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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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CONTENTS

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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.

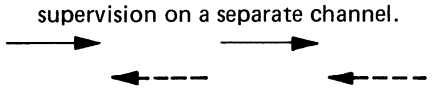
4) Transmission may be at any data transfer rate, either serial or parallel and either start/stop or synchronous.

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 :

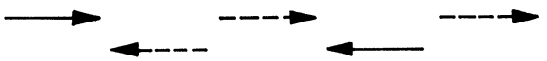
a) One-way transfer of information with alternate supervision on the same channel.

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) SOH / STX — TEXT — ETX / (ETB, ETX, ETB)

b) SOH / STX — TEXT — ETB / (ETB, ETX, ETB)

(See note 2, below)

c) SOH / STX — HEADING — STX / STX — TEXT — ETX / (ETB, ETX, ETB)

d) SOH / STX — HEADING — STX / STX — TEXT — ETB / (ETB, ETX, ETB)

(See note 2, below)

e) SOH / STX — HEADING — STX / ETB / (ETB, ETX, ETB)

(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 E N Q

(See note below)

b) Selecting

1) Station selection

Selecting address E N Q

(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) E N Q

3) Out of neutral

(Prefix) E N Q

c) Return to control station — Return to neutral state

(Prefix) E O T

(See note below)

d) Disconnect

(Prefix) D L E E O T

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) A C K

b) Negative reply to :

— an information message

(Prefix) N A K

c) Negative reply to :

— a polling supervisory sequence

(Prefix) E O T

d) Negative reply to :

— a selecting supervisory sequence

(Prefix) N A K

e) Request for :

— an interruption

(Prefix) E O T

— a return of responsibility to the control station

(Prefix) E O T

— return to neutral state

(Prefix) E O T

(See note 2, below)

f) Disconnect

(Prefix) D L E E O T

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.

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.

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

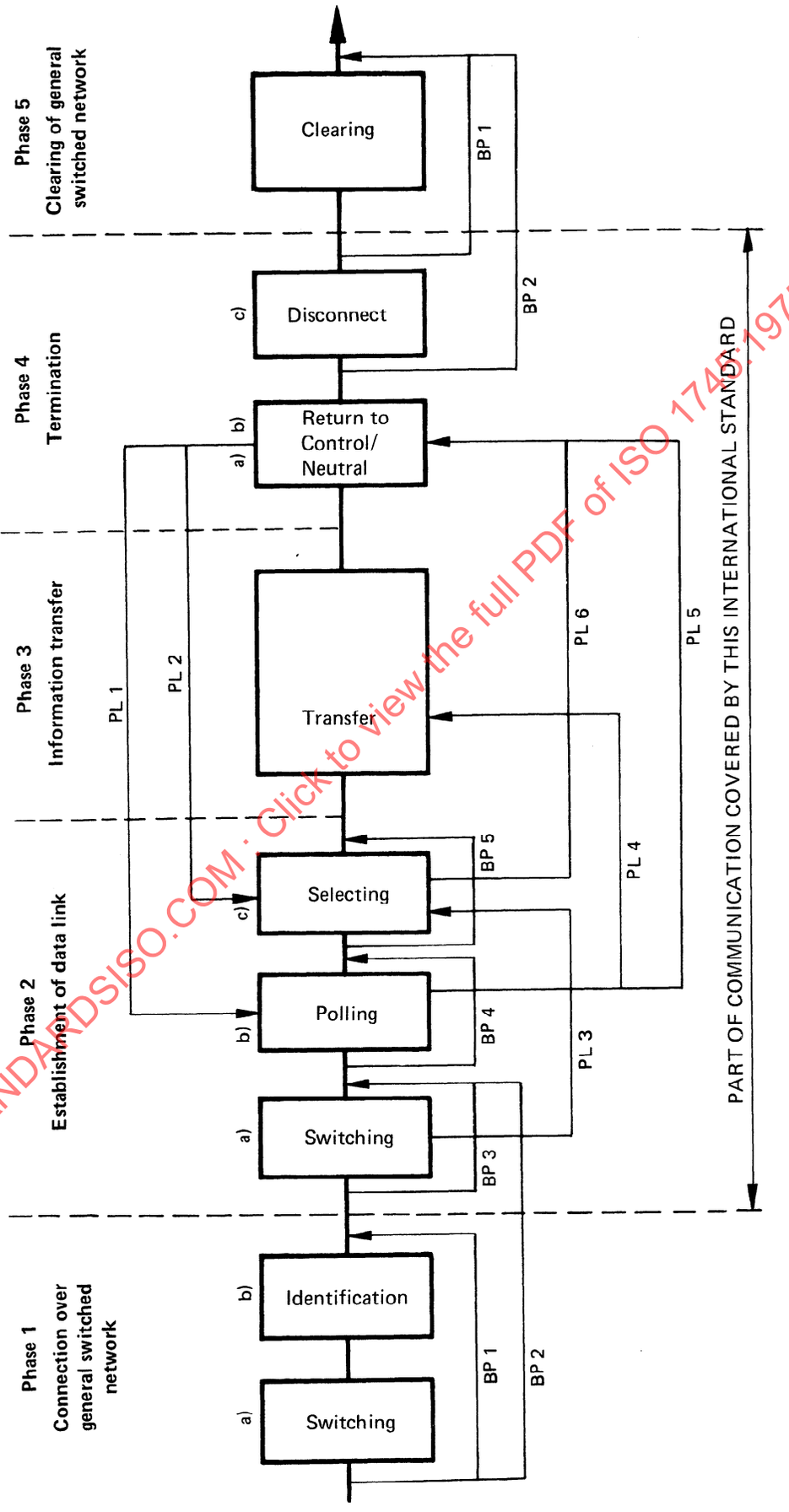


FIGURE 1 — **Phase linkage diagram**

By-pass 2 (BP2)

This by-pass applies to systems which do not involve line switching.

By-pass 3 (BP3)

This by-pass applies to systems that do not involve private line switching.

By-pass 4 (BP4)

In systems with control station, the suppression of the polling sub-phase allows only the sending of information from the control station to the others.

In systems without control station, each station can still select the other in order to transfer information but cannot poll in order to request transmission from the other end.

By-pass 5 (BP5)

This by-pass applies to systems with control station in which only the transfer of information from the tributary stations to the control station is required.

4.2 Phase diagrams

The detailed procedures for the phases 2 to 4 are given in the following text and illustrated by flow diagrams.

4.2.1 *Establishment of data link* (Phase 2) (see figure 2)

a) SWITCHING

A private switching process may be used. This, however, is not described in this International Standard.

b) POLLING

Polling is the process of inviting stations, one at a time in an orderly fashion, to transmit messages. The basic function of polling is to prevent contention by ensuring that only one station transmits at a time.

The polling process can only be performed by a control station, following EOT.

When a station receives its appropriate polling supervisory sequence, it becomes the master station.

Each polling supervisory sequence must uniquely identify one station on the data link. However, a given station may be assigned more than one address (for example, to distinguish between different precedences of originating traffic).

If no response or a non-valid response is received after transmission of a polling supervisory sequence, the control station must clear the possibly established data link by sending a termination supervisory sequence (EOT, see 4.2.3, termination phase, and 4.3, recovery procedures).

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

Polling sequences are always preceded by EOT except in systems involving Phase 1 where the omission of EOT is optional. Some selecting sequences may be preceded by EOT.

c) SELECTING

Selecting is the normal process for inviting one or more stations to receive an information message. However, it can be used for the sole purpose of checking the identification of a station and/or for obtaining its status.

The selecting process can only be performed by a master station.

When used on a multistation data link, the selecting supervisory sequence uniquely identifies, by means of its address, one or several stations. This function is called station selection. The address may include information other than that indicating the address of the desired station, for example, priority, device selections, etc. The address of the selecting supervisory sequence may identify either a single station on the link or a group of stations on the link.

The station selection sequence may be sent either by the control station taking the master status or by a station previously polled.

When used on a point-to-point data link, the selecting supervisory sequence, which may be limited to the character ENQ, essentially turns the data link out of its neutral state.

In all cases, the selecting supervisory sequence calls for a status reply from the selected or opposed station. If no response or a non-valid response is received, the master station must take action to recover the communication (see 4.3, recovery procedures).

NOTES

1 An exception to the above is the use of the so-called "Fast select" method in which the information message follows immediately the selecting address (ENQ is not used). The use of this method requires special agreement between sender and recipient.

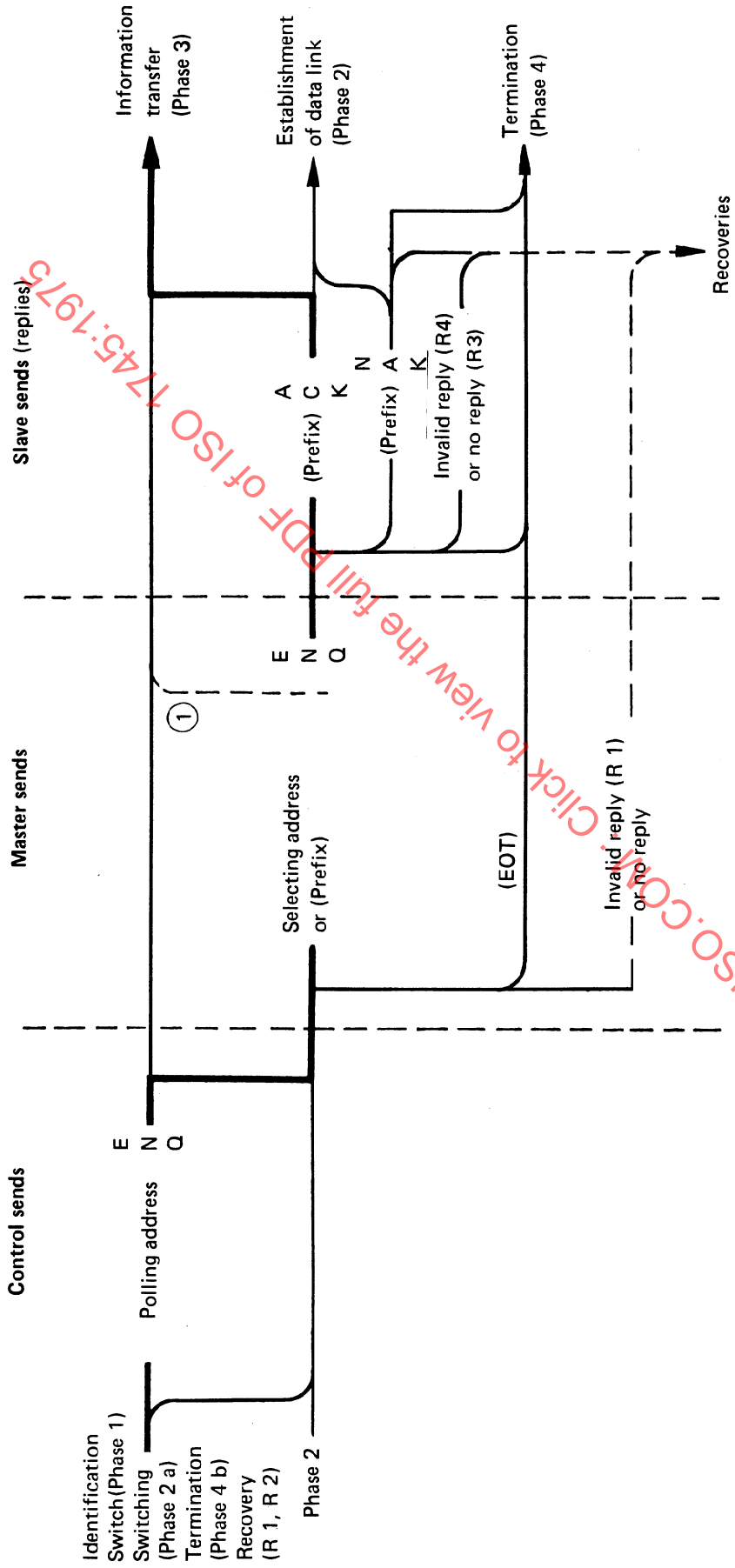
2 The method for achieving the sequential or group selection of a number of stations with the purpose of transmitting the same message to all stations is not completely defined by this International Standard.

4.2.2 *Information transfer* (phase 3) (see figure 3)

a) HEADING

The heading of an information message is a sequence of characters sent by a master station which constitutes the auxiliary information pertinent to the communication of a text. Such auxiliary information may include, for instance, characters representing routing, priority, security, message numbering, and associated characters. The definition of specific portions of a heading is not within the scope of this International Standard.

The sequence of characters which constitutes the heading is prefixed by the start of heading (SOH) character and is terminated only with the start of text (STX) character.



1 For those systems where the information message follows the selecting address (Fast Select path), ENQ is not used.

2 In most cases, the transmission of EOT is necessary after the connection has been established and before a polling or selecting supervisory sequence is transmitted.

FIGURE 2 – Phase 2 – Establishment of data link

The heading is not a "stand alone" message but must always be immediately followed by a text and is applicable only to that text. Any arrangement for association of one heading with more than one text can only be made by prior agreement between the affected parties and is not within the scope of this International Standard.

The heading may be sub-divided into more than one information block by terminating each such block with the end of transmission block (ETB) character and by prefixing the next following portion of the heading with the SOH character. The block check character (BCC), if used, immediately follows the ETB character (see ISO 1155).

b) TEXT

The text portion of an information message contains the information that is to be transmitted as an entity from the sender to the recipient(s). A text is always embodied between the STX and ETX characters, and is always transmitted by a master station.

The text may be sub-divided into more than one information block. Each of the blocks is terminated by an end of block control character (ETB, or ETX if it is the last block of text). The following portion of the text must be prefixed with the STX character.

If block checking is employed, the block check character immediately follows the ETB or ETX character.

The master station stops sending after each text or block has been sent, and normally does not resume transmission until the reply has been received.

c) REPLIES

Replies are used by the slave station to inform the master station of the status of the slave station and of the validity of the received message.

If the information message, or block, was acceptable, and the slave station is ready to receive, the slave station replies by transmitting the acknowledge character (ACK). The master station then transmits the next information message or block. If the master station has no more to transmit, it passes to termination phase.

If the information message or block is unacceptable, the slave station responds with the negative acknowledge character (NAK). This negative acknowledgement indicates to the master station that the data was unacceptable and also that the slave station is ready to receive. The next block of data transmitted is normally a retransmission of the previous information message or block.

If, during the information transfer, the slave station becomes unable to receive further, this station waits for the end of the transmitted information message or block and then responds by EOT. This EOT shall be interpreted by the other station(s) as a request for interruption and, according to the type of system used, either returns the responsibility of the communication to the control station or returns the data link to neutral state (see 4.2.3, termination phase).

Up to 15 characters may precede the final character of the reply sequence to convey information of a qualifying nature. The nature of this information is not a subject of this International Standard (see 3.1b), supervisory sequences formats).

4.2.3 *Termination* (Phase 4) (see figure 4).

There are essentially three situations when a station may elect to terminate the transmission in progress :

a) When a station refuses the establishment of a data link, either because it has nothing to transmit (negative reply to polling), or because it is unable to transmit (negative reply to polling), or because it is unable to receive (negative reply to selecting).

b) When the master station has successfully transmitted all of the data it desires to send :

The master station then transmits the end of transmission control character (EOT), indicating to the slave station that the master station has no more data to transmit. The master station thus relinquishes its right to transmit (unless it is also the control station).

c) When an unusual situation arises where either the master or the slave station desires to stop the transmission in progress :

If a master station sends EOT at any time other than after a terminated transmission, the transmission in progress is said to be aborted.

If a slave station sends EOT instead of a normal reply (ACK, NAK), the transmission in progress is said to be interrupted.

In all circumstances, such as a), b), c), the sending of EOT by any of the stations terminates the transmission, that is to say :

— in systems comprising a control station, returns the responsibility and the control of the communication to that control station; this function is called "Return to Control";

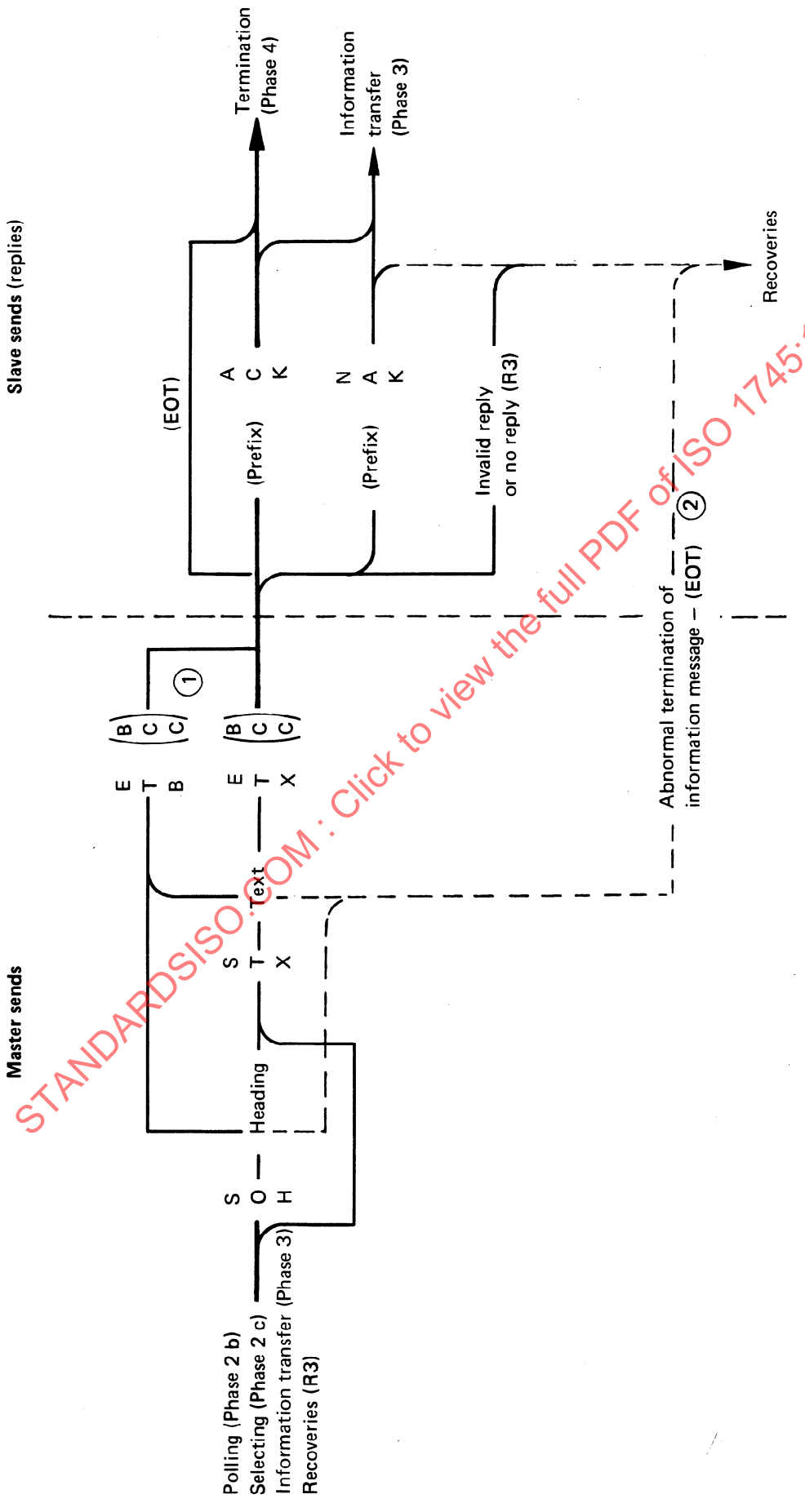
— in point-to-point systems, without control station, returns the data link to neutral state; this function is called "Return to Neutral".

In addition, in all the cases of termination, if the clearing of the connection (private and/or general network) is the intended consequence of the termination, the "Disconnect" supervisory sequence (DLE.EOT) shall be sent, either instead of EOT or following the receipt of an EOT.

4.3 Recovery procedures

It has been recognized that a number of recovery procedures are required to deal with various abnormal situations. Some recovery procedures are outlined in the following and their linkage to the appropriate phase is outlined in the diagrams in 4.2.

In all cases, after appropriate time-out periods, it shall be the responsibility of either the control station or the master station (never of a slave station) to take action.



① The BCC in brackets is optional.

② EOT can abort the transfer at any point in the transfer phase.

FIGURE 3 – **Phase 3 – Information transfer**

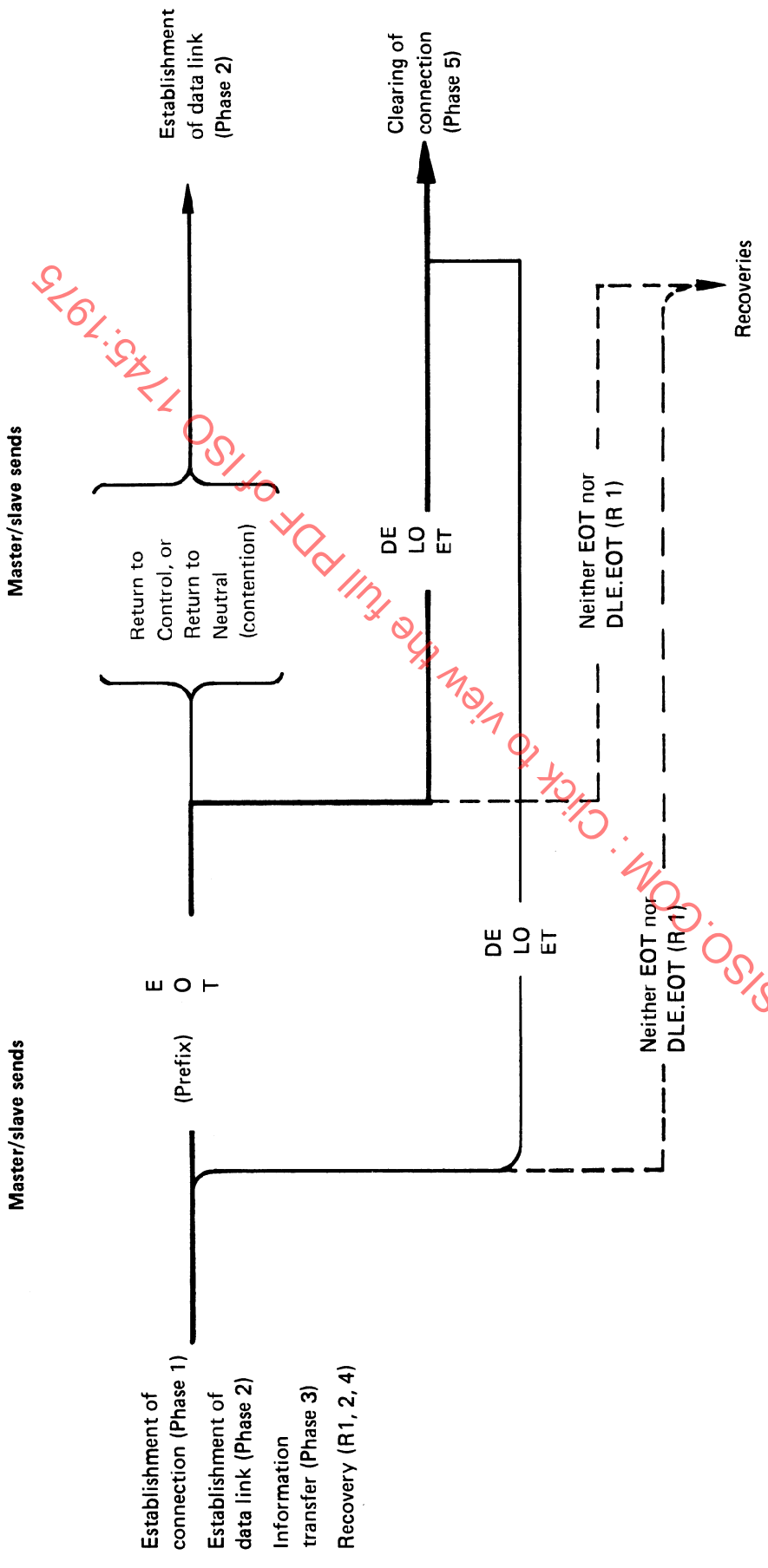


FIGURE 4 – **Phase 4 – Termination**

4.3.1 *Recovery procedures by control station*

R1 – In the case of :

– no reply or invalid reply to a polling supervisory sequence, or

– invalid, or absence of termination supervisory sequence,

the control station must transmit EOT.

R2 – In the case of repeated unsuccessful polling of one, several or all stations, the control station should, for example, set an alarm or report to the operator. Subsequent manual or automatic continuation is system-dependent and falls outside the scope of this International Standard.

4.3.2 *Recovery procedures by master station*

R3 – In the case of :

– no reply or invalid reply to an information message, or

– no reply or invalid reply to a selecting supervisory sequence,

the master station must repeat the previous transmission.

This procedure can lead to duplication of blocks. A possible alternative is :

In the case of no reply or an invalid reply to an information message, ENQ can be transmitted by the master station as a request to the slave station to repeat its previous response (ACK or NAK). This procedure is preferably used in conjunction with a response numbering scheme to ensure that blocks are neither added nor deleted.

R4 – In the case of :

– repeated unsuccessful transmission of an information message, or

– repeated unsuccessful transmission of a selecting supervisory sequence, or

– repeated negative replies (NAK) to an information message,

the master station should set an alarm or report to the operator and go to the termination phase. Subsequent manual or automatic continuation is system-dependent and falls outside the scope of this International Standard.

5 DESCRIPTION OF USE OF THE TRANSMISSION CONTROL CHARACTERS

In the following, the definition of the ten transmission control characters already given in clause 2 is recalled and the functional description of their use is summarized. See also 3.1.

SOH – Start of heading – TC 1

Definition

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

Description of use

1) SOH is transmitted by a master station.

2) If a heading is used it must be preceded by SOH.

3) If a heading is sub-divided into transmission blocks, each block must be preceded again by SOH.

4) If block checking is used, see ISO 1155.

5) SOH is not permitted in text.

STX – Start of text – TC 2

Definition

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

Description of use

1) STX is transmitted by the master station.

2) A text must be preceded by STX.

3) If a heading is used, STX in the message indicates the end of the heading.

4) If the text is sub-divided into transmission blocks, each block must be preceded again by STX.

5) If block checking is used, see ISO 1155.

6) STX is not permitted in the heading.

ETX – End of text – TC 3

Definition

A transmission control character which terminates a text.

Description of use

1) ETX is only transmitted by the master station.

2) ETX indicates the end of the text of each information message.

3) If an information message is sub-divided into transmission blocks, ETX is used to terminate the last block.

4) ETX calls for a reply from the slave station.

5) If block checking is used, ETX signals that the next following character is a block check character. See ISO 1155.

6) ETX is not permitted in text or heading.

EOT – End of transmission – TC 4

Definition

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

Description of use

1) EOT may be transmitted by a control, master, or slave station.

2) The control station transmits EOT to condition all tributary stations to anticipate the reception of a forward supervisory sequence.

3) The master station, in a system with control station, transmits EOT to relinquish its right to transmit in favour of the control station.

4) The master station, in a system without control station, transmits EOT to indicate either the end or the aborting of a transmission and resets the master and slave stations to the neutral state.

5) The slave station transmits EOT to indicate its inability to receive further information messages. This is an abnormal reply or interruption and leads into termination phase.

6) EOT is not permitted in text or heading.

NOTE – Depending upon the system characteristics and configuration, EOT transmitted by a tributary station (master or slave) may reset some or all tributary stations.

ENQ – Enquiry – TC 5

Definition

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.

Description of use

1) ENQ is transmitted by the control station during polling and by the master station during selecting.

2) In the polling sub-phase, ENQ is used to indicate the end of a polling address.

3) In the selecting sub-phase, ENQ is used to indicate the end of a selecting address or prefix when a reply is required from the slave station.

More specifically, ENQ can in this sub-phase

- terminate a station selection sequence;
- request identification and/or status;
- turn a data link out of neutral state.

4) ENQ is not permitted in text or heading.

ACK – Acknowledge – TC 6

Definition

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

Description of use

1) ACK is transmitted only by a slave station as an affirmative reply to a master station.

2) When supplementary information is included in the reply (for example, station identification or status information) it is prefixed to ACK.

3) In the selecting sub-phase, ACK is transmitted as a reply to a selecting supervisory sequence to indicate that the slave station is ready to receive.

4) In the information transfer phase, ACK indicates that the last transmitted information message or block was received correctly, and that the slave station is ready to receive the next one.

5) ACK is not permitted in text or heading.

DLE – Data link escape – TC 7

Definition

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 graphics and transmission control characters can be used in DLE sequences.

Description of use

1) DLE immediately followed by EOT is transmitted by a master or a slave station to "disconnect", that is, to initiate the clearing of the connection over private and/or general switched network.

2) Other uses of DLE require prior agreement until additional DLE sequences are defined in future International Standards for modes other than the basic mode.

NAK – Negative acknowledge – TC 8

Definition

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

Description of use

1) NAK is transmitted only by a slave station as a negative reply to the master station.

2) When supplementary information is included in the reply (for example, station identification or status information) it is prefixed to NAK.

3) The slave station transmits NAK after receipt of a selecting supervisory sequence to indicate its inability to receive an information message.

4) In the information transfer phase, NAK indicates that the last transmitted information message or block was not received correctly, and the slave station is ready to receive the same one.

5) NAK is not permitted in text or heading.

SYN — Synchronous idle — TC 9

Definition

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 terminal equipments.

Description of use

1) SYN may be transmitted by a control, master, or slave station.

2) SYN is used to achieve character synchronization in synchronous data communication systems. At least two SYN characters must be transmitted prior to the transmission of any information message or supervisory sequence.

NOTE — It is assumed that the receiving station requires two consecutive SYN characters to reliably achieve character synchronization.

3) SYN can be used as "time-fill" to maintain, for instance, synchronization during periods when no other characters are available for transmission. When used as "time-fill", SYN may be added at any point in a character sequence, except :

a) between ETX or ETB and the block check character when block checking is implemented;

b) within DLE sequences.

4) SYN is generally removed at the receiving terminal installation.

5) If block checking is used, see ISO 1155.

ETB — End of transmission block — TC 10

Definition

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.

Description of use

1) ETB is transmitted only by the master station.

2) If an information message is sub-divided into transmission blocks, ETB is used to terminate each block, with the exception of the final one.

3) ETB calls for a reply from the slave station.

4) If block checking is used, ETB indicates that the next following character is a block check character (BCC). See ISO 1155.