INTERNATIONAL STANDARD

ISO/IEC 7776

Second edition
1995-07-01

Information technology — Telecommunications and information exchange between systems — High-level data link control procedures — Description of the X.25 LAPB-compatible DTE data link procedures

Technologies de l'information — Télécommunications et échange d'information entre systèmes — Procédures de commande de liaison de données de haut niveau — Description des procédures de liaison de données ETTD compatibles X.25 *LAPB*

Reference number
ISO/IEC 7776:1995(E)

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ISO/IEC Copyright Office • Case Postale 56 • CH-1211 Genève 20 • Switzerland

Printed in Switzerland

Foreword

ISO (the International Organization for Standardization) and IEC (the International Electrotechnical Commission) form the specialized system for worldwide standardization. National bodies that are members of ISO or IEC participate in the development of International Standards through technical committees established by the respective organization to deal with particular fields of technical activity. ISO and IEC technical committees collaborate in fields of mutual interest. Other international organizations, governmental and non-governmental, in liaison with ISO and IEC, also take part in the work.

In the field of information technology, ISO and IEC have established a joint technical committee, ISO/IEC JTC 1. Draft International Standards adopted by the joint technical committee are circulated to national bodies for voting. Publication as an International Standard requires approval by at least 75 % of the national bodies casting a vote.

International Standard ISO/IEC 7776 was prepared by Joint Technical Committee ISO/IEC JTC 1, *Information technology*.

This second edition cancels and replaces the first edition (ISO 7776:1986), and consolidates Amendment 1:1992, as well as Technical Corrigenda 1, 2 and 3.

Annex A forms an integral part of this International Standard. Annex B is for information only.

Introduction

This document provides the ISO/IEC description of the ITU-T Recommendation X.25 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/IEC description of how two DTEs are capable of communicating directly with one another at the Data Link layer 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 of 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. Annex B contains a list of these repeated requirements and references to the corresponding International Standards.

To evaluate conformance of a particular implementation, it is necessary to have a statement of which capabilities and options have been implemented. Such a statement is called a "Protocol Implementation Conformance Statement" (PICS), as defined in ISO/IEC 9646-1. This International Standard provides such a PICS proforma in compliance with the relevant requirements, and in accordance with the relevant guidance, given in ISO/IEC 9646-2.

Information technology — Telecommunications and information exchange between systems — High-level data link control procedures — Description of the X.25 LAPB-compatible DTE data link procedures

1 Scope

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

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/IEC balanced asynchronous class of procedure with optional functions 2 and 8 (BAC, 2, 8). Extended (modulo 128) operation is the ISO/IEC 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 3 also describes two methods for encoding the frames, as sequences of bits when synchronous transmission is used, and as sequences of octets when start/stop transmission is used. The start/stop encoding specifies optional mechanisms, for use in environments that are sensitive to transmission of octets with values that could be interpreted as ISO/IEC 646 control characters, and/or in environments that support transfer of only seven data bits per start/stop character. The choice of encoding is made by bilateral agreement, or other suitable means, to suit the data transmission characteristics of the environment.

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 layer 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

1) Future revisions of this International Standard will be made in accordance with revisions of ITU-T Recommendation X.25. The present version is based on the 1993 ITU-T Recommendation X.25

agreement on the choice of procedure with the remote end is needed. An attempt has been made to minimize such choices consistent with the 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.)

Clause 7 covers the Static Conformance requirements, the Dynamic Conformance requirements, and the Protocol Implementation Conformance Statement (PICS).

2 Normative references.

The following standards contain provisions which, through reference in this text, constitute provisions of this International Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this International Standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO/IEC 646: 1991, *Information technology — ISO 7-bit coded character set for information interchange.*

ISO/IEC 3309: 1993, *Information technology — Telecommunications and information exchange between systems — High-level data link control (HDLC) procedures — Frame structure.*

ISO/IEC 4335: 1993, *Information technology — Telecommunications and information exchange between systems — High-level data link control (HDLC) procedures — Elements of procedure.*

ISO 7478: 1987, *Information processing systems — Data communication — Multilink procedures.*

ISO/IEC 7809: 1993, *Information technology — Telecommunications and information exchange between systems — High-level data link control procedures (HDLC) — Classes of procedures.*

ISO/IEC 9646-1:1994, *Information technology — Open Systems Interconnection — Conformance testing methodology and framework — Part 1: General concepts.*

ISO/IEC 9646-2:1994, *Information technology — Open Systems Interconnection — Conformance testing methodology and framework — Part 2: Abstract Test Suite specification.*

ITU-T 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 01111110	A 8-bits	C *-bits	FCS 16-bits	F 01111110

FCS = Frame Check Sequence

Bit order of transmission

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

FCS = Frame Check Sequence

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

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.

For start/stop transmission there shall be eight (8) information bits between the start element and the stop element: the information field is therefore constrained to be octet-aligned.

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

3.5 Transparency

3.5.1 Synchronous transmission

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.

3.5.2 Start/stop transmission

Two principal levels of transparency processing are specified for use with start/stop transmission. These are seven-bit data path transparency (SBDPT), specified in 3.5.2.1, and control-escape transparency, specified in 3.5.2.2. Control-escape transparency shall always be performed. SBDPT is an option, use or non-use of which is selected for a given data link by means outside the scope of this International Standard (for example, a priori knowledge, bilateral agreement, heuristic implementation techniques). The control-escape transparency processing may optionally be extended in its application in one of the two ways specified in 3.5.2.3; use or non-use of either of these for a given data link is again selected by means outside the scope of this International Standard.

3.5.2.1 Seven-bit data path transparency

When SBDPT is selected, the content of each frame — from Address field to FCS field inclusive — shall be transferred between sender and receiver as a frame-image derived from the original frame as follows.

The sequence of octets making up the frame content is considered as divided into a sequence of contiguous seven-octet segments, with possibly a final segment having length between one and six octets inclusive. These segments are referred to as *original segments*.

The frame-image consists of a sequence of image segments defined, in one-to-one correspondence with the original segments, as follows:

a) image segments occur in the same order as the corresponding original segments;

b) each image segment is one octet longer than its original segment;

c) the first part of each image segment is a copy of its original segment, but with the most significant bit (MSB) of each octet set to zero;

d) the remaining, final, octet of each image segment has its least significant bit set to the value of the MSB of the last octet of the original segment, its next to least significant bit set to the value of the MSB of the next to last octet (if any) of the original segment, and so on;

e) in the final octet of each image segment, all higher order bits for which no corresponding octet exists in the original segment are set to zero.

NOTES

1 At the transmitter, the final octet of each image segment can be generated by shifting left the MSB of each octet in the original segment, in sequence, into an initially zero octet: this achieves the correct bit-positioning both for complete seven-octet segments and for any short segment at the end of a frame.

2 The MSB of each image-segment octet is defined as zero only for uniqueness of the mapping: because its value is known and plays no part in the reconstruction of the original segment at the receiver, it need not actually be transmitted as a zero bit value. This allows image segments to be transferred across data paths that, for example, force parity setting of the MSB of each octet.

3.5.2.2 Control-escape transparency

The following transparency mechanism shall be applied to each frame-image: a frame-image is as defined in 3.5.2.1 when SBDPT is selected, and otherwise is identical to the frame content from Address field to FCS field inclusive.

The control escape octet identifies an octet occurring within a frame-image to which the following transparency procedure is applied. The encoding of the control escape octet is:

1	2	3	4	5	6	7	8	Bit position in octet
1	0	1	1	1	1	1	0	

↑ Low order bit, first bit transmitted / received

The transmitter shall examine each octet of the frame-image between the two flag octets and shall:

a) upon the occurrence of the flag sequence or a control escape octet, complement the sixth bit of the octet, and

b) insert a control escape octet immediately preceding the octet resulting from the above, prior to transmission.

The receiver shall examine the frame-image between the two flag octets and shall, upon receipt of a control escape octet and prior to FCS calculation:

a) discard the control escape octet, and

b) restore the immediately following octet by complementing its sixth bit.

3.5.2.3 Extended transparency

The transmitter may apply the above control-escape transparency procedure (3.5.2.2) to octets in the groups defined below, in addition to the flag and control escape octets.

3.5.2.3.1 Flow-control transparency

The flow-control transparency option provide transparency processing for the DC1/XON and DC3/XOFF control characters defined in ISO/IEC 646: that is, for the octet values 1000100x and 1100100x, respectively, where the 8th bit "x" represents either "0" or "1". This has the effect of assuring that the octet stream does not contain values that could be interpreted by intermediate equipment as flow control characters (regardless of parity).

3.5.2.3.2 Control-character octet transparency

The control-character octet transparency option provides transparency processing for all octets in which both the 6th and 7th bit are "0" (i.e., xxxxx00x, where each "x" represents either "0" or "1"), and for the DELETE character octet (i.e., 1111111x, where "x" represent "0" or "1"). This has the effect of assuring that the octet stream does not contain values that could be interpreted by intermediate equipment as the control characters or DELETE character defined by ISO/IEC 646 (regardless of parity).

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 start and stop elements (start/stop transmission) and bits (synchronous transmission) or octets (start/stop transmission) 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 start and stop elements (start/stop transmission) and bits (synchronous transmission) or octets (start/stop transmission) 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 Transmission considerations

3.7.1 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 8.

3.7.2 Start/stop transmission

For start/stop transmission, each octet is delimited by a start element and a stop element. Mark-hold (continuous logical "1" state) is used for inter-octet time fill if required. Typical octet transmission is as shown in Figure 1.

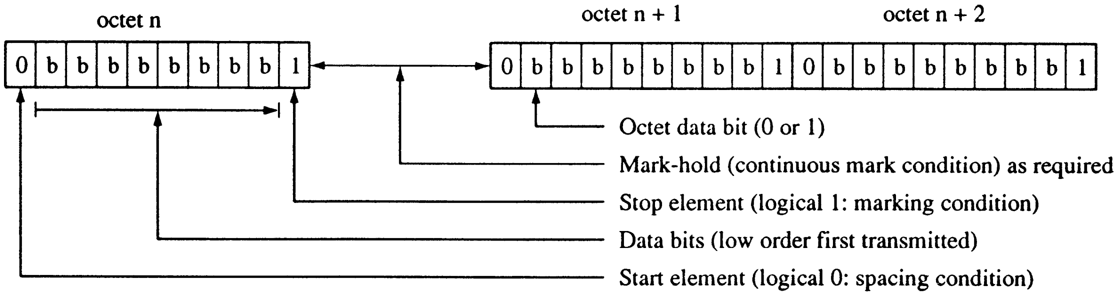

Figure 1 — Start/stop transmission

3.8 Invalid frames

3.8.1 Synchronous transmission

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 layer or in the higher layer. Detection at the Data Link layer, 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.

3.8.2 Start/stop transmission

An invalid frame is one:

a) containing fewer than four octets between flags, excluding octets inserted for transparency;

b) in which octet framing is violated (i.e., a "0" bit occurs where a stop element is expected); or

c) ending with a control escape – closing flag sequence.

3.9 Frame abortion

3.9.1 Synchronous transmission

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

3.9.2 Start/stop transmission

Aborting a frame is performed by transmitting the two-octet sequence "control escape – closing flag".

3.10 Interframe time fill

3.10.1 Synchronous transmission

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

3.10.2 Start/stop transmission

Interframe time fill is accomplished by transmitting either successive flags (with mark-hold for inter-octet time fill if required) or a continuous mark condition (logical "1" state) between frames.

3.11 Data link channel states

3.11.1 Synchronous transmission

3.11.1.1 Active channel state

The DTE outgoing channel is in 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.

3.11.1.2 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 T3, the DTE should consider the data link to be in the disconnected state. T3 is as defined in 5.7.1.3.

3.11.2 Start/stop transmission

3.11.2.1 Active channel state

The DTE outgoing channel is in active condition when the DTE is actively transmitting a frame, an abortion sequence, or interframe time fill consisting of flag octets separated by inter-octet time fill not greater than the timeout value for idle channel state (see 3.11.2.2). 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 as just specified for the outgoing channel.

3.11.2.2 Idle channel state

The DTE outgoing channel is in an idle condition when the DTE causes a continuous "1" state that persists for a period of time determined by the timeout value T5 at the DCE/remote DTE. The DTE incoming channel is defined to be in an idle condition when the DTE detects that a continuous "1" state has persisted for a period of time exceeding the DTE timeout value T5. T5 is as defined in 5.7.1.5.

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 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 response 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.

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 6 = 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)

4.1.1.1 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) and extended (modulo 128) operation.

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 response 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 response 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:

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 (disconnect)		1	1	0	0	P	0	1	0
		UA (unnumbered acknowledge)	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