International Standard 7776

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Information processing systems — Data communication — High-level data link control procedures — Description of the X.25 LAPB-compatible DTE data link procedures

Systèmes de traitement de l'information — Communication de données — Procédures de commande de liaison de données à haut niveau — Description des procédures de liaison d'équipement terminal de transmission de données ETTD compatible X.25 LAPB

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work.

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. They are approved in accordance with ISO procedures requiring at least 75 % approval by the member bodies voting.

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Users should note that all International Standards undergo revision from time to time and that any reference made herein to any other International Standard implies its latest edition, unless otherwise stated.

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0 Introduction

This document provides the ISO description of the CCITT Recommendation X.25 Level 2 LAPB interface operation as viewed by the DTE. It is the DTE counterpart of the X.25 LAPB DCE description.

This document also provides the ISO description of how two DTEs are capable of communicating directly with one another at the Data Link Level using the X.25 LAPB procedures without an intervening public data network.

The data link layer provides the DTE with three basic functions:

a) link initialization: necessary for the DTE to begin communication in a known state;

b) flow control: control the flow of frames between the DTE and the other station (DCE or DTE) to ensure that they are not sent more quickly than they can be received; and

c) error control: provided in two forms:

1) a cyclic redundancy check (CRC) using a 16-bit polynomial to detect mutilated frames, and

2) use of sequence numbers to ensure against losing entire frames.

(The data link layer endeavours to ensure correct receipt of all frames by retransmission of mutilated or missing frames.)

This International Standard repeats requirements of other International Standards. An annex, which does not form an integral part, contains a list of these repeated requirements and references to the corresponding International Standards.

1 Scope and field of application

This International Standard defines an application of the following HDLC Standards: ISO 3309, ISO 4335, ISO 7478, and ISO 7809. When there is difficulty in the interpretation of a reworded requirement from one of the other International Standards, the original requirement of ISO 3309, ISO 4335, ISO 7478 or ISO 7809 is definitive. It also defines the structure, elements and procedures for the operation of a DTE using the X.25 Level 2 LAPB protocol as specified in CCITT Recommendation X.25.[1] The procedure is applicable to data interchange between a DTE and a DCE, or between two DTEs. The procedures are defined for use on synchronous, duplex links.

Clause 3 describes two frame structures: one for basic (modulo 8) operation and one for extended (modulo 128) operation. Basic (modulo 8) operation is the ISO balanced asynchronous class of procedure with optional functions 2 and 8 (BAC, 2, 8). Extended (modulo 128) operation is the ISO balanced asynchronous class of procedure with optional functions 2, 8, and 10 (BAC, 2, 8, 10). For those DTE/DCE connections that support both basic (modulo 8) operation and extended (modulo 128) operation, the choice is made at subscription-time only. For those DTE/remote DTE connections that support both basic (modulo 8) operation and extended (modulo 128) operation, the choice is made by bilateral agreement.

NOTE — The procedure herein described as basic (modulo 8) operation is the only one available in all public data networks.

Clause 4 describes the elements of procedures. Some aspects are only operable for the basic (modulo 8) operation and some for the extended (modulo 128) operation.

Clauses 5 and 6 describe the single link procedure (SLP) which is derived from the frame structure and the elements of procedures, and an optional multilink procedure (MLP), respectively. The SLP is used for data interchange over a single data link and the MLP is used for data interchange over a multiple of parallel SLPs. An MLP is required if the effects of individual SLP failures are not to disrupt the higher level operation. An MLP can also be used over a single SLP by prior bilateral agreement. For DTE/DCE connections the choice of an MLP operation or not is made at subscription-time only. For DTE/remote DTE connections, the choice is made by bilateral agreement.

Where choices among alternative actions are indicated in the procedures, a recommended choice is usually indicated. Unless specifically stated otherwise, the choice of action does not affect interoperability with other implementations of this International Standard although efficiency of operation may be affected. Where such choices do affect interoperability, the procedures explicitly state that prior bilateral agreement on the choice of procedure with the remote end is needed. An attempt has been made to minimize such choices consistent with the

1) Future revisions of this International Standard will be made in accordance with revisions of CCITT Recommendation X.25. The present version is based on the 1984 CCITT Recommendation X.25.

need to satisfy a broad range of applications. A basic requirement for all implementations of this International Standard is that they be capable of responding, as specified, to any actions taken at the remote end that are permitted by this International Standard (except possibly for those procedures whose use involves prior bilateral agreement).

2 References

ISO 3309, *Information processing systems — Data communication — High-level data link control procedures — Frame structure.*

ISO 4335, *Information processing systems — Data communication — High-level data link control procedures — Consolidation of elements of procedures.*

ISO 7478, *Information processing systems — Data communication — Multilink procedures.*[1)]

ISO 7809, *Information processing systems — Data communication — High-level data link control procedures — Consolidation of classes of procedures.*

CCITT Recommendation X.25, *Interface between data terminal equipment (DTE) and data circuit-terminating equipment (DCE) for terminals operating in the packet mode and connected to public data networks by dedicated circuit.*

3 Frame structure

All transmissions on a SLP are in frames conforming to one of the formats of table 1 for basic (modulo 8) operation, or alternatively one of the formats of table 2 for extended (modulo 128) operation. The flag preceding the address field is defined as the opening flag. The flag following the FCS field is defined as the closing flag.

All transmissions from the DCE/remote DTE are expected to use this frame structure.

Table 1 — Frame formats — Basic (modulo 8) operation

Bit order of transmission

12345678	12345678	12345678	16 to 1	12345678
Flag	**Address**	**Control**	**FCS**	**Flag**
F	A	C	FCS	F
01111110	8-bits	8-bits	16-bits	01111110

FCS = Frame Check Sequence

Bit order of transmission

12345678	12345678	12345678		16 to 1	12345678
Flag	**Address**	**Control**	**Information**	**FCS**	**Flag**
F	A	C	I	FCS	F
01111110	8-bits	8-bits	N-bits	16-bits	01111110

FCS = Frame Check Sequence

Table 2 — Frame formats — Extended (modulo 128) operation

Bit order of transmission

12345678	12345678	1 to *	16 to 1	12345678
Flag	**Address**	**Control**	**FCS**	**Flag**
F	A	C	FCS	F
01111110	8-bits	*-bits	16-bits	01111110

FCS = Frame Check Sequence

Bit order of transmission

12345678	12345678	1 to *		16 to 1	12345678
Flag	**Address**	**Control**	**Information**	**FCS**	**Flag**
F	A	C	I	FCS	F
01111110	8-bits	*-bits	N-bits	16-bits	01111110

FCS = Frame Check Sequence

* 16 for frame formats that contain sequence numbers; 8 for frame formats that do not contain sequence numbers.

1) At present at the stage of draft.

3.1 Flag sequence

All frames shall start and end with the flag sequence consisting of one "0" bit followed by six contiguous "1" bits and one "0" bit. The DTE hunts continuously for this sequence on a bit-by-bit basis, and thus uses the flag sequence for frame synchronization. The DTE/DCE/remote DTE may send one or more complete flag sequences between frames. The DTE shall only send complete eight-bit flag sequences when sending multiple flag sequences (see 3.10). A single flag may be used as both the closing flag for one frame and the opening flag for the next frame.

3.2 Address field

The address field shall consist of one octet. The address field identifies the intended receiver of a command frame and the transmitter of a response frame. The coding of the address field is described in 5.1.

3.3 Control field

For basic (modulo 8) operation, the control field shall consist of one octet. For extended (modulo 128) operation, the control field shall consist of two octets for frame formats that contain sequence numbers, and one octet for frame formats that do not contain sequence numbers. The content of this field is described in 4.1.

3.4 Information field

The information field of a frame, when present, follows the control field (see 3.3) and precedes the frame check sequence (see 3.6). (See 4.3.9 and 6.2 for the various codings and groupings of bits in the information field that are defined for use in this International Standard.) The coding and grouping of bits received from a higher layer are unrestricted, except for requirements that are imposed by the higher layer itself.

See 4.3.9 and 5.7.3 with regard to the maximum information field length.

3.5 Transparency

A DTE, when transmitting, shall examine the frame content between the two flag sequences including the address, control, information and FCS fields and shall insert a "0" bit after all sequences of five contiguous "1" bits (including the last five bits of the FCS) to ensure that a flag sequence is not simulated. A DTE, when receiving, shall examine the frame content and shall discard any "0" bit which directly follows five contiguous "1" bits.

3.6 Frame check sequence (FCS) field

The FCS field shall be a 16-bit sequence. It shall be the ones complement of the sum (modulo 2) of

a) the remainder of

$x^k (x^{15} + x^{14} + x^{13} + x^{12} + x^{11} + x^{10} + x^9 + x^8 + x^7 + x^6 + x^5 + x^4 + x^3 + x^2 + x + 1)$

divided (modulo 2) by the generator polynomial

$x^{16} + x^{12} + x^5 + 1$,

where k is the number of bits in the frame existing between, but not including, the final bit of the opening flag and the first bit of the FCS, excluding bits inserted for transparency, and

b) the remainder of the division (modulo 2) by the generator polynomial

$x^{16} + x^{12} + x^5 + 1$

of the product of x^{16} by the content of the frame existing between, but not including, the final bit of the opening flag and the first bit of the FCS, excluding bits inserted for transparency.

As a typical implementation, at the transmitter, the initial content of the register of the device computing the remainder of the division is preset to all ones and is then modified by division by the generator polynomial (as described above) of the address, control and information fields; the ones complement of the resulting remainder is transmitted as the 16-bit FCS.

At the receiver, the initial content of the register of the device computing the remainder is preset to all ones. The final remainder after multiplication by x^{16} and then division (modulo 2) by the generator polynomial

$x^{16} + x^{12} + x^5 + 1$

of the serial incoming protected bits and the FCS will be

0001110100001111 (x^{15} through x^0, respectively)

in the absence of transmission errors.

3.7 Order of bit transmission

Addresses, commands, responses and sequence numbers shall be transmitted with the low-order bit first (for example, the first bit of the sequence number that is transmitted shall have the weight 2^0).

The order of transmitting bits within the information field is specified for specific information field formats as defined elsewhere in this International Standard. The FCS shall be transmitted to the line commencing with the coefficient of the highest term, which is found in bit position 16 of the FCS field (see tables 1 and 2).

NOTE — The low-order bit is defined as bit 1, as depicted in tables 1 to 10.

3.8 Invalid frames

An invalid frame is defined as one which

a) is not properly bounded by two flags;

b) contains fewer than 32 bits between flags;

c) contains a Frame Check Sequence (FCS) error; or

d) contains an address field encoding other than that defined in 5.1.

NOTE — For those DTEs and DCEs that are octet-aligned, a detection of non-octet alignment may be made at the Data Link Level or in the higher level. Detection at the Data Link Level, while not required, is accomplished by adding a frame validity check that requires the number of bits between the opening flag and the closing flag, excluding bits inserted for transparency, to be an integral number of octets in length, or the frame is considered invalid.

3.9 Frame abortion

Aborting a frame is performed by transmitting at least seven contiguous "1" bits (with no inserted "0" bits).

3.10 Interframe time fill

Interframe time fill is accomplished by transmitting contiguous flags between frames (i.e., multiple 8-bit flag sequences).

3.11 Data link channel states

3.11.1 Active channel state

The DTE outgoing channel is in an active condition when the DTE is actively transmitting a frame, an abortion sequence or interframe time fill. The DTE incoming channel is defined to be in an active condition when the DTE is actively receiving a frame, an abortion sequence or interframe time fill.

3.11.2 Idle channel state

The DTE outgoing channel is in an idle condition when the DTE causes a continuous "1" state that persists for at least 15 bit times. The DTE incoming channel is defined to be in an idle condition when the DTE detects that a continuous "1" state has persisted for at least 15 bit times.

The action to be taken by a DCE upon detection of the idle channel state is not defined at this time. The DTE, upon detection of the idle channel state, may interpret the idle condition as an indication that the DCE is not able to support set up of the data link.

NOTE — Upon detection of the idle channel state for at least time T3, the DTE should consider the data link to be in the disconnected state. T3 is as defined in 5.7.1.3.

4 Elements of procedures

The elements of procedures are defined in terms of actions that occur at the DTE on receipt of commands from the DCE/remote DTE.

The elements of procedures specified below contain a selection of commands and responses relevant to the data link and system configuration described in clause 1.

4.1 Control field formats and state variables

4.1.1 Control field formats

The control field indicates the type of commands or responses, and contains sequence numbers where applicable.

Three types of control field formats are used to perform numbered information transfer (I format), numbered supervisory functions (S format) and unnumbered control functions (U format). The control field formats for basic (modulo 8) operation are depicted in table 3 and the control field formats for extended (modulo 128) operation are depicted in table 4.

4.1.1.1 Information transfer format — I

The I format is used by the DTE to perform an information transfer. The functions of N(S), N(R) and P are independent; i.e., each I frame shall have an N(S), an N(R) which may or may not acknowledge additional I frames received by the DTE, and a P bit that may be set to "0" or "1".

4.1.1.2 Supervisory format — S

The S format is used by the DTE to perform data link supervisory control functions such as acknowledging I frames, requesting retransmission of I frames, and requesting a temporary suspension of transmission of I frames. The functions of N(R) and P/F are independent; i.e., each supervisory frame shall have an N(R) which may or may not acknowledge additional I frames received by the DTE, and a P/F bit that may be set to "0" or "1".

4.1.1.3 Unnumbered format — U

The U format is used by the DTE to provide additional data link control functions. This format shall contain no sequence numbers, but shall include a P/F bit that may be set to "0" or "1". The unnumbered frames shall have the same control field length (one octet) in both basic (modulo 8) operation and extended (modulo 128) operation.

Table 3 — Control field formats — Basic (modulo 8) operation

Control field format	Control field bits							
	1	2	3	4	5	6	7	8
I format	0	N(S)			P	N(R)		
S format	1	0	S	S	P/F	N(R)		
U format	1	1	M	M	P/F	M	M	M

N(S) = transmitter send sequence number (bit 2 = low-order bit)

N(R) = transmitter receive sequence number (bit 6 = low-order bit)

S = supervisory function bit

M = modifier function bit

P/F = poll bit when issued as a command; final bit when issued as a response (1 = Poll/Final)

P = poll bit (1 = Poll)

Table 4 — Control field formats — Extended (modulo 128) operation

Control field format	Control field bits															
	1st octet								2nd octet							
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
I format	0	N(S)							P	N(R)						
S format	1	0	S	S	X	X	X	X	P/F	N(R)						
U format	1	1	M	M	P/F	M	M	M								

N(S) = transmitter send sequence number (bit 2 = low-order bit)

N(R) = transmitter receive sequence number (bit 10 = low-order bit)

S = supervisory function bit

M = modifier function bit

X = reserved and set to "0"

P/F = poll bit when issued as a command, final bit when issued as a response (1 = Poll/Final)

P = poll bit (1 = Poll)

4.1.2 Control field parameters

The various parameters associated with the control field formats are described below.

4.1.2.1 Modulus

Each I frame shall be sequentially numbered and may have the value 0 through modulus minus one (where "modulus" is the modulus of the sequence numbers). The modulus equals 8 or 128 and the sequence numbers cycle through the entire range.

4.1.2.2 Frame variables and sequence numbers

4.1.2.2.1 Send state variable V(S)

The DTE send state variable, V(S), denotes the sequence number of the next in-sequence I frame to be transmitted by the DTE. The send state variable can take on the value 0 through modulus minus one. The value of the DTE send state variable shall be incremented by one with each successive I frame transmission, but shall not exceed N(R) of the last received I or S frame by more than the maximum number of outstanding I frames (k). The value of k is defined in 5.7.4.

4.1.2.2.2 Send sequence number N(S)

Only I frames contain N(S), the send sequence number of transmitted I frames. Prior to transmission of an in-sequence I frame by the DTE, the value of N(S) shall be set equal to the value of the DTE send state variable.

4.1.2.2.3 Receive state variable V(R)

The DTE receive state variable denotes the sequence number of the next in-sequence I frame expected to be received by the DTE. The receive state variable can take on the value 0 through modulus minus one. The value of the DTE receive state variable shall be incremented by one on receipt of an error-free, in-sequence I frame whose send sequence number N(S) equals the DTE receive state variable.

4.1.2.2.4 Receive sequence number N(R)

All I frames and supervisory frames shall contain N(R), the expected sequence number of the next received I frame. Prior to transmission of a frame of the above types by the DTE, the value of N(R) shall be set equal to the current value of the DTE receive state variable. N(R) indicates that the transmitter of the N(R) has correctly received all I frames numbered up to N(R) – 1 inclusive.

4.1.2.2.5 Poll/Final bit P/F

All frames contain P/F, the poll/final bit. In command frames the P/F bit is referred to as the P bit. In reponse frames the P/F bit is referred to as the F bit.

4.2 Functions of the poll/final bit

The poll (P) bit set to "1" shall be used by the DTE to solicit (poll) a reponse from the DCE/remote DTE. The final (F) bit set to "1" shall be used by the DTE to indicate the response frame transmitted by the DTE as a result of a soliciting (poll) command received from the DCE/remote DTE

The use of the P/F bit is described in 5.2.

4.3 Commands and responses

The commands and responses supported by the DTE are represented in table 5 for basic (modulo 8) operation and in table 6 for extended (modulo 128) operation. For purposes of this International Standard, the supervisory function bit encoding "11" and those encodings of the modifier function bits in tables 3 and 4 not identified in tables 5 and 6 are identified as "undefined or not implemented" command and response control fields. The commands and responses in tables 5 and 6 are defined as follows:

4.3.1 Information (I) command

The function of the information (I) command shall be to transfer across a data link sequentially numbered frames containing an information field.

Table 5 — Commands and responses — Basic (modulo 8) operation

Format	Commands	Responses	Encoding 1	2	3	4	5	6	7	8
Information transfer	I (information)		0	N(S)			P	N(R)		
Supervisory	RR (receive ready)	RR (receive ready)	1	0	0	0	P/F	N(R)		
	RNR (receive not ready)	RNR (receive not ready)	1	0	1	0	P/F	N(R)		
	REJ (reject)	REJ (reject)	1	0	0	1	P/F	N(R)		
Unnumbered	SABM (set asynchronous balanced mode)		1	1	1	1	P	1	0	0
	DISC (disconnected)		1	1	0	0	P	0	1	0
		UA (unnumbered acknowledgment)	1	1	0	0	F	1	1	0
		DM (disconnected mode)	1	1	1	1	F	0	0	0
		FRMR (frame reject)	1	1	1	0	F	0	0	1

Table 6 — Commands and responses — Extended (modulo 128) operation

Format	Commands	Responses	Encoding 1	2	3	4	5	6	7	8	9	10 to 16
Information transfer	I (information)		0	N(S)							P	N(R)
Supervisory	RR (receive ready)	RR (receive ready)	1	0	0	0	0	0	0	0	P/F	N(R)
	RNR (receive not ready)	RNR (receive not ready)	1	0	1	0	0	0	0	0	P/F	N(R)
	REJ (reject)	REJ (reject)	1	0	0	1	0	0	0	0	P/F	N(R)
Unnumbered	SABM (set asychronous balanced mode extended)		1	1	1	1	P	1	0	0		
	DISC (disconnect)		1	1	0	0	P	0	1	0		
		UA (unnumbered acknowledgment)	1	1	0	0	F	1	1	0		
		DM (disconnected mode)	1	1	1	1	F	0	0	0		
		FRMR (frame reject)	1	1	1	0	F	0	0	1		

4.3.2 Receive ready (RR) command and response

The receive ready (RR) supervisory frame shall be used by the DTE to

a) indicate that the DTE is ready to receive an I frame, and

b) acknowledge previously received I frames numbered up to N(R) – 1 inclusive.

An RR frame may be used to indicate the clearance of a busy condition that was reported by the earlier transmission of an RNR frame by that same station (DTE or DCE/remote DTE). In addition to indicating the DTE status, the RR command with the P bit set to "1" may be used by the DTE to ask for the status of the DCE/remote DTE.

4.3.3 Receive not ready (RNR) command and response

The receive not ready (RNR) supervisory frame shall be used by the DTE to indicate a busy condition; i.e., temporary inability to accept additional incoming I frames. I frames numbered up to and including N(R) – 1 shall be acknowledged. I frame N(R) and subsequent I frames received, if any, shall not be acknowledged; the acceptance status of these I frames will be indicated in subsequent exchanges.

In addition to indicating the DTE status, the RNR command with the P bit set to "1" may be used to ask for the status of the DCE/remote DTE.

4.3.4 Reject (REJ) command and response

The reject (REJ) supervisory frame shall be used by the DTE to request retransmission of I frames starting with the frame numbered N(R). I frames numbered N(R) – 1 and below shall be acknowledged. Additional I frames pending initial transmission may be transmitted following the retransmitted I frame(s).

Only one REJ exception condition for a given direction of information transfer may be established at any time. The REJ exception condition shall be cleared (reset) upon the receipt of an I frame with an N(S) equal to the N(R) of the REJ frame. (A REJ frame may be retransmitted, however, if the REJ exception condition is not cleared within the acknowledgment time-limit T1, see 4.4.2.2.)

An REJ frame may be used to indicate the clearance of a busy condition that was reported by the earlier transmission of an RNR frame by that same station. In addition to indicating the DTE status, the REJ command with the P bit set to "1" may be used to ask for the status of the DCE/remote DTE.

4.3.5 Set asynchronous balanced mode (SABM) command/Set asynchronous balanced mode extended (SABME) command

The SABM unnumbered command shall be used to place the addressed DCE or DTE in an asynchronous balanced mode (ABM) information transfer phase where all command/response control fields shall be one octet in length.

The SABME unnumbered command shall be used to place the addressed DCE or DTE in an asynchronous balanced mode (ABM) information transfer phase where numbered command/response control fields shall be two octets in length, and unnumbered command/response control fields shall be one octet in length.

NOTE — For DTE/DCE connections, the mode of operation of the data link [basic (modulo 8) or extended (modulo 128)] shall be determined at subscription time and shall only be changed by going through a new subscription process. For DTE/DTE connections, the mode of operation of the data link [basic (modulo 8) or extended (modulo 128)] shall be determined by bilateral agreement.

No information field shall be permitted with the SABM or SABME command. The transmission of a SABM/SABME command shall indicate the clearance of a busy condition that was reported by the earlier transmission of an RNR frame by that same station. The DTE confirms acceptance of SABM/SABME [basic (modulo 8) operation/extended (modulo 128) operation] command by the transmission at the first opportunity of a UA response. Upon acceptance of this command, the DTE send state variable V(S) and receive state variable V(R) shall be set to "0".

Previously transmitted I frames that are unacknowledged when this command is actioned shall remain unacknowledged (i.e., they are not retransmitted following link set-up). It shall be the responsibility of a higher-level protocol (for example, Network Layer or MLP) to recover from the possible loss of the contents (data units) of such I frames.

4.3.6 Disconnect (DISC) command

The DISC unnumbered command shall be used by the DTE to terminate the mode previously set. It shall inform the DCE/remote DTE receiving the DISC command that the DTE sending the DISC command is suspending operation. No information field shall be permitted with the DISC command. Prior to actioning the command, the DCE/remote DTE receiving the DISC command shall confirm the acceptance of the DISC command by the transmission of a UA response. The DTE sending the DISC command shall enter the disconnected phase when it receives the acknowledging UA response.

Previously transmitted I frames that are unacknowledged when this command is actioned shall remain unacknowledged (i.e., they are not retransmitted following link set-up). It shall be the responsibility of a higher-level protocol (for example, Network Layer or MLP) to recover from the possible loss of the contents (data units) of such I frames.