach a multistation link via the general network;

Phase 2 c) — We try to select station X;

Phase 4 a) — Station X refuses to receive;

Phase 2 b) — We poll station Y;

Phase 3 — Station Y transmits information to us;

Phase 4 — Station Y terminates its transmission;

Phase 4 c) — We decide to disconnect;

Phase 5 — The general network is cleared.

All the permitted phase linkages are shown on the phase diagrams in 4.2, along with more detailed descriptions of the phases and sub-phases.

In some systems, not all the phases or sub-phases shown on the phase linkage diagram will be required. Examples are illustrated by different by-passes :

By-pass 1 (BP1)

This by-pass applies to systems composed entirely of leased or private circuits not connected to the general switched network.

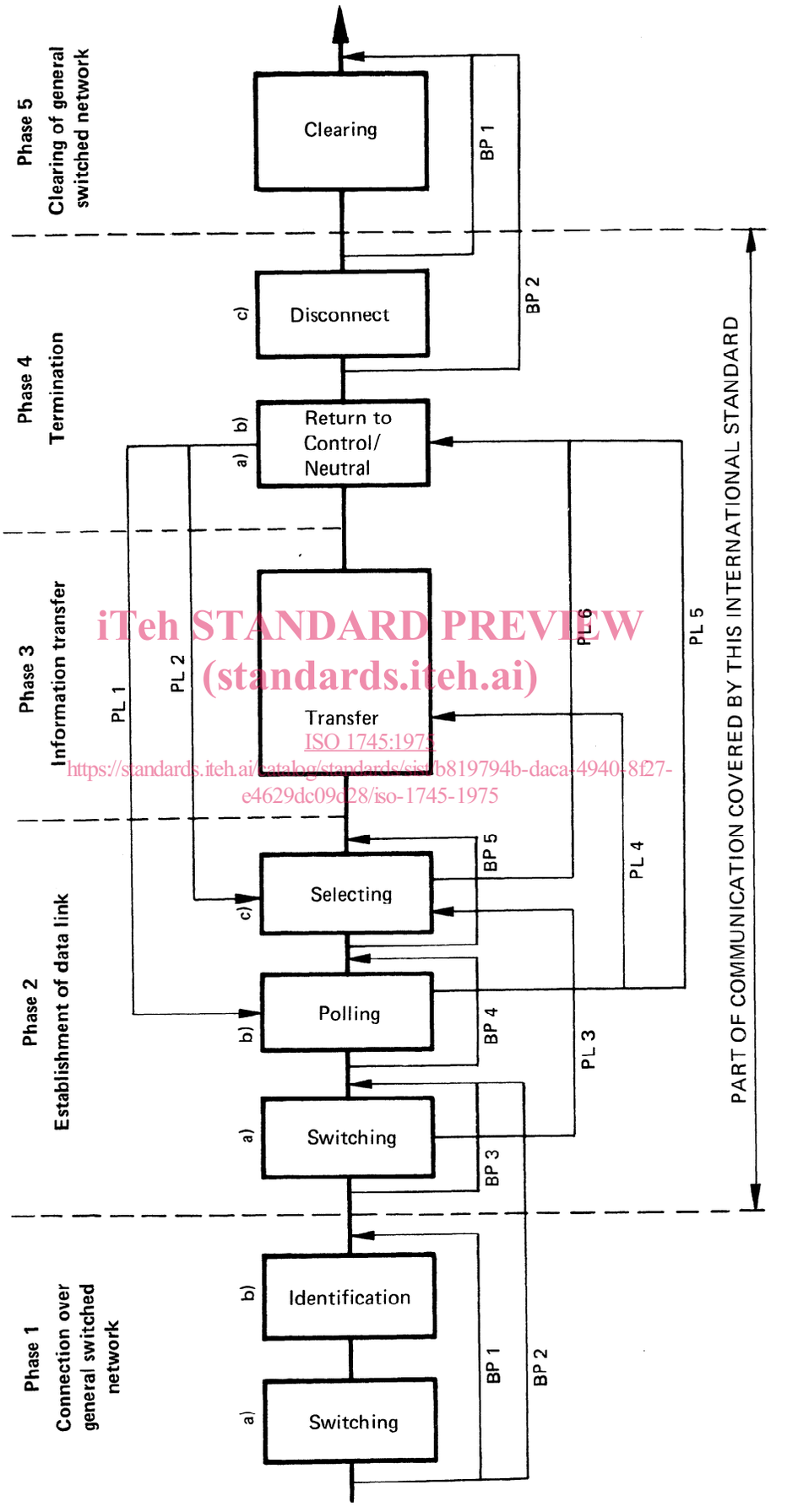


FIGURE 1 — **Phase linkage diagram**